TGD BASED VIEW ABOUT LIVING MATTER AND REMOTE MENTAL INTERACTIONS

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Preface

This book belongs to a series of online books summarizing the recent state Topological Geometro-dynamics (TGD) and its applications. TGD can be regarded as a unified theory of fundamental interactions but is not the kind of unified theory as so called GUTs constructed by graduate students at seventies and eighties using detailed recipes for how to reduce everything to group theory. Nowadays this activity has been completely computerized and it probably takes only a few hours to print out the predictions of this kind of unified theory as an article in the desired format. TGD is something different and I am not ashamed to confess that I have devoted the last 37 years of my life to this enterprise and am still unable to write The Rules.

If I remember correctly, I got the basic idea of Topological Geometrodynamics (TGD) during autumn 1977, perhaps it was October. What I realized was that the representability of physical space-times as 4-dimensional surfaces of some higher-dimensional space-time obtained by replacing the points of Minkowski space with some very small compact internal space could resolve the conceptual difficulties of general relativity related to the definition of the notion of energy. This belief was too optimistic and only with the advent of what I call zero energy ontology the understanding of the notion of Poincare invariance has become satisfactory. This required also the understanding of the relationship to General Relativity.

It soon became clear that the approach leads to a generalization of the notion of space-time with particles being represented by space-time surfaces with finite size so that TGD could be also seen as a generalization of the string model. Much later it became clear that this generalization is consistent with conformal invariance only if space-time is 4-dimensional and the Minkowski space factor of imbedding space is 4-dimensional. During last year it became clear that 4-D Minkowski space and 4-D complex projective space CP_2 are completely unique in the sense that they allow twistor space with Kähler structure.

It took some time to discover that also the geometrization of also gauge interactions and elementary particle quantum numbers could be possible in this framework: it took two years to find the unique internal space (CP_2) providing this geometrization involving also the realization that family replication phenomenon for fermions has a natural topological explanation in TGD framework and that the symmetries of the standard model symmetries are much more profound than pragmatic TOE builders have believed them to be. If TGD is correct, main stream particle physics chose the wrong track leading to the recent deep crisis when people decided that quarks and leptons belong to same multiplet of the gauge group implying instability of proton.

There have been also longstanding problems.

- Gravitational energy is well-defined in cosmological models but is not conserved. Hence the conservation of the inertial energy does not seem to be consistent with the Equivalence Principle. Furthermore, the imbeddings of Robertson-Walker cosmologies turned out to be vacuum extremals with respect to the inertial energy. About 25 years was needed to realize that the sign of the inertial energy can be also negative and in cosmological scales the density of inertial energy vanishes: physically acceptable universes are creatable from vacuum. Eventually this led to the notion of zero energy ontology (ZEO) which deviates dramatically from the standard ontology being however consistent with the crossing symmetry of quantum field theories. In this framework the quantum numbers are assigned with zero energy states located at the boundaries of so called causal diamonds defined as intersections of future and past directed light-cones. The notion of energy-momentum becomes length scale dependent since one has a scale hierarchy for causal diamonds. This allows to understand the non-conservation of energy as apparent.

  Equivalence Principle as it is expressed by Einstein's equations follows from Poincare invariance once it is realized that GRT space-time is obtained from the many-sheeted space-time of TGD by lumping together the space-time sheets to a regionof Minkowski space and endowing it with an effective metric given as a sum of Minkowski metric and deviations of the metrices of space-time sheets from Minkowski metric. Similar description relates classical gauge potentials identified as components of induced spinor connection to Yang-Mills gauge potentials in GRT space-time. Various topological inhomogenities below resolution scale identified as particles are described using energy momentum tensor and gauge currents.

- From the beginning it was clear that the theory predicts the presence of long ranged classical electro-weak and color gauge fields and that these fields necessarily accompany classical electromagnetic fields.

  It took about 26 years to gain the maturity to admit the obvious: these fields are classical correlates for long range color and weak interactions assignable to dark matter. The only possible conclusion is that TGD physics is a fractal consisting of an entire hierarchy of fractal copies of standard model physics. Also the understanding of electro-weak massivation and screening of weak charges has been a long standing problem, and 32 years was needed to discover that what I call weak form of electric-magnetic duality gives a satisfactory solution of the problem and provides also surprisingly powerful insights to the mathematical structure of quantum TGD.

  The latest development was the realization that the well- definedness of electromagnetic charge as quantum number for the modes of the induced spinors field requires that the CP_2 projection of the region in which they are non-vanishing carries vanishing W boson field and is 2-D. This implies in the generic case their localization to 2-D surfaces: string world sheets and possibly also partonic 2-surfaces. This localization applies to all modes except covariantly constant right handed neutrino generating supersymmetry and mplies that string model in 4-D space-time is part of TGD. Localization is possible only for Kähler-Dirac assigned with Kähler action defining the dynamics of space-time surfaces. One must however leave open the question whether W field might vanish for the space-time of GRT if related to many-sheeted space-time in the proposed manner even when they do not vanish for space-time sheets.

I started the serious attempts to construct quantum TGD after my thesis around 1982. The original optimistic hope was that path integral formalism or canonical quantization might be enough to construct the quantum theory but the first discovery made already during first year of TGD was that these formalisms might be useless due to the extreme non-linearity and enormous vacuum degeneracy of the theory. This turned out to be the case.

- It took some years to discover that the only working approach is based on the generalization of Einstein's program. Quantum physics involves the geometrization of the infinite-dimensional "world of classical worlds" (WCW) identified as 3-dimensional surfaces. Still few years had to pass before I understood that general coordinate invariance leads to a more or less unique solution of the problem and in positive energyontology implies that space-time surfaces are analogous to Bohr orbits. This in positive energy ontology in which space-like 3-surface is basic object. It is not clear whether Bohr orbitology is necessary also in ZEO in which space-time surfaces connect space-like 3-surfaces at the light-like boundaries of causal diamond CD obtained as intersection of future and past directed light-cones (with CP_2 factor included). The reason is that the pair of 3-surfaces replaces the boundary conditions at single 3-surface involving also time derivatives. If one assumes Bohr orbitology then strong correlations between the 3-surfaces at the ends of CD follow. Still a couple of years and I discovered that quantum states of the Universe can be identified as classical spinor fields in WCW. Only quantum jump remains the genuinely quantal aspect of quantum physics.

- During these years TGD led to a rather profound generalization of the space-time concept. Quite general properties of the theory led to the notion of many-sheeted space-time with sheets representing physical subsystems of various sizes. At the beginning of 90s I became dimly aware of the importance of p-adic number fields and soon ended up with the idea that p-adic thermodynamics for a conformally invariant system allows to understand elementary particle massivation with amazingly few input assumptions. The attempts to understand p-adicity from basic principles led gradually to the vision about physics as a generalized number theory as an approach complementary to the physics as an infinite-dimensional spinor geometry of WCW approach. One of its elements was a generalization of the number concept obtained by fusing real numbers and various p-adic numbers along common rationals. The number theoretical trinity involves besides p-adic number fields also quaternions and octonions and the notion of infinite prime.

- TGD inspired theory of consciousness entered the scheme after 1995 as I started to write a book about consciousness. Gradually it became difficult to say where physics ends and

consciousness theory begins since consciousness theory could be seen as a generalization of quantum measurement theory by identifying quantum jump as a moment of consciousness and by replacing the observer with the notion of self identified as a system which is conscious as long as it can avoid entanglement with environment. The somewhat cryptic statement "Everything is conscious and consciousness can be only lost" summarizes the basic philosophy neatly.

The idea about p-adic physics as physics of cognition and intentionality emerged also rather naturally and implies perhaps the most dramatic generalization of the space-time concept in which most points of p-adic space-time sheets are infinite in real sense and the projection to the real imbedding space consists of discrete set of points. One of the most fascinating outcomes was the observation that the entropy based on p-adic norm can be negative. This observation led to the vision that life can be regarded as something in the intersection of real and p-adic worlds. Negentropic entanglement has interpretation as a correlate for various positively colored aspects of conscious experience and means also the possibility of strongly correlated states stable under state function reduction and different from the conventional bound states and perhaps playing key role in the energy metabolism of living matter.

If one requires consistency of Negentropy Mazimization Pronciple with standard measurement theory, negentropic entanglement defined in terms of number theoretic negentropy is necessarily associated with a density matrix proportional to unit matrix and is maximal and is characterized by the dimension n of the unit matrix. Negentropy is positive and maximal for a p-adic unique prime dividing n.

- One of the latest threads in the evolution of ideas is not more than nine years old. Learning about the paper of Laurent Nottale about the possibility to identify planetary orbits as Bohr orbits with a gigantic value of gravitational Planck constant made once again possible to see the obvious. Dynamical quantized Planck constant is strongly suggested by quantum classical correspondence and the fact that space-time sheets identifiable as quantum coherence regions can have arbitrarily large sizes. Second motivation for the hierarchy of Planck constants comes from bio-electromagnetism suggesting that in living systems Planck constant could have large values making macroscopic quantum coherence possible. The interpretation of dark matter as a hierarchy of phases of ordinary matter characterized by the value of Planck constant is very natural.

  During summer 2010 several new insights about the mathematical structure and interpretation of TGD emerged. One of these insights was the realization that the postulated hierarchy of Planck constants might follow from the basic structure of quantum TGD. The point is that due to the extreme non-linearity of the classical action principle the correspondence between canonical momentum densities and time derivatives of the imbedding space coordinates is one-to-many and the natural description of the situation is in terms of local singular covering spaces of the imbedding space. One could speak about effective value of Planck constant $h_{eff} = n \times h$ coming as a multiple of minimal value of Planck constant. Quite recently it became clear that the non-determinism of Kähler action is indeed the fundamental justification for the hierarchy: the integer n can be also interpreted as the integer characterizing the dimension of unit matrix characterizing negentropic entanglement made possible by the many-sheeted character of the space-time surface.

  Due to conformal invariance acting as gauge symmetry the n degenerate space-time sheets must be replaced with conformal equivalence classes of space-time sheets and conformal transformations correspond to quantum critical deformations leaving the ends of space-time surfaces invariant. Conformal invariance would be broken: only the sub-algebra for which conformal weights are divisible by n act as gauge symmetries. Thus deep connections between conformal invariance related to quantum criticality, hierarchy of Planck constants, negentropic entanglement, effective p-adic topology, and non-determinism of Kähler action perhaps reflecting p-adic non-determinism emerges.

  The implications of the hierarchy of Planck constants are extremely far reaching so that the significance of the reduction of this hierarchy to the basic mathematical structure distinguishing between TGD and competing theories cannot be under-estimated.

From the point of view of particle physics the ultimate goal is of course a practical construction recipe for the S-matrix of the theory. I have myself regarded this dream as quite too ambitious taking into account how far reaching re-structuring and generalization of the basic mathematical structure of quantum physics is required. It has indeed turned out that the dream about explicit formula is unrealistic before one has understood what happens in quantum jump. Symmetries and general physical principles have turned out to be the proper guide line here. To give some impressions about what is required some highlights are in order.

- With the emergence of ZEO the notion of S-matrix was replaced with M-matrix defined between positive and negative energy parts of zero energy states. M-matrix can be interpreted as a complex square root of density matrix representable as a diagonal and positive square root of density matrix and unitary S-matrix so that quantum theory in ZEO can be said to define a square root of thermodynamics at least formally. M-matrices in turn bombine to form the rows of unitary U-matrix defined between zero energy states.

- A decisive step was the strengthening of the General Coordinate Invariance to the requirement that the formulations of the theory in terms of light-like 3-surfaces identified as 3-surfaces at which the induced metric of space-time surfaces changes its signature and in terms of space-like 3-surfaces are equivalent. This means effective 2-dimensionality in the sense that partonic 2-surfaces defined as intersections of these two kinds of surfaces plus 4-D tangent space data at partonic 2-surfaces code for the physics. Quantum classical correspondence requires the coding of the quantum numbers characterizing quantum states assigned to the partonic 2-surfaces to the geometry of space-time surface. This is achieved by adding to the modified Dirac action a measurement interaction term assigned with light-like 3-surfaces.

- The replacement of strings with light-like 3-surfaces equivalent to space-like 3-surfaces means enormous generalization of the super conformal symmetries of string models. A further generalization of these symmetries to non-local Yangian symmetries generalizing the recently discovered Yangian symmetry of $\mathcal{N} = 4$ supersymmetric Yang-Mills theories is highly suggestive. Here the replacement of point like particles with partonic 2-surfaces means the replacement of conformal symmetry of Minkowski space with infinite-dimensional super-conformal algebras. Yangian symmetry provides also a further refinement to the notion of conserved quantum numbers allowing to define them for bound states using non-local energy conserved currents.

- A further attractive idea is that quantum TGD reduces to almost topological quantum field theory. This is possible if the Kähler action for the preferred extremals defining WCW Kähler function reduces to a 3-D boundary term. This takes place if the conserved currents are so called Beltrami fields with the defining property that the coordinates associated with flow lines extend to single global coordinate variable. This ansatz together with the weak form of electric-magnetic duality reduces the Kähler action to Chern-Simons term with the condition that the 3-surfaces are extremals of Chern-Simons action subject to the constraint force defined by the weak form of electric magnetic duality. It is the latter constraint which prevents the trivialization of the theory to a topological quantum field theory. Also the identification of the Kähler function of WCW as Dirac determinant finds support as well as the description of the scattering amplitudes in terms of braids with interpretation in terms of finite measurement resolution coded to the basic structure of the solutions of field equations.

- In standard QFT Feynman diagrams provide the description of scattering amplitudes. The beauty of Feynman diagrams is that they realize unitarity automatically via the so called Cutkosky rules. In contrast to Feynman's original beliefs, Feynman diagrams and virtual particles are taken only as a convenient mathematical tool in quantum field theories. QFT approach is however plagued by UV and IR divergences and one must keep mind open for the possibility that a genuine progress might mean opening of the black box of the virtual particle.

  In TGD framework this generalization of Feynman diagrams indeed emerges unavoidably. Light-like 3-surfaces replace the lines of Feynman diagrams and vertices are replaced by 2-D partonic 2-surfaces. Zero energy ontology and the interpretation of parton orbits as light-like

"wormhole throats" suggests that virtual particle do not differ from on mass shell particles only in that the four- and three- momenta of wormhole throats fail to be parallel. The two throats of the wormhole contact defining virtual particle would contact carry on mass shell quantum numbers but for virtual particles the four-momenta need not be parallel and can also have opposite signs of energy.

The localization of the nodes of induced spinor fields to 2-D string world sheets (and possibly also to partonic 2-surfaces) implies a stringy formulation of the theory analogous to stringy variant of twistor formalism with string world sheets having interpretation as 2-braids. In TGD framework fermionic variant of twistor Grassmann formalism leads to a stringy variant of twistor diagrammatics in which basic fermions can be said to be on mass-shell but carry non-physical helicities in the internal lines. This suggests the generalization of the Yangian symmetry to infinite-dimensional super-conformal algebras.

TGD based view about quantum consciousness relies on following ideas and inputs.

- TGD inspired theory of consciousness can be seen as a generalization of quantum measurement theory by bringing in conscious observer. The basic new elements are the resolution of the basic problem of the measurement theory by the introduction of ZEO, which brings new elements also to the quantum measurement theory and leads to a view about how the arrow of time and its flow are generated. p-Adic physics brings in the notion of negentropic entanglement and Negentropy Maximization Principle provides the basic variational principle. The possibility of negentropic entanglement predicts evolution as gradual increase of negentropic resources of the Universe.

  The notion of self - at least as effective notion- emerges naturally from negentropic entanglement and from more precise view about sequence of state function reductions which now leaves invariant only the second part of zero energy state but changes the other one. The generation of "Akashic records" defined by negentropically entangled systems are in vital role in the understanding of evolution.

- CDs serve as correlates of selves and a hierarchy of selves is predicted and closely relates to the p-adic hierarchy and hierarchy of Planck constants. Subselves are interpreted as mental images of self and the sharing of mental images by fusion of subselves gives rise to a kind of stereo consciousness.

The following list gives the basic elements of TGD inspire quantum biology.

- Many-sheeted space-time allows the interpretation of the structures of macroscopic world around us in terms of space-time topology. Magnetic/field body acts as intentional agent using biological body as a sensory receptor and motor instrument and controlling biological body and inheriting its hierarchical fractal structure. Fractal hierarchy of EEGs and its variants can be seen as communication and control tools of magnetic body. Also collective levels of consciousness have a natural interpretation in terms of magnetic body. Magnetic body makes also possible entanglement in macroscopic length scales. The braiding of magnetic flux tubes makes possible topological quantum computations and provides a universal mechanism of memory. One can also undersand the real function of various information molecules and corresponding receptors by interpreting the receptors as addresses in quantum computer memory and information molecules as ends of flux tubes which attach to these receptors to form a connection in quantum web.

- Magnetic body carrying dark matter and forming an onion-like structure with layers characterized by large values of Planck constant is the key concept of TGD inspired view about Quantum Mind to biology.. Magnetic body is identified as intentional agent using biological body as sensory receptor and motor instrument. EEG and its fractal variants are identified as a communication and control tool of the magnetic body and a fractal hierarchy of analogs of EEG is predicted. Living system is identified as a kind of Indra's net with biomolecules representing the nodes of the net and magnetic flux tubes connections between then.

  The reconnection of magnetic flux tubes and phase transitions changing Planck constant and therefore the lengths of the magnetic flux tubes are identified as basic mechanisms behind

DNA replication and analogous processes and also behind the phase transitions associated with the gel phase in cell interior. The braiding of magnetic flux makes possible universal memory representation recording the motions of the basic units connected by flux tubes. Braiding also defines topological quantum computer programs updated continually by the flows of the basic units. The model of DNA as topological quantum computer is discussed as an application. In zero energy ontology the braiding actually generalize to 2-braiding for string world sheets in 4-D space-time and brings in new elements.

- Zero energy ontology (ZEO) makes possible the proposed p-adic description of intentions and cognitions and their transformations to action. Time mirror mechanism based on sending of negative energy signal to geometric past would apply to both long term memory recall, remote metabolism, and realization of intentional acting as an activity beginning in the geometric past in accordance with the findings of Libet. ZEO gives a precise content to the notion of negative energy signal in terms of zero energy state for which the arrow of geometric time is opposite to the standard one.

  The associated notion of causal diamond (CD) is essential element and assigns to elementary particles new fundamental time scales which are macroscopic: for electron the time scale is .1 seconds, the fundamental biorhythm. An essentially new element is time-like entanglement which allows to understand among other things the quantum counterparts of Boolean functions in terms of time-like entanglement in fermionic degrees of freedom.

- The assignment of dark matter with a hierarchy of Planck constants gives rise to a hierarchy of macroscopic quantum phases making possible macroscopic and macrotemporal quantum coherence and allowing to understand evolution as a gradual increase of Planck constant. The model for dark nucleons leads to a surprising conclusion: the states of nucleons correspond to DNA, RNA, tRNA, and amino-acids in a natural manner and vertebrate genetic code as correspondence between DNA and amino-acids emerges naturally. This suggests that genetic code is realized at the level of dark hadron physics and living matter in the usual sense provides a secondary representation for it. The hierarchy of Planck constants emerges from basic TGD under rather general assumptions.

- p-Adic physics can be identified as physics of cognition and intentionality. Negentropic entanglement possible for number theoretic entanglement entropy makes sense for rational (and even algebraic) entanglement and leads to the identification of life as something residing in the intersection of real and p-adic worlds. NMP respects negentropic entanglement and the attractive idea is that the experience of understanding and positively colored emotions relate to negentropic entanglement.

- Living matter as conscious hologram is one of the basic ideas of TGD inspired biology and consciousness theory. The basic objection against TGD is that the interference of classical fields is impossible in the standard sense for the reason that that classical fields are not primary dynamical variables in TGD Universe. The resolution is based on the observation that only the interference of the effects caused by these fields can be observed experimentally and that many-sheeted space-time allows to realized the summation of effects in terms of multiple topological condensations of particles to several parallel space-time sheets. One concrete implication is fractality of qualia. Qualia appear in very wide range of scales: our qualia could in fact be those of magnetic body. The proposed mechanism for the generation of qualia realizes the fractality idea.

Various anomalies of living matter have been in vital role in the development of not only TGD view about living matter but also TGD itself.

- TGD approach to living matter was strongly motivated by the findings about strange behavior of cell membrane and of cellular water, and gel behavior of cytoplasm. Also the findings about effects of ELF em fields on vertebrate brain were decisive and led to the proposal of the hierarchy of Planck constants found later to emerge naturally from the non-determinism of Kähler action. Rather satisfactorily, the other manner to introduce the hierarchy of Planck constants is in terms of gravitational Planck constant: at least in microscopic scales the equivalence of these approaches makes sense and leads to highly non-trivial predictions. The basic

testable prediction is that dark photons have cyclotron frequencies inversely proportional to their massess but universal energy spectrum in visible and UV range which corresponds to the transition energies for biomolecules so that they are ideal for biocontrol at the level of both magnetic bodies and at the level of biochemistry.

- Water is in key role in living matter and also in TGD inspired view about living matter. The anomalies of water lead to a model for dark nuclei as dark proton strings with the surprising prediction that DNA, RNA, aninoacids and even tRNA are in one-one correspondence with the resulting 3-quark states and that vertebrate genetic code emerges naturally. This leads to a vision about water as primordial lifeform still playing a vital role in living organisms. The model of water memory and homeopathy in turn generalizes to a vision about how immune system might have evolved.

- Metabolic energy is necessary for conscious information processing in living matter. This suggests that metabolism should be basically tranfer of negentropic entanglement from nutrients to the organism. ATP could be seen as a molecule of consciousness in this picture and high energy phosphate bond would make possible the transfer of negentropy.

What I have said above is strongly biased view about the recent situation in quantum TGD and its applications to biology and consciousness. This vision is single man's view and doomed to contain unrealistic elements as I know from experience. My dream is that young critical readers could take this vision seriously enough to try to demonstrate that some of its basic premises are wrong or to develop an alternative based on these or better premises. I must be however honest and tell that 37 years of TGD is a really vast bundle of thoughts and quite a challenge for anyone who is not able to cheat himself by taking the attitude of a blind believer or a light-hearted debunker trusting on the power of easy rhetoric tricks.

Matti Pitkänen

Hanko,
September 16, 2014

Acknowledgements

In the situation in which the conventional scientific communication channels are strictly closed it is important to have some loop hole through which the information about the work done can at least in principle leak to the publicity through the iron wall of the academic censorship. Without any exaggeration I can say that without the world wide web I would not have survived as a scientist nor as individual. Homepage and blog are however not enough since only the formally published result is a result in recent day science. Publishing is however impossible without a direct support from power holders- even in archives like arXiv.org.

Situation changed for five years ago as Andrew Adamatsky proposed the writing of a book about TGD when I had already got used to the thought that my work would not be published during my life time. The Prespacetime Journal and two other journals related to quantum biology and consciousness - all of them founded by Huping Hu - have provided this kind of loop holes. In particular, Dainis Zeps, Phil Gibbs, and Arkadiusz Jadczyk deserve my gratitude for their kind help in the preparation of an article series about TGD catalyzing a considerable progress in the understanding of quantum TGD. Also the viXra archive founded by Phil Gibbs and its predecessor Archive Freedom have been of great help: Victor Christianto deserves special thanks for doing the hard work needed to run Archive Freedom. Also the Neuroquantology Journal founded by Sultan Tarlaci deserves a special mention for its publication policy. And last but not least: there are people who experience as a fascinating intellectual challenge to spoil the practical working conditions of a person working with something which might be called unified theory: I am grateful for the people who have helped me to survive through the virus attacks, an activity which has taken roughly one month per year during the last half decade and given a strong hue of grey to my hair.

For a person approaching his sixty year birthday it is somewhat easier to overcome the hard feelings due to the loss of academic human rights than for an inpatient youngster. Unfortunately the economic situation has become increasingly difficult during the twenty years after the economic depression in Finland which in practice meant that Finland ceased to be a constitutional state in the strong sense of the word. It became possible to depose people like me from the society without fear about public reactions and the classification as dropout became a convenient tool of ridicule to circumvent the ethical issues. During last few years when the right wing has held the political power this trend has been steadily strengthening. In this kind of situation the concrete help from individuals has been and will be of utmost importance. Against this background it becomes obvious that this kind of work is not possible without the support from outside and I apologize for not being able to mention all the people who have helped me during these years.

Matti Pitkänen

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Chapter 1

Introduction

1.1 Motivations for the book

The latest TGD inspired articles related to quantum biology, quantum mind, and remote mental interactions were published in JNLRMI around 2003. Several new ideas related to basic TGD, TGD inspired quantum biology and theory of consciousness have emerged during the subsequent 8 years: for a short summary about the development of ideas see the article *Evolution of TGD* [L25].

My original intention was to write just single article trying to give a summary about the progress of quantum TGD first and after that I will discuss the implications for quantum TGD based view about biology, consciousness and remote mental interactions and similar anomalies.

As usually happens, also now I realized that I am not able to write this kind of short article. The amount of topics has grown during years quite large and is scattered around to several books and gradually I began to feel desperate. I simply could not decide what should I take and what should I leave. Finally I drifted to the predictable outcome: I decided to wrote several articles with topic restricted to the recent state of quantum TGD itself, TGD inspired views about consciousness, and some basic aspects of biology, neuroscience, and remote mental interactions. The decision was made easy after recalling that I had written a series of three articles to the journal Journal of Consciousness Exploration and Research founded by Huping Hu. It was rather easy to add the developments that had happened during last three years to these articles and write a new article about remote mental interactions and about testing the vision. The final step was the realization that it is natural to organize the article in a form of book.

There are other arguments in defence of book format. For a long time the basic challenge of TGD has been to give a precise meaning for heuristic ideas and loosely formulated concepts. Why this kind of approach requiring scanning through of all what one has written is so fruitful is that it forces to realize that definitions which have seemed obvious, are not at all obvious after all. At this stage when so little is known, internal consistency is an extremely valuable constraint on free imagination. Although reprocessing all this topic requires patience, it helps so identify internal inconsistencies. There has been quite a flux of ideas during last years and it is also very useful to allow them to interact.

Therefore the outcome was six articles transformed into chapters of a book. The reader should not be scared. I have tried to write these chapters so that one could read them in any order and there are links to the material at my homepage.

1.2 Basic Ideas of Topological Geometrodynamics (TGD)

Standard model describes rather successfully both electroweak and strong interactions but sees them as totally separate and contains a large number of parameters which it is not able to predict. For about four decades ago unified theories known as Grand Unified Theories (GUTs) trying to understand electroweak interactions and strong interactions as aspects of the same fundamental gauge interaction assignable to a larger symmetry group emerged. Later superstring models trying to unify even gravitation and strong and weak interactions emerged. The shortcomings of both GUTs and superstring models are now well-known. If TGD - whose basic idea emerged 37 years

ago - would emerge now it would be seen as an attempt trying to solve the difficulties of these approaches to unification.

The basic physical picture behind TGD corresponds to a fusion of two rather disparate approaches: namely TGD as a Poincare invariant theory of gravitation and TGD as a generalization of the old-fashioned string model. The CMAP files at my homepage provide an overview about ideas and evolution of TGD and make easier to understand what TGD and its applications are about (`http://www.tgdtheory.fi/cmaphtml.html` [L35]).

1.2.1 Basic vision very briefly

T(opological) G(eometro)D(ynamics) is one of the many attempts to find a unified description of basic interactions. The development of the basic ideas of TGD to a relatively stable form took time of about half decade [K2].

The basic vision and its relationship to existing theories is now rather well understood.

1. Space-times are representable as 4-surfaces in the 8-dimensional imbedding space $H = M^4 \times CP_2$, where M^4 is 4-dimensional (4-D) Minkowski space and CP_2 is 4-D complex projective space (see Appendix).

2. Induction procedure allows to geometrize various fields. Space-time metric characterizing gravitational fields corresponds to the induced metric obtained by projecting the metric tensor of H to the space-time surface. Electroweak gauge potentials are identified as projections of the components of CP_2 spinor connection to the space-time surface, and color gauge potentials as projections of CP_2 Killing vector fields representing color symmetries. Also spinor structure can be induced: induced spinor gamma matrices are projections of gamma matrices of H and induced spinor fields just H spinor fields restricted to space-time surface.

3. Geometrization of quantum numbers is achieved. The isometry group of the geometry of CP_2 codes for the color gauge symmetries of strong interactions. Vierbein group codes for electroweak symmetries, and explains their breaking in terms of CP_2 geometry so that standard model gauge group results. There are also important deviations from standard model: color quantum numbers are not spin-like but analogous to orbital angular momentum: this difference is expected to be seen only in CP_2 scale. In contrast to GUTs, quark and lepton numbers are separately conserved and family replication has a topological explanation in terms of topology of the partonic 2-surface carrying fermionic quantum numbers.

   M^4 and CP_2 are unique choices for many other reasons. For instance, they are the unique 4-D space-times allowing twistor space with Kähler structure. M^4 light-cone boundary allows a huge extension of 2-D conformal symmetries. Imbedding space H has a number theoretic interpretation as 8-D space allowing octonionic tangent space structure. M^4 and CP_2 allow quaternionic structures. Therefore standard model symmetries have number theoretic meaning.

4. Induced gauge potentials are expressible in terms of imbedding space coordinates and their gradients and general coordinate invariance implies that there are only 4 field like variables locally. Situation is thus extremely simple mathematically. The objection is that one loses linear superposition of fields. The resolution of the problem comes from the generalization of the concepts of particle and space-time.

   Space-time surfaces can be also particle like having thus finite size. In particular, space-time regions with Euclidian signature of the induced metric (temporal and spatial dimensions in the same role) emerge and have interpretation as lines of generalized Feynman diagrams. Particle in space-time can be identified as a topological inhomogenuity in background space-time surface which looks like the space-time of general relativity in long length scales.

   One ends up with a generalization of space-time surface to many-sheeted space-time with space-time sheets having extremely small distance of about 10^4 Planck lengths (CP_2 size). As one adds a particle to this kind of structure, it touches various space-time sheets and thus interacts with the associated classical fields. Their effects superpose linearly in good approximation and linear superposition of fields is replaced with that for their effects.

This resolves the basic objection. It also leads to the understanding of how the space-time of general relativity and quantum field theories emerges from TGD space-time as effective space-time when the sheets of many-sheeted space-time are lumped together to form a region of Minkowski space with metric replaced with a metric identified as the sum of empty Minkowski metric and deviations of the metrics of sheets from empty Minkowski metric. Gauge potentials are identified as sums of the induced gauge potentials. TGD is therefore a microscopic theory from which standard model and general relativity follow as a topological simplification however forcing to increase dramatically the number of fundamental field variables.

5. A further objection is that classical weak fields identified as induced gauge fields are long ranged and should cause large parity breaking effects due to weak interactions. These effects are indeed observed but only in living matter. The resolution of problem is implied by the condition that the modes of the induced spinor fields have well-defined electromagnetic charge. This forces their localization to 2-D string world sheets in the generic case having vanishing weak gauge fields so that parity breaking effects emerge just as they do in standard model. Also string model like picture emerges from TGD and one ends up with a rather concrete view about generalized Feynman diagrammatics.

The great challenge is to construct a mathematical theory around these physically very attractive ideas and I have devoted the last thirty seven years for the realization of this dream and this has resulted in eight online books about TGD and nine online books about TGD inspired theory of consciousness and of quantum biology.

1.2.2 Two manners to see TGD and their fusion

As already mentioned, TGD can be interpreted both as a modification of general relativity and generalization of string models.

TGD as a Poincare invariant theory of gravitation

The first approach was born as an attempt to construct a Poincare invariant theory of gravitation. Space-time, rather than being an abstract manifold endowed with a pseudo-Riemannian structure, is regarded as a surface in the 8-dimensional space $H = M^4_{\times} CP_2$, where M^4 denotes Minkowski space and $CP_2 = SU(3)/U(2)$ is the complex projective space of two complex dimensions [A29, A15, A22, A13].

The identification of the space-time as a sub-manifold [A11, A28] of $M^4 \times CP_2$ leads to an exact Poincare invariance and solves the conceptual difficulties related to the definition of the energy-momentum in General Relativity.

It soon however turned out that sub-manifold geometry, being considerably richer in structure than the abstract manifold geometry, leads to a geometrization of all basic interactions. First, the geometrization of the elementary particle quantum numbers is achieved. The geometry of CP_2 explains electro-weak and color quantum numbers. The different H-chiralities of H-spinors correspond to the conserved baryon and lepton numbers. Secondly, the geometrization of the field concept results. The projections of the CP_2 spinor connection, Killing vector fields of CP_2 and of H-metric to four-surface define classical electro-weak, color gauge fields and metric in X^4.

The choice of H is unique from the condition that TGD has standard model symmetries. Also number theoretical vision selects $H = M^4 \times CP_2$ uniquely. M^4 and CP_2 are also unique spaces allowing twistor space with Kähler structure.

TGD as a generalization of the hadronic string model

The second approach was based on the generalization of the mesonic string model describing mesons as strings with quarks attached to the ends of the string. In the 3-dimensional generalization 3-surfaces correspond to free particles and the boundaries of the 3- surface correspond to partons in the sense that the quantum numbers of the elementary particles reside on the boundaries. Various boundary topologies (number of handles) correspond to various fermion families so that one obtains an explanation for the known elementary particle quantum numbers. This approach

leads also to a natural topological description of the particle reactions as topology changes: for instance, two-particle decay corresponds to a decay of a 3-surface to two disjoint 3-surfaces.

This decay vertex does not however correspond to a direct generalization of trouser vertex of string models. Indeed, the important difference between TGD and string models is that the analogs of string world sheet diagrams do not describe particle decays but the propagation of particles via different routes. Particle reactions are described by generalized Feynman diagrams for which 3-D light-like surface describing particle propagating join along their ends at vertices. As 4-manifolds the space-time surfaces are therefore singular like Feynman diagrams as 1-manifolds.

Fusion of the two approaches via a generalization of the space-time concept

The problem is that the two approaches to TGD seem to be mutually exclusive since the orbit of a particle like 3-surface defines 4-dimensional surface, which differs drastically from the topologically trivial macroscopic space-time of General Relativity. The unification of these approaches forces a considerable generalization of the conventional space-time concept. First, the topologically trivial 3-space of General Relativity is replaced with a "topological condensate" containing matter as particle like 3-surfaces "glued" to the topologically trivial background 3-space by connected sum operation. Secondly, the assumption about connectedness of the 3-space is given up. Besides the "topological condensate" there could be "vapor phase" that is a "gas" of particle like 3-surfaces and string like objects (counterpart of the "baby universes" of GRT) and the non-conservation of energy in GRT corresponds to the transfer of energy between different sheets of the space-time and possibly existence vapour phase.

What one obtains is what I have christened as many-sheeted space-time (see fig. `http://www.tgdtheory.fi/appfigures/manysheeted.jpg` or fig. 9 in the appendix of this book). One particular aspect is topological field quantization meaning that various classical fields assignable to a physical system correspond to space-time sheets representing the classical fields to that particular system. One can speak of the field body of a particular physical system. Field body consists of topological light rays, and electric and magnetic flux quanta. In Maxwell's theory system does not possess this kind of field identity. The notion of magnetic body is one of the key players in TGD inspired theory of consciousness and quantum biology.

This picture became more detailed with the advent of zero energy ontology (ZEO). The basic notion of ZEO is causal diamond (CD) identified as the Cartesian product of CP_2 and of the intersection of future and past directed light-cones and having scale coming as an integer multiple of CP_2 size is fundamental. CDs form a fractal hierarchy and zero energy states decompose to products of positive and negative energy parts assignable to the opposite boundaries of CD defining the ends of the space-time surface. The counterpart of zero energy state in positive energy ontology is the pair of initial and final states of a physical event, say particle reaction.

At space-time level ZEO means that 3-surfaces are pairs of space-like 3-surfaces at the opposite light-like boundaries of CD. Since the extremals of Kähler action connect these, one can say that by holography the basic dynamical objects are the space-time surface connecting these 3-surfaces. This changes totally the vision about notions like self-organization: self-organization by quantum jumps does not take for a 3-D system but for the entire 4-D field pattern associated with it.

General Coordinate Invariance (GCI) allows to identify the basic dynamical objects as space-like 3-surfaces at the ends of space-time surface at boundaries of CD: this means that space-time surface is analogous to Bohr orbit. An alternative identification is as light-like 3-surfaces at which the signature of the induced metric changes from Minkowskian to Euclidian and interpreted as lines of generalized Feynman diagrams. Also the Euclidian 4-D regions would have similar interpretation. The requirement that the two interpretations are equivalent, leads to a strong form of General Coordinate Invariance. The outcome is effective 2-dimensionality stating that the partonic 2-surfaces identified as intersections of the space-like ends of space-time surface and light-like wormhole throats are the fundamental objects. That only effective 2-dimensionality is in question is due to the effects caused by the failure of strict determinism of Kähler action. In finite length scale resolution these effects can be neglected below UV cutoff and above IR cutoff. One can also speak about strong form of holography.

1.2.3   Basic objections

Objections are the most powerful tool in theory building. The strongest objection against TGD is the observation that all classical gauge fields are expressible in terms of four imbedding space coordinates only- essentially CP_2 coordinates. The linear superposition of classical gauge fields taking place independently for all gauge fields is lost. This would be a catastrophe without many-sheeted space-time. Instead of gauge fields, only the effects such as gauge forces are superposed. Particle topologically condenses to several space-time sheets simultaneously and experiences the sum of gauge forces. This transforms the weakness to extreme economy: in a typical unified theory the number of primary field variables is countered in hundreds if not thousands, now it is just four.

Second objection is that TGD space-time is quite too simple as compared to GRT space-time due to the imbeddability to 8-D imbedding space. One can also argue that Poincare invariant theory of gravitation cannot be consistent with General Relativity. The above interpretation allows to understand the relationship to GRT space-time and how Equivalence Principle (EP) follows from Poincare invariance of TGD. The interpretation of GRT space-time is as effective space-time obtained by replacing many-sheeted space-time with Minkowski space with effective metric determined as a sum of Minkowski metric and sum over the deviations of the induced metrices of space-time sheets from Minkowski metric. Poincare invariance suggests strongly classical EP for the GRT limit in long length scales at least. One can consider also other kinds of limits such as the analog of GRT limit for Euclidian space-time regions assignable to elementary particles. In this case deformations of CP_2 metric define a natural starting point and CP_2 indeed defines a gravitational instanton with very large cosmological constant in Einstein-Maxwell theory. Also gauge potentials of standard model correspond classically to superpositions of induced gauge potentials over space-time sheets.

Topological field quantization

Topological field quantization distinguishes between TGD based and more standard - say Maxwellian - notion of field. In Maxwell's fields created by separate systems superpose and one cannot tell which part of field comes from which system except theoretically. In TGD these fields correspond to different space-time sheets and only their effects on test particle superpose. Hence physical systems have well-defined field identifies - field bodies - in particular magnetic bodies.

The notion of magnetic body carrying dark matter with non-standard large value of Planck constant has become central concept in TGD inspired theory of consciousness and living matter, and by starting from various anomalies of biology one ends up to a rather detailed view about the role of magnetic body as intentional agent receiving sensory input from the biological body and controlling it using EEG and its various scaled up variants as a communication tool. Among other thins this leads to models for cell membrane, nerve pulse, and EEG.

1.2.4   p-Adic variants of space-time surfaces

There is a further generalization of the space-time concept inspired by p-adic physics forcing a generalization of the number concept through the fusion of real numbers and various p-adic number fields. Also the hierarchy of Planck constants forces a generalization of the notion of space-time but this generalization can be understood in terms of the failure of strict determinism for Kähler action defining the fundamental variational principle behind the dynamics of space-time surfaces.

A very concise manner to express how TGD differs from Special and General Relativities could be following. Relativity Principle (Poincare Invariance), General Coordinate Invariance, and Equivalence Principle remain true. What is new is the notion of sub-manifold geometry: this allows to realize Poincare Invariance and geometrize gravitation simultaneously. This notion also allows a geometrization of known fundamental interactions and is an essential element of all applications of TGD ranging from Planck length to cosmological scales. Sub-manifold geometry is also crucial in the applications of TGD to biology and consciousness theory.

1.2.5   The threads in the development of quantum TGD

The development of TGD has involved several strongly interacting threads: physics as infinite-dimensional geometry; TGD as a generalized number theory, the hierarchy of Planck constants

interpreted in terms of dark matter hierarchy, and TGD inspired theory of consciousness. In the following these threads are briefly described.

The theoretical framework involves several threads.

1. Quantum T(opological) G(eometro)D(ynamics) as a classical spinor geometry for infinite-dimensional WCW, p-adic numbers and quantum TGD, and TGD inspired theory of consciousness and of quantum biology have been for last decade of the second millenium the basic three strongly interacting threads in the tapestry of quantum TGD.

2. The discussions with Tony Smith initiated a fourth thread which deserves the name 'TGD as a generalized number theory'. The basic observation was that classical number fields might allow a deeper formulation of quantum TGD. The work with Riemann hypothesis made time ripe for realization that the notion of infinite primes could provide, not only a reformulation, but a deep generalization of quantum TGD. This led to a thorough and extremely fruitful revision of the basic views about what the final form and physical content of quantum TGD might be. Together with the vision about the fusion of p-adic and real physics to a larger coherent structure these sub-threads fused to the "physics as generalized number theory" thread.

3. A further thread emerged from the realization that by quantum classical correspondence TGD predicts an infinite hierarchy of macroscopic quantum systems with increasing sizes, that it is not at all clear whether standard quantum mechanics can accommodate this hierarchy, and that a dynamical quantized Planck constant might be necessary and strongly suggested by the failure of strict determinism for the fundamental variational principle. The identification of hierarchy of Planck constants labelling phases of dark matter would be natural. This also led to a solution of a long standing puzzle: what is the proper interpretation of the predicted fractal hierarchy of long ranged classical electro-weak and color gauge fields. Quantum classical correspondences allows only single answer: there is infinite hierarchy of p-adically scaled up variants of standard model physics and for each of them also dark hierarchy. Thus TGD Universe would be fractal in very abstract and deep sense.

The chronology based identification of the threads is quite natural but not logical and it is much more logical to see p-adic physics, the ideas related to classical number fields, and infinite primes as sub-threads of a thread which might be called "physics as a generalized number theory". In the following I adopt this view. This reduces the number of threads to four.

TGD forces the generalization of physics to a quantum theory of consciousness, and represent TGD as a generalized number theory vision leads naturally to the emergence of p-adic physics as physics of cognitive representations. The eight online books [K96, K71, K55, K117, K83, K116, K115, K82] about TGD and nine online books about TGD inspired theory of consciousness and of quantum biology [K88, K11, K62, K9, K35, K42, K46, K81, K109] are warmly recommended to the interested reader.

Quantum TGD as spinor geometry of World of Classical Worlds

A turning point in the attempts to formulate a mathematical theory was reached after seven years from the birth of TGD. The great insight was "Do not quantize". The basic ingredients to the new approach have served as the basic philosophy for the attempt to construct Quantum TGD since then and have been the following ones:

1. Quantum theory for extended particles is free(!), classical(!) field theory for a generalized Schrödinger amplitude in the configuration space CH ("world of classical worlds",WCW) consisting of all possible 3-surfaces in H. "All possible" means that surfaces with arbitrary many disjoint components and with arbitrary internal topology and also singular surfaces topologically intermediate between two different manifold topologies are included. Particle reactions are identified as topology changes [A21, A31, A32]. For instance, the decay of a 3-surface to two 3-surfaces corresponds to the decay $A \to B + C$. Classically this corresponds to a path of WCW leading from 1-particle sector to 2-particle sector. At quantum level this corresponds to the dispersion of the generalized Schrödinger amplitude localized to 1-particle

sector to two-particle sector. All coupling constants should result as predictions of the theory since no nonlinearities are introduced.

2. During years this naive and very rough vision has of course developed a lot and is not anymore quite equivalent with the original insight. In particular, the space-time correlates of Feynman graphs have emerged from theory as Euclidian space-time regions and the strong form of General Coordinate Invariance has led to a rather detailed and in many respects unexpected visions. This picture forces to give up the idea about smooth space-time surfaces and replace space-time surface with a generalization of Feynman diagram in which vertices represent the failure of manifold property. I have also introduced the word "world of classical worlds" (WCW) instead of rather formal "configuration space". I hope that "WCW" does not induce despair in the reader having tendency to think about the technicalities involved!

3. WCW is endowed with metric and spinor structure so that one can define various metric related differential operators, say Dirac operator, appearing in the field equations of the theory [1]. The most ambitious dream is that zero energy states correspond to a complete solution basis for the Dirac operator of WCW so that this classical free field theory would dictate M-matrices defined between positive and negative energy parts of zero energy states which form orthonormal rows of what I call U-matrix as a matrix defined between zero energy states. Given M-matrix in turn would decompose to a product of a hermitian density matrix and unitary S-matrix.

   M-matrix would define time-like entanglement coefficients between positive and negative energy parts of zero energy states (all net quantum numbers vanish for them) and can be regarded as a hermitian square root of density matrix multiplied by a unitary S-matrix. Quantum theory would be in well-defined sense a square root of thermodynamics. The orthogonality and hermiticity of the complex square roots of density matrices commuting with S-matrix means that they span infinite-dimensional Lie algebra acting as symmetries of the S-matrix. Therefore quantum TGD would reduce to group theory in well-defined sense: its own symmetries would define the symmetries of the theory. In fact the Lie algebra of Hermitian M-matrices extends to Kac-Moody type algebra obtained by multiplying hermitian square roots of density matrices with powers of the S-matrix. Also the analog of Yangian algebra involving only non-negative powers of S-matrix is possible.

4. By quantum classical correspondence the construction of WCW spinor structure reduces to the second quantization of the induced spinor fields at space-time surface. The basic action is so called modified Dirac action (or Kähler-Dirac action) in which gamma matrices are replaced with the modified (Kähler-Dirac) gamma matrices defined as contractions of the canonical momentum currents with the imbedding space gamma matrices. In this manner one achieves super-conformal symmetry and conservation of fermionic currents among other things and consistent Dirac equation. The modified gamma matrices define as anticommutators effective metric, which might provide geometrization for some basic observables of condensed matter physics. One might also talk about bosonic emergence in accordance with the prediction that the gauge bosons and graviton are expressible in terms of bound states of fermion and anti-fermion.

5. An important result relates to the notion of induced spinor connection. If one requires that spinor modes have well-defined em charge, one must assume that the modes in the generic situation are localized at 2-D surfaces - string world sheets or perhaps also partonic 2-surfaces - at which classical W boson fields vanish. Covariantly constant right handed neutrino generating super-symmetries forms an exception. The vanishing of also Z^0 field is possible for Kähler-Dirac action and should hold true at least above weak length scales. This implies that string model in 4-D space-time becomes part of TGD. Without these conditions classical weak fields can vanish above weak scale only for the GRT limit of TGD for which gauge potentials are sums over those for space-time sheets.

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[1]There are four kinds of Dirac operators in TGD. WCW Dirac operator appearing in Super-Virasoro conditions, imbedding space Dirac operator whose modes define the ground states of Super-Virasoro representations, Kähler-Dirac operator at space-time surfaces, and the algebraic variant of M^4 Dirac operator appearing in propagators

The localization simplifies enormously the mathematics and one can solve exactly the Kähler-Dirac equation for the modes of the induced spinor field just like in super string models.

At the light-like 3-surfaces at which the signature of the induced metric changes from Euclidian to Minkowskian so that $\sqrt{g_4}$ vanishes one can pose the condition that the algebraic analog of massless Dirac equation is satisfied by the nodes so that Kähler-Dirac action gives massless Dirac propagator localizable at the boundaries of the string world sheets.

The evolution of these basic ideas has been rather slow but has gradually led to a rather beautiful vision. One of the key problems has been the definition of Kähler function. Kähler function is Kähler action for a preferred extremal assignable to a given 3-surface but what this preferred extremal is? The obvious first guess was as absolute minimum of Kähler action but could not be proven to be right or wrong. One big step in the progress was boosted by the idea that TGD should reduce to almost topological QFT in which braids would replace 3-surfaces in finite measurement resolution, which could be inherent property of the theory itself and imply discretization at partonic 2-surfaces with discrete points carrying fermion number.

1. TGD as almost topological QFT vision suggests that Kähler action for preferred extremals reduces to Chern-Simons term assigned with space-like 3-surfaces at the ends of space-time (recall the notion of causal diamond (CD)) and with the light-like 3-surfaces at which the signature of the induced metric changes from Minkowskian to Euclidian. Minkowskian and Euclidian regions would give at wormhole throats the same contribution apart from coefficients and in Minkowskian regions the $\sqrt{g_4}$ factorc coming from metric would be imaginary so that one would obtain sum of real term identifiable as Kähler function and imaginary term identifiable as the ordinary Minkowskian action giving rise to interference effects and stationary phase approximation central in both classical and quantum field theory.

   Imaginary contribution - the presence of which I realized only after 33 years of TGD - could also have topological interpretation as a Morse function. On physical side the emergence of Euclidian space-time regions is something completely new and leads to a dramatic modification of the ideas about black hole interior.

2. The manner to achieve the reduction to Chern-Simons terms is simple. The vanishing of Coulomb contribution to Kähler action is required and is true for all known extremals if one makes a general ansatz about the form of classical conserved currents. The so called weak form of electric-magnetic duality defines a boundary condition reducing the resulting 3-D terms to Chern-Simons terms. In this manner almost topological QFT results. But only "almost" since the Lagrange multiplier term forcing electric-magnetic duality implies that Chern-Simons action for preferred extremals depends on metric.

TGD as a generalized number theory

Quantum T(opological)D(ynamics) as a classical spinor geometry for infinite-dimensional configuration space ("world of classical worldss", WCW), p-adic numbers and quantum TGD, and TGD inspired theory of consciousness, have been for last ten years the basic three strongly interacting threads in the tapestry of quantum TGD. The fourth thread deserves the name 'TGD as a generalized number theory'. It involves three separate threads: the fusion of real and various p-adic physics to a single coherent whole by requiring number theoretic universality discussed already, the formulation of quantum TGD in terms of hyper-counterparts of classical number fields identified as sub-spaces of complexified classical number fields with Minkowskian signature of the metric defined by the complexified inner product, and the notion of infinite prime.

1. p-Adic TGD and fusion of real and p-adic physics to single coherent whole

The p-adic thread emerged for roughly ten years ago as a dim hunch that p-adic numbers might be important for TGD. Experimentation with p-adic numbers led to the notion of canonical identification mapping reals to p-adics and vice versa. The breakthrough came with the successful p-adic mass calculations using p-adic thermodynamics for Super-Virasoro representations with the super-Kac-Moody algebra associated with a Lie-group containing standard model gauge group. Although the details of the calculations have varied from year to year, it was clear that p-adic

physics reduces not only the ratio of proton and Planck mass, the great mystery number of physics, but all elementary particle mass scales, to number theory if one assumes that primes near prime powers of two are in a physically favored position. Why this is the case, became one of the key puzzles and led to a number of arguments with a common gist: evolution is present already at the elementary particle level and the primes allowed by the p-adic length scale hypothesis are the fittest ones.

It became very soon clear that p-adic topology is not something emerging in Planck length scale as often believed, but that there is an infinite hierarchy of p-adic physics characterized by p-adic length scales varying to even cosmological length scales. The idea about the connection of p-adics with cognition motivated already the first attempts to understand the role of the p-adics and inspired 'Universe as Computer' vision but time was not ripe to develop this idea to anything concrete (p-adic numbers are however in a central role in TGD inspired theory of consciousness). It became however obvious that the p-adic length scale hierarchy somehow corresponds to a hierarchy of intelligences and that p-adic prime serves as a kind of intelligence quotient. Ironically, the almost obvious idea about p-adic regions as cognitive regions of space-time providing cognitive representations for real regions had to wait for almost a decade for the access into my consciousness.

In string model context one tries to reduces the physics to Planck scale. The price is the inability to say anything about physics in long length scales. In TGD p-adic physics takes care of this shortcoming by predicting the physics also in long length scales.

There were many interpretational and technical questions crying for a definite answer.

1. What is the relationship of p-adic non-determinism to the classical non-determinism of the basic field equations of TGD? Are the p-adic space-time region genuinely p-adic or does p-adic topology only serve as an effective topology? If p-adic physics is direct image of real physics, how the mapping relating them is constructed so that it respects various symmetries? Is the basic physics p-adic or real (also real TGD seems to be free of divergences) or both? If it is both, how should one glue the physics in different number field together to get *the* Physics? Should one perform p-adicization also at the level of the WCW? Certainly the p-adicization at the level of super-conformal representation is necessary for the p-adic mass calculations.

2. Perhaps the most basic and most irritating technical problem was how to precisely define p-adic definite integral which is a crucial element of any variational principle based formulation of the field equations. Here the frustration was not due to the lack of solution but due to the too large number of solutions to the problem, a clear symptom for the sad fact that clever inventions rather than real discoveries might be in question. Quite recently I however learned that the problem of making sense about p-adic integration has been for decades central problem in the frontier of mathematics and a lot of profound work has been done along same intuitive lines as I have proceeded in TGD framework. The basic idea is certainly the notion of algebraic continuation from the world of rationals belonging to the intersection of real world and various p-adic worlds.

   The notion of p-adic manifold [K119] identified as p-adic space-time surface solving p-adic analogs of field equations and having real space-time sheets as chart maps provides a possible solution of the basic challenge. One can also speak of real space-time surfaces having p-adic space-time surfaces as chart maps (cognitive maps, "thought bubbles"). Discretization required having interpretation in terms of finite measurement resolution is unavoidable in this approach.

Despite various uncertainties, the number of the applications of the poorly defined p-adic physics has grown steadily and the applications turned out to be relatively stable so that it was clear that the solution to these problems must exist. It became only gradually clear that the solution of the problems might require going down to a deeper level than that represented by reals and p-adics.

The key challenge is to fuse various p-adic physics and real physics to single larger structures. This has inspired a proposal for a generalization of the notion of number field by fusing real numbers and various p-adic number fields and their extensions along rationals and possible common algebraic numbers. This leads to a generalization of the notions of imbedding space and space-time concept and one can speak about real and p-adic space-time sheets. The quantum dynamics should be such that it allows quantum transitions transforming space-time sheets belonging to different number

fields to each other. The space-time sheets in the intersection of real and p-adic worlds are of special interest and the hypothesis is that living matter resides in this intersection. This leads to surprisingly detailed predictions and far reaching conjectures. For instance, the number theoretic generalization of entropy concept allows negentropic entanglement central for the applications to living matter (see fig. `http://www.tgdtheory.fi/appfigures/cat.jpg` or fig. 21 in the appendix of this book).

The basic principle is number theoretic universality stating roughly that the physics in various number fields can be obtained as completion of rational number based physics to various number fields. Rational number based physics would in turn describe physics in finite measurement resolution and cognitive resolution. The notion of finite measurement resolution has become one of the basic principles of quantum TGD and leads to the notions of braids as representatives of 3-surfaces and inclusions of hyper-finite factors as a representation for finite measurement resolution. The braids actually co-emerge with string world sheets implied by the condition that em charge is well-defined for spinor modes.

2. The role of classical number fields

The vision about the physical role of the classical number fields relies on certain speculative questions inspired by the idea that space-time dynamics could be reduced to associativity or co-associativity condition. Associativity means here associativity of tangent spaces of space-time region and co-associativity associativity of normal spaces of space-time region.

1. Could space-time surfaces X^4 be regarded as associative or co-associative ("quaternionic" is equivalent with "associative") surfaces of H endowed with octonionic structure in the sense that tangent space of space-time surface would be associative (co-associative with normal space associative) sub-space of octonions at each point of X^4 [K86]. This is certainly possible and an interesting conjecture is that the preferred extremals of Kähler action include associative and co-associative space-time regions.

2. Could the notion of compactification generalize to that of number theoretic compactification in the sense that one can map associative (co-associative) surfaces of M^8 regarded as octonionic linear space to surfaces in $M^4 \times CP_2$ [K86]? This conjecture - $M^8 - H$ duality - would give for $M^4 \times CP_2$ deep number theoretic meaning. CP_2 would parametrize associative planes of octonion space containing fixed complex plane $M^2 \subset M^8$ and CP_2 point would thus characterize the tangent space of $X^4 \subset M^8$. The point of M^4 would be obtained by projecting the point of $X^4 \subset M^8$ to a point of M^4 identified as tangent space of X^4. This would guarantee that the dimension of space-time surface in H would be four. The conjecture is that the preferred extremals of Kähler action include these surfaces.

3. $M^8 - H$ duality can be generalized to a duality $H \to H$ if the images of the associative surface in M^8 is associative surface in H. One can start from associative surface of H and assume that it contains the preferred M^2 tangent plane in 8-D tangent space of H or integrable distribution $M^2(x)$ of them, and its points to H by mapping M^4 projection of H point to itself and associative tangent space to CP_2 point. This point need not be the original one! If the resulting surface is also associative, one can iterate the process indefinitely. WCW would be a category with one object.

4. G_2 defines the automorphism group of octonions, and one might hope that the maps of octonions to octonions such that the action of Jacobian in the tangent space of associative or co-associative surface reduces to that of G_2 could produce new associative/co-associative surfaces. The action of G_2 would be analogous to that of gauge group.

5. One can also ask whether the notions of commutativity and co-commutativity could have physical meaning. The well-definedness of em charge as quantum number for the modes of the induced spinor field requires their localization to 2-D surfaces (right-handed neutrino is an exception) - string world sheets and partonic 2-surfaces. This can be possible only for Kähler action and could have commutativity and co-commutativity as a number theoretic counterpart. The basic vision would be that the dynamics of Kähler action realizes number theoretical geometrical notions like associativity and commutativity and their co-notions.

The notion of number theoretic compactification stating that space-time surfaces can be regarded as surfaces of either M^8 or $M^4 \times CP_2$. As surfaces of M^8 identifiable as space of hyper-octonions they are hyper-quaternionic or co-hyper-quaternionic- and thus maximally associative or co-associative. This means that their tangent space is either hyper-quaternionic plane of M^8 or an orthogonal complement of such a plane. These surface can be mapped in natural manner to surfaces in $M^4 \times CP_2$ [K86] provided one can assign to each point of tangent space a hyper-complex plane $M^2(x) \subset M^4 \subset M^8$. One can also speak about $M^8 - H$ duality.

This vision has very strong predictive power. It predicts that the preferred extremals of Kähler action correspond to either hyper-quaternionic or co-hyper-quaternionic surfaces such that one can assign to tangent space at each point of space-time surface a hyper-complex plane $M^2(x) \subset M^4$. As a consequence, the M^4 projection of space-time surface at each point contains $M^2(x)$ and its orthogonal complement. These distributions are integrable implying that space-time surface allows dual slicings defined by string world sheets Y^2 and partonic 2-surfaces X^2. The existence of this kind of slicing was earlier deduced from the study of extremals of Kähler action and christened as Hamilton-Jacobi structure. The physical interpretation of $M^2(x)$ is as the space of non-physical polarizations and the plane of local 4-momentum.

Number theoretical compactification has inspired large number of conjectures. This includes dual formulations of TGD as Minkowskian and Euclidian string model type theories, the precise identification of preferred extremals of Kähler action as extremals for which second variation vanishes (at least for deformations representing dynamical symmetries) and thus providing space-time correlate for quantum criticality, the notion of number theoretic braid implied by the basic dynamics of Kähler action and crucial for precise construction of quantum TGD as almost-topological QFT, the construction of WCW metric and spinor structure in terms of second quantized induced spinor fields with modified Dirac action defined by Kähler action realizing the notion of finite measurement resolution and a connection with inclusions of hyper-finite factors of type II_1 about which Clifford algebra of WCW represents an example.

The two most important number theoretic conjectures relate to the preferred extremals of Kähler action. The general idea is that classical dynamics for the preferred extremals of Kähler action should reduce to number theory: space-time surfaces should be either associative or co-associative in some sense.

Associativity (co-associativity) would be that tangent (normal) spaces of space-time surfaces associative (co-associative) in some sense and thus quaternionic (co-quaternionic). This can be formulated in two manners.

1. One can introduce octonionic tangent space basis by assigning to the "free" gamma matrices octonion basis or in terms of octonionic representation of the imbedding space gamma matrices possible in dimension $D = 8$.

2. Associativity (quaternionicity) would state that the projections of octonionic basic vectors or induced gamma matrices basis to the space-time surface generates associative (quaternionic) sub-algebra at each space-time point. Co-associativity is defined in analogous manner and can be expressed in terms of the components of second fundamental form.

3. For gamma matrix option induced rather than modified gamma matrices must be in question since modified gamma matrices can span lower than 4-dimensional space and are not parallel to the space-time surfaces as imbedding space vectors.

3. Infinite primes

The discovery of the hierarchy of infinite primes and their correspondence with a hierarchy defined by a repeatedly second quantized arithmetic quantum field theory gave a further boost for the speculations about TGD as a generalized number theory.

After the realization that infinite primes can be mapped to polynomials possibly representable as surfaces geometrically, it was clear how TGD might be formulated as a generalized number theory with infinite primes forming the bridge between classical and quantum such that real numbers, p-adic numbers, and various generalizations of p-adics emerge dynamically from algebraic physics as various completions of the algebraic extensions of rational (hyper-)quaternions and (hyper-)octonions. Complete algebraic, topological and dimensional democracy would characterize the theory.

What is especially interesting is that p-adic and real regions of the space-time surface might aso emerge automatically as solutions of the field equations. In the space-time regions where the solutions of field equations give rise to in-admissible complex values of the imbedding space coordinates, p-adic solution can exist for some values of the p-adic prime. The characteristic non-determinism of the p-adic differential equations suggests strongly that p-adic regions correspond to 'mind stuff', the regions of space-time where cognitive representations reside. This interpretation implies that p-adic physics is physics of cognition. Since Nature is probably a brilliant simulator of Nature, the natural idea is to study the p-adic physics of the cognitive representations to derive information about the real physics. This view encouraged by TGD inspired theory of consciousness clarifies difficult interpretational issues and provides a clear interpretation for the predictions of p-adic physics.

1.2.6 Hierarchy of Planck constants and dark matter hierarchy

By quantum classical correspondence space-time sheets can be identified as quantum coherence regions. Hence the fact that they have all possible size scales more or less unavoidably implies that Planck constant must be quantized and have arbitrarily large values. If one accepts this then also the idea about dark matter as a macroscopic quantum phase characterized by an arbitrarily large value of Planck constant emerges naturally as does also the interpretation for the long ranged classical electro-weak and color fields predicted by TGD. Rather seldom the evolution of ideas follows simple linear logic, and this was the case also now. In any case, this vision represents the fifth, relatively new thread in the evolution of TGD and the ideas involved are still evolving.

Dark matter as large $\hbar$ phases

D. Da Rocha and Laurent Nottale [E8] have proposed that Schrödinger equation with Planck constant $\hbar$ replaced with what might be called gravitational Planck constant $\hbar_{gr} = \frac{GmM}{v_0}$ ($\hbar = c = 1$). v_0 is a velocity parameter having the value $v_0 = 144.7 \pm .7$ km/s giving $v_0/c = 4.6 \times 10^{-4}$. This is rather near to the peak orbital velocity of stars in galactic halos. Also subharmonics and harmonics of v_0 seem to appear. The support for the hypothesis coming from empirical data is impressive.

Nottale and Da Rocha believe that their Schrödinger equation results from a fractal hydrodynamics. Many-sheeted space-time however suggests that astrophysical systems are at some levels of the hierarchy of space-time sheets macroscopic quantum systems. The space-time sheets in question would carry dark matter.

Nottale's hypothesis would predict a gigantic value of h_{gr}. Equivalence Principle and the independence of gravitational Compton length on mass m implies however that one can restrict the values of mass m to masses of microscopic objects so that h_{gr} would be much smaller. Large h_{gr} could provide a solution of the black hole collapse (IR catastrophe) problem encountered at the classical level. The resolution of the problem inspired by TGD inspired theory of living matter is that it is the dark matter at larger space-time sheets which is quantum coherent in the required time scale [K79] .

It is natural to assign the values of Planck constants postulated by Nottale to the space-time sheets mediating gravitational interaction and identifiable as magnetic flux tubes (quanta) possibly carrying monopole flux and identifiable as remnants of cosmic string phase of primordial cosmology. The magnetic energy of these flux quanta would correspond to dark energy and magnetic tension would give rise to negative "pressure" forcing accelerate cosmological expansion. This leads to a rather detailed vision about the evolution of stars and galaxies identified as bubbles of ordinary and dark matter inside magnetic flux tubes identifiable as dark energy.

Hierarchy of Planck constants from the anomalies of neuroscience and biology

The quantal ELF effects of ELF em fields on vertebrate brain have been known since seventies. ELF em fields at frequencies identifiable as cyclotron frequencies in magnetic field whose intensity is about 2/5 times that of Earth for biologically important ions have physiological effects and affect also behavior. What is intriguing that the effects are found only in vertebrates (to my best knowledge). The energies for the photons of ELF em fields are extremely low - about 10^{-10} times

lower than thermal energy at physiological temperatures- so that quantal effects are impossible in the framework of standard quantum theory. The values of Planck constant would be in these situations large but not gigantic.

This inspired the hypothesis that these photons correspond to so large a value of Planck constant that the energy of photons is above the thermal energy. The proposed interpretation was as dark photons and the general hypothesis was that dark matter corresponds to ordinary matter with non-standard value of Planck constant. If only particles with the same value of Planck constant can appear in the same vertex of Feynman diagram, the phases with different value of Planck constant are dark relative to each other. The phase transitions changing Planck constant can however make possible interactions between phases with different Planck constant but these interactions do not manifest themselves in particle physics. Also the interactions mediated by classical fields should be possible. Dark matter would not be so dark as we have used to believe.

The hypothesis $h_{eff} = h_{gr}$ - at least for microscopic particles - implies that cyclotron energies of charged particles do not depend on the mass of the particle and their spectrum is thus universal although corresponding frequencies depend on mass. In bio-applications this spectrum would correspond to the energy spectrum of bio-photons assumed to result from dark photons by h_{eff} reducing phase transition and the energies of bio-photons would be in visible and UV range associated with the excitations of bio-molecules.

Also the anomalies of biology (see for instance [K63, K64, K106]) support the view that dark matter might be a key player in living matter.

Does the hierarchy of Planck constants reduce to the vacuum degeneracy of Kähler action?

This starting point led gradually to the recent picture in which the hierarchy of Planck constants is postulated to come as integer multiples of the standard value of Planck constant. Given integer multiple $\hbar = n\hbar_0$ of the ordinary Planck constant $\hbar_0$ is assigned with a multiple singular covering of the imbedding space [K24]. One ends up to an identification of dark matter as phases with non-standard value of Planck constant having geometric interpretation in terms of these coverings providing generalized imbedding space with a book like structure with pages labelled by Planck constants or integers characterizing Planck constant. The phase transitions changing the value of Planck constant would correspond to leakage between different sectors of the extended imbedding space. The question is whether these coverings must be postulated separately or whether they are only a convenient auxiliary tool.

The simplest option is that the hierarchy of coverings of imbedding space is only effective. Many-sheeted coverings of the imbedding space indeed emerge naturally in TGD framework. The huge vacuum degeneracy of Kähler action implies that the relationship between gradients of the imbedding space coordinates and canonical momentum currents is many-to-one: this was the very fact forcing to give up all the standard quantization recipes and leading to the idea about physics as geometry of the "world of classical worlds". If one allows space-time surfaces for which all sheets corresponding to the same values of the canonical momentum currents are present, one obtains effectively many-sheeted covering of the imbedding space and the contributions from sheets to the Kähler action are identical. If all sheets are treated effectively as one and the same sheet, the value of Planck constant is an integer multiple of the ordinary one. A natural boundary condition would be that at the ends of space-time at future and past boundaries of causal diamond containing the space-time surface, various branches co-incide. This would raise the ends of space-time surface in special physical role.

A more precise formulation is in terms of presence of large number of space-time sheets connecting given space-like 3-surfaces at the opposite boundaries of causal diamond. Quantum criticality presence of vanishing second variations of Kähler action and identified in terms of conformal invariance broken down to to sub-algebras of super-conformal algebras with conformal weights divisible by integer n is highly suggestive notion and would imply that n sheets of the effective covering are actually conformal equivalence classes of space-time sheets with same Kähler action and same values of conserved classical charges (see fig. http://www.tgdtheory.fi/appfigures/planckhierarchy.jpg, which is also in the appendix of this book). n would naturally correspond the value of h_{eff} and its factors negentropic entanglement with unit density matrix would be between the n sheets of two coverings of this kind. p-Adic prime would be largest prime power factor

of n.

Dark matter as a source of long ranged weak and color fields

Long ranged classical electro-weak and color gauge fields are unavoidable in TGD framework. The smallness of the parity breaking effects in hadronic, nuclear, and atomic length scales does not however seem to allow long ranged electro-weak gauge fields. The problem disappears if long range classical electro-weak gauge fields are identified as space-time correlates for massless gauge fields created by dark matter. Also scaled up variants of ordinary electro-weak particle spectra are possible. The identification explains chiral selection in living matter and unbroken $U(2)_{ew}$ invariance and free color in bio length scales become characteristics of living matter and of bio-chemistry and bio-nuclear physics.

The recent view about the solutions of Kähler- Dirac action assumes that the modes have a well-defined em charge and this implies that localization of the modes to 2-D surfaces (right-handed neutrino is an exception). Classical W boson fields vanish at these surfaces and also classical Z^0 field can vanish. The latter would guarantee the absence of large parity breaking effects above intermediate boson scale scaling like h_{eff}.

1.3 TGD as a generalization of physics to a theory consciousness

General Coordinate Invariance forces the identification of quantum jump as quantum jump between entire deterministic quantum histories rather than time=constant snapshots of single history. The new view about quantum jump forces a generalization of quantum measurement theory such that observer becomes part of the physical system. The basic idea is that quantum jump can be identified as momentum of consciousness. Thus a general theory of consciousness is unavoidable outcome. This theory is developed in detail in the books [K88, K11, K62, K9, K35, K42, K46, K81, K109] .

It is good to list first the basic challenges of TGD inspired theory of consciousness. The challenges can be formulated as questions. Reader can decide how satisfactory the answered proposed by TGD are.

1. What does one mean with quantum jump? Can one overcome the basic problem of the standard quantum measurement theory, that which forcing Bohr to give up totally the idea about objective reality?

2. How do the experienced time and geometric time relate in this framework? How the arrow of subjective time translates to that of geometric time?

3. How to define conscious information? Is it conserved or even increased during time evolution as biological evolution suggests? How does this increase relate to second law implied basically by the randomness of state function reduction?

4. Conscious entities/selves/observers seem to exist. If they are real how do they emerge?

1.3.1 Quantum jump as a moment of consciousness

The identification of quantum jump between deterministic quantum histories (WCW spinor fields) as a moment of consciousness defines microscopic theory of consciousness. Quantum jump involves the steps

$$\Psi_i \rightarrow U\Psi_i \rightarrow \Psi_f \ ,$$

where U is informational "time development" operator, which is unitary like the S-matrix characterizing the unitary time evolution of quantum mechanics. U is however only formally analogous to Schrödinger time evolution of infinite duration although there is *no* real time evolution involved. It is not however clear whether one should regard U-matrix and S-matrix as two different things or not: U-matrix is a completely universal object characterizing the dynamics of evolution by self-organization whereas S-matrix is a highly context dependent concept in wave mechanics and

in quantum field theories where it at least formally represents unitary time translation operator at the limit of an infinitely long interaction time. The S-matrix understood in the spirit of superstring models is however something very different and could correspond to U-matrix.

The requirement that quantum jump corresponds to a measurement in the sense of quantum field theories implies that each quantum jump involves localization in zero modes which parameterize also the possible choices of the quantization axes. Thus the selection of the quantization axes performed by the Cartesian outsider becomes now a part of quantum theory. Together these requirements imply that the final states of quantum jump correspond to quantum superpositions of space-time surfaces which are macroscopically equivalent. Hence the world of conscious experience looks classical. At least formally quantum jump can be interpreted also as a quantum computation in which matrix U represents unitary quantum computation which is however not identifiable as unitary translation in time direction and cannot be 'engineered'.

In ZEO U-matrix should correspond relates zero energy states to each other and M matrices defining the rows of U matrix should be assignable to a fixed CD. Zero energy states should have wave function in the moduli space of CDs such that the second boundary of every CD would belong to a boundary of fixed light-cone but second boundary would be free with possible constraint that the distance between the tips of CD is multiple of CP_2 time.

Zero energy states of ZEO correspond in positive energy ontology to physical events and break time reversal invariance. This because either the positive or negative energy part of the state is reduced/equivalently prepared whereas the second end of CD corresponds to a superposition of (negative/positive energy) states with varying particle numbers and single particle quantum numbers just as in ordinary particle physics experiment.

The first state function reduction at given boundary of CD must change the roles of the ends of CDs. This reduction can be followed by a sequence of reductions to the same boundary of CD and not changing the boundary nor the parts of zero energy states associated with it but changing the states at the second end and also quantum distribution of the second boundary in the moduli space of CDs. In standard measurement theory the follow-up reductions would not affect the state at all.

The understanding of how the arrow of time and experience about its flow emerge have been the most difficult problem of TGD inspired theory of consciousness and I have consider4r several proposals during years having the geometry of future light-cone as the geometric core element.

1. The basic objection is that the arrow of geometric time alternates at imbedding space level but we know that arrow of time looks the same in the part of the Universe we live. Possible exceptions however exist, for instance phase conjugate laser beams seem to obey opposite arrow of time. Also biological phenomena might involve non-standard arrow of time at some levels. This led Fantappie [J103] to introduce the notion of syntropy. This suggests that the arrow of time depends on the size scale of CD and of space-time sheet.

2. It took some time to realize that the solution of the problem is trivial in ZEO. In the ordinary quantum measurement theory one must assume that state function reduction can occur repeatedly: the assumption is that nothing happens to the state during repeated reductions. The outcome is Zeno effect: the watched pot does not boil.

   In TGD framework situation is different. Repeated state function reduction leaves the already reduce parts of zero energy state invariant but can change the part of states at the opposite boundary. One must allow a delocalization of the second boundary of CDs and one assumes that the second tip has quantized distance to the fixed one coming as multiple of CP_2 time. Also Lorentz boosts leaving the second CD boundary invariant must be allowed. One must therefore introduce a wave function in the moduli space of CDs with second boundary forming part of fixed light-cone boundary ($\delta M_\pm^4 \times CP_2$).

3. The sequence of state function reductions on a fixed boundary of CD leads to the increase of the average temporal distance between the tips of CDs and this gives rise to the experience about flow of time as shifting of contents of perception towards future if the change is what contributes to conscious experience and gives rise to a fixed arrow of time.

4. Contrary to original working hypothesis, state function reduction in the usual sense does not solely determine the ordinary conscious experience. It can however contribute to conscious

experience and the act of free will is a good candidate in this respect. TGD view about realization of intentional action assumes that intentional actions involve negative energy signals propagating backwards in geometric time. This would mean that at some level of CD hierarchy the arrow of geometric time indeed changes and the reduction start to occur at opposite boundary of CD at some level of length scale hierarchy.

1.3.2   Negentropy Maximization Principle (NMP)

Information is the basic aspect of consciousness and this motivates the introduction of Negentropy Maximization Principle (NMP) [K49] as the fundamental variational principle of consciousness theory. The amount of negentropy of zero energy state should increase in each quantum jump. The ordinary entanglement entropy is also non-negative so that negentropy could be at best zero. Since p-adic physics is assumed to be a correlate of cognition, it is natural to generalizes Shannon entropy to its number theoretic variant by replacing the probabilities appearing as arguments of logarithms of probabilities with their p-adic norms. This gives negentropy which can be positive so that NMP can generates entanglement.

Consistency with quantum measurement theory allows only negentropic density matrices proportional to unit matrix and negentropy has the largest positive value for the largest power of prime factor of the dimension of density matrix. Unitary entanglement matrix familiar from quantum computation corresponds to unit density matrix and large $h_{eff} = n \times h$ states are excellent candidates for forming negentropic entanglement (see fig. `http://www.tgdtheory.fi/appfigures/cat.jpg` or fig. 21 in the appendix of this book) .

The interpretation of negentropic entanglement is as a rule. The instances of the rule correspond to the pairs appearing in the superposition and the large the number of pairs is, the higher the abstraction level of the rule is. NMP is not in conflict with the second law since negentropy in the sense of NMP is not single particle property. Ordinary quantum jumps indeed generate entropy at the level of ensemble as also quantum jumps for states for which the density matrix is direct sum of unit matrices with various dimensions.

NMP forces the negentropic entanglement resources of the Universe to grow and thus implies evolution. I have coined the name "Akashic records" for these resources forming something analogous to library. The negentropic entanglement need not be conscious as such but could generate conscious experience via interaction free measurement for which negentropic entanglement itself is not affected.

1.3.3   The notion of self

The concept of self seems to be absolutely essential for the understanding of the macroscopic and macro-temporal aspects of consciousness and would be counterpart for observer in quantum measurement theory.

1. The original view was that self corresponds to a subsystem able to remain un-entangled under the sequential informational 'time evolutions' U. It is however unclear how it could be possible to avoid generation of entanglement.

2. In ZEO the situation changes. Self corresponds to a sequence of quantum jumps for which the parts of zero energy states at either boundary of CD remain unchanged. Therefore one can say that self defined in terms of parts of states assignable to this boundary remains unaffected as sub-system and does not generate entanglement. At the other boundary changes occur and give rise to the experience of time flow and arrow of time since the average temporal distance between the tips of CD tends to increase.

   When the reductions begin to occur at the opposite boundary of CD, self "falls asleep": symmetry suggests that new self living in opposite direction of geometric time is generated. Also in biological the change of time direction at some level of hierarchy might take place.

3. It looks natural to assume that the experiences of the self after the last 'wake-up' sum up to single average experience. This means that subjective memory is identifiable as conscious, immediate short term memory. Selves form an infinite hierarchy with the entire Universe at the top. Self can be also interpreted as mental images: our mental images are selves

having mental images and also we represent mental images of a higher level self. A natural hypothesis is that self S experiences the experiences of its sub-selves as kind of abstracted experience: the experiences of sub-selves S_i are not experienced as such but represent kind of averages $\langle S_{ij} \rangle$ of sub-sub-selves S_{ij}. Entanglement between selves, most naturally realized by the formation of flux tube bonds between cognitive or material space-time sheets, provides a possible a mechanism for the fusion of selves to larger selves (for instance, the fusion of the mental images representing separate right and left visual fields to single visual field) and forms wholes from parts at the level of mental images.

4. Self corresponds in neuro science to self model defining a model for organism and for the external world. Information or negentropy seems to be necessary for understanding self. Negentropically entangled states - Akashic records - are excellent candidates for selves and would thus correspond to dark matter in TGD sense since the number of states in superposition corresponds to the integer n defining h_{eff}. It is enough that self is potentially conscious: this could mean that it conscious experience about self is generated only in interaction free measurement. Repeated state function reductions to given boundary of CD is second possibility. This would assign irreversibility and definite arrow of time and experience of time flow with self.

5. CDs would serve as imbedding space correlates of selves and quantum jumps would be followed by cascades of state function reductions beginning from given CD and proceeding downwards to the smaller scales (smaller CDs). At space-time level space-time sheets in given p-adic length scale would be the natural correlates of selves. One ends also ends up with concrete ideas about how the localization of the contents of sensory experience and cognition to the "upper" (changing) boundary of CD could take place. One cannot exclude the possibility that state function reduction cascades could also take place in parallel branches of the quantum state.

1.3.4 Relationship to quantum measurement theory

TGD based quantum measurement has several new elements. Negentropic entanglement and hierarchy of Planck constants, NMP, the prediction that state function reduction can take place to both boundaries of CD implying that the arrow of geometric time can change (this is expected to occur in microscopic scales whether the arrow of time is not established), and the possibility to understand the flow and arrow of geometric time.

1. The standard quantum measurement theory a la von Neumann involves the interaction of brain with the measurement apparatus. If this interaction corresponds to entanglement between microscopic degrees of freedom m with the macroscopic effectively classical degrees of freedom M characterizing the reading of the measurement apparatus coded to brain state, then the reduction of this entanglement in quantum jump reproduces standard quantum measurement theory provide the unitary time evolution operator U acts as flow in zero mode degrees of freedom and correlates completely some orthonormal basis of WCW spinor fields in non-zero modes with the values of the zero modes. The flow property guarantees that the localization is consistent with unitarity: it also means 1-1 mapping of quantum state basis to classical variables (say, spin direction of the electron to its orbit in the external magnetic field).

2. The assumption that localization occurs in zero modes in each quantum jump implies that the world of conscious experience looks classical. It is also consistent with the state function reduction of the standard quantum measurement theory as the following arguments demonstrate (it took incredibly long time to realize this almost obvious fact!).

3. Since zero modes represent classical information about the geometry of space-time surface (shape, size, classical Kähler field,...), they have interpretation as effectively classical degrees of freedom and are the TGD counterpart of the degrees of freedom M representing the reading of the measurement apparatus. The entanglement between quantum fluctuating non-zero modes and zero modes is the TGD counterpart for the $m - M$ entanglement. Therefore the

localization in zero modes is equivalent with a quantum jump leading to a final state where the measurement apparatus gives a definite reading.

This simple prediction is of utmost theoretical importance since the black box of the quantum measurement theory is reduced to a fundamental quantum theory. This reduction is implied by the replacement of the notion of a point like particle with particle as a 3-surface. Also the infinite-dimensionality of the zero mode sector of the WCW of 3-surfaces is absolutely essential. Therefore the reduction is a triumph for quantum TGD and favors TGD against string models.

Standard quantum measurement theory involves also the notion of state preparation which reduces to the notion of self measurement. In ZEO state preparation corresponds at some level of the self hierarchy to the a state function reduction to boundary opposite than before. In biology sensory perception and motor action would correspond to state function reduction sequences at opposite boundaries of CDs at some levels of the hierarchy.

Self measurement is governed by Negentropy Maximization Principle (NMP) stating that the information content of conscious experience is maximized. In the self measurement the density matrix of some subsystem of a given self localized in zero modes (after ordinary quantum measurement) is measured. The self measurement takes place for that subsystem of self for which the reduction of the entanglement entropy is maximal in the measurement. In p-adic context NMP can be regarded as the variational principle defining the dynamics of cognition. In real context self measurement could be seen as a repair mechanism allowing the system to fight against quantum thermalization by reducing the entanglement for the subsystem for which it is largest (fill the largest hole first in a leaking boat).

1.3.5   Selves self-organize

The fourth basic element is quantum theory of self-organization based on the identification of quantum jump as the basic step of self-organization [K73] . Quantum entanglement gives rise to the generation of long range order and the emergence of longer p-adic length scales corresponds to the emergence of larger and larger coherent dynamical units and generation of a slaving hierarchy. Energy (and quantum entanglement) feed implying entropy feed is a necessary prerequisite for quantum self-organization. Zero modes represent fundamental order parameters and localization in zero modes implies that the sequence of quantum jumps can be regarded as hopping in the zero modes so that Haken's classical theory of self organization applies almost as such. Spin glass analogy is a further important element: self-organization of self leads to some characteristic pattern selected by dissipation as some valley of the "energy" landscape.

Dissipation can be regarded as the ultimate Darwinian selector of both memes and genes. The mathematically ugly irreversible dissipative dynamics obtained by adding phenomenological dissipation terms to the reversible fundamental dynamical equations derivable from an action principle can be understood as a phenomenological description replacing in a well defined sense the series of reversible quantum histories with its envelope.

ZEO brings in important additional element to the theory of self-organization. The maxima of Kähler function corresponds to the most probable 3-surfaces. Kähler function receives contributions only from the Euclidian regions ("lines" of generalized Feynman diagrams) whereas the contribution to vacuum functional from Minkowskian regions is exponent of imaginary action so that saddle points with stationary phase are in question in these regions. In ZEO 3-surfaces are replaced by pairs of 3-surfaces at opposite boundaries of CD. The maxima actually correspond to temporal patterns of classical fields connecting these 3-surfaces: this means that self-organization is four spatiotemporal rather than spatial patterns - a crucial distinction from the usual view allowing to understand the evolution of behavioral patterns quantally. In biology this allows to understand temporal evolutions of organisms as the most probable self-organization patterns having as correlates the evolutions of the magnetic body of the system.

1.3.6   Classical non-determinism of Kähler action

A further basic element is non-determinism of Kähler action. This led to the concepts of association sequence and cognitive space-time sheet, which are not wrong notions but replaced by new ones.

1. The huge vacuum degeneracy of the Kähler action suggests strongly that the preferred is not always unique. For instance, a sequence of bifurcations can occur so that a given space-time branch can be fixed only by selecting a finite number of 3-surfaces with time like(!) separations on the orbit of 3-surface. Quantum classical correspondence suggest an alternative formulation. Space-time surface decomposes into maximal deterministic regions and their temporal sequences have interpretation a space-time correlate for a sequence of quantum states defined by the initial (or final) states of quantum jumps. This is consistent with the fact that the variational principle selects preferred extremals of Kähler action as generalized Bohr orbits.

2. In the case that non-determinism is located to a finite time interval and is microscopic, this sequence of 3-surfaces has interpretation as a simulation of a classical history, a geometric correlate for contents of consciousness. When non-determinism has long lasting and macroscopic effect one can identify it as volitional non-determinism associated with our choices. Association sequences relate closely with the cognitive space-time sheets defined as space-time sheets having finite time duration.

Later a more detailed view about non-determinism in the framework of ZEO has emerged and quantum criticality is here the basic notion. The space-time surface connecting two 3-surfaces at the ends of CD is not unique. Conformal transformations which act trivially at the ends of space-time surface generate a continuum of new extremals with the same value of Kähler action and classical conserved quantities. The number n of conformal equivalence classes is finite and defines the value of h_{eff} (see fig. `http://www.tgdtheory.fi/appfigures/planckhierarchy.jpg`, which is also in the appendix of this book). There exists a hierarchy of breakdowns of conformal symmetry labelled by n. The fractal hierarchy of CDs gives rise to fractal hierarchy of non-determinisms of this kind.

1.3.7 p-Adic physics as physics of cognition and intentionality

A further basic element adds a physical theory of cognition to this vision. TGD space-time decomposes into regions obeying real and p-adic topologies labelled by primes $p = 2, 3, 5, ...$ p-Adic regions obey the same field equations as the real regions but are characterized by p-adic non-determinism since the functions having vanishing p-adic derivative are pseudo constants which are piecewise constant functions. Pseudo constants depend on a finite number of positive pinary digits of arguments just like numerical predictions of any theory always involve decimal cutoff. This means that p-adic space-time regions are obtained by gluing together regions for which integration constants are genuine constants. The natural interpretation of the p-adic regions is as cognitive representations of real physics. The freedom of imagination is due to the p-adic non-determinism. p-Adic regions perform mimicry and make possible for the Universe to form cognitive representations about itself. p-Adic physics space-time sheets serve also as correlates for intentional action.

A more more precise formulation of this vision requires a generalization of the number concept obtained by fusing reals and p-adic number fields along common rationals (in the case of algebraic extensions among common algebraic numbers). This picture is discussed in [K85] . The application this notion at the level of the imbedding space implies that imbedding space has a book like structure with various variants of the imbedding space glued together along common rationals (algebraics, see fig. `http://www.tgdtheory.fi/appfigures/book.jpg`, which is also in the appendix. The implication is that genuinely p-adic numbers (non-rationals) are strictly infinite as real numbers so that most points of p-adic space-time sheets are at real infinity, outside the cosmos, and that the projection to the real imbedding space is discrete set of rationals (algebraics). Hence cognition and intentionality are almost completely outside the real cosmos and touch it at a discrete set of points only.

This view implies also that purely local p-adic physics codes for the p-adic fractality characterizing long range real physics and provides an explanation for p-adic length scale hypothesis stating that the primes $p \simeq 2^k$, k integer are especially interesting. It also explains the long range correlations and short term chaos characterizing intentional behavior and explains why the physical realizations of cognition are always discrete (say in the case of numerical computations). Furthermore, a concrete quantum model for how intentions are transformed to actions emerges.

The discrete real projections of p-adic space-time sheets serve also space-time correlate for a logical thought. It is very natural to assign to p-adic pinary digits a p-valued logic but as such this kind of logic does not have any reasonable identification. p-Adic length scale hypothesis suggest that the $p = 2^k - n$ pinary digits represent a Boolean logic B^k with k elementary statements (the points of the k-element set in the set theoretic realization) with n taboos which are constrained to be identically true.

1.3.8   p-Adic and dark matter hierarchies and hierarchy of selves

Dark matter hierarchy assigned to a spectrum of Planck constant having arbitrarily large values brings additional elements to the TGD inspired theory of consciousness.

1. Macroscopic quantum coherence can be understood since a particle with a given mass can in principle appear as arbitrarily large scaled up copies (Compton length scales as $\hbar$). The phase transition to this kind of phase implies that space-time sheets of particles overlap and this makes possible macroscopic quantum coherence.

2. The space-time sheets with large Planck constant can be in thermal equilibrium with ordinary ones without the loss of quantum coherence. For instance, the cyclotron energy scale associated with EEG turns out to be above thermal energy at room temperature for the level of dark matter hierarchy corresponding to magnetic flux quanta of the Earth's magnetic field with the size scale of Earth and a successful quantitative model for EEG results [K20] .

Dark matter hierarchy leads to detailed quantitative view about quantum biology with several testable predictions [K20] . The general prediction is that Universe is a kind of inverted Mandelbrot fractal for which each bird's eye of view reveals new structures in long length and time scales representing scaled down copies of standard physics and their dark variants. These structures would correspond to higher levels in self hierarchy. This prediction is consistent with the belief that 75 per cent of matter in the universe is dark.

1. Living matter and dark matter

Living matter as ordinary matter quantum controlled by the dark matter hierarchy has turned out to be a particularly successful idea. The hypothesis has led to models for EEG predicting correctly the band structure and even individual resonance bands and also generalizing the notion of EEG [K20] . Also a generalization of the notion of genetic code emerges resolving the paradoxes related to the standard dogma [K44, K20] . A particularly fascinating implication is the possibility to identify great leaps in evolution as phase transitions in which new higher level of dark matter emerges [K20] .

It seems safe to conclude that the dark matter hierarchy with levels labelled by the values of Planck constants explains the macroscopic and macro-temporal quantum coherence naturally. That this explanation is consistent with the explanation based on spin glass degeneracy is suggested by following observations. First, the argument supporting spin glass degeneracy as an explanation of the macro-temporal quantum coherence does not involve the value of $\hbar$ at all. Secondly, the failure of the perturbation theory assumed to lead to the increase of Planck constant and formation of macroscopic quantum phases could be precisely due to the emergence of a large number of new degrees of freedom due to spin glass degeneracy. Thirdly, the phase transition increasing Planck constant has concrete topological interpretation in terms of many-sheeted space-time consistent with the spin glass degeneracy.

2. Dark matter hierarchy and the notion of self

The vision about dark matter hierarchy leads to a more refined view about self hierarchy and hierarchy of moments of consciousness [K19, K20] . The larger the value of Planck constant, the longer the life-time of self measured as the increase of the average distance between tips of CDs appearing in the quantum superposition during the period of repeated reductions not affecting the part of the zero energy state at the other boundary of CD- Quantum jumps form also a hierarchy with respect to p-adic and dark hierarchies and the geometric durations of quantum jumps scale like $\hbar$.

The fact that we can remember phone numbers with 5 to 9 digits supports the view that self experiencse subselves as separate mental images. Averaging over experiences of sub-selves of sub-self would however occur.

3. The time span of long term memories as signature for the level of dark matter hierarchy

The basic question is what time scale can one assign to the geometric duration of quantum jump measured naturally as the size scale of the space-time region about which quantum jump gives conscious information. This scale is naturally the size scale in which the non-determinism of quantum jump is localized. During years I have made several guesses about this time scales but zero energy ontology and the vision about fractal hierarchy of quantum jumps within quantum jumps leads to a unique identification.

CD as an imbedding space correlate of self defines the time scale τ for the space-time region about which the consciousness experience is about. The temporal distances between the tips of CD as come as integer multiples of CP_2 length scales and for prime multiples correspond to what I have christened as secondary p-adic time scales. A reasonable guess is that secondary p-adic time scales are selected during evolution and the primes near powers of two are especially favored. For electron, which corresponds to Mersenne prime $M_{127} = 2^{127} - 1$ this scale corresponds to .1 seconds defining the fundamental time scale of living matter via 10 Hz biorhythm (alpha rhythm). The unexpected prediction is that all elementary particles correspond to time scales possibly relevant to living matter.

Dark matter hierarchy brings additional finesse. For the higher levels of dark matter hierarchy τ is scaled up by $\hbar/\hbar_0$. One could understand evolutionary leaps as the emergence of higher levels at the level of individual organism making possible intentionality and memory in the time scale defined τ.

Higher levels of dark matter hierarchy provide a neat quantitative view about self hierarchy and its evolution. Various levels of dark matter hierarchy would naturally correspond to higher levels in the hierarchy of consciousness and the typical duration of life cycle would give an idea about the level in question. The level would determine also the time span of long term memories as discussed in [K20] . The emergence of these levels must have meant evolutionary leap since long term memory is also accompanied by ability to anticipate future in the same time scale. This picture would suggest that the basic difference between us and our cousins is not at the level of genome as it is usually understood but at the level of the hierarchy of magnetic bodies [K44, K20]. In fact, higher levels of dark matter hierarchy motivate the introduction of the notions of super-genome and hyper-genome. The genomes of entire organ can join to form super-genome expressing genes coherently. Hyper-genomes would result from the fusion of genomes of different organisms and collective levels of consciousness would express themselves via hyper-genome and make possible social rules and moral.

1.4 Quantum biology and quantum neuroscience in TGD Universe

Quantum biology - rather than only quantum brain - is an essential element of Quantum Mind in TGD Universe. Cells, biomolecules, and even elementary particles are conscious entities and the biological evolution is evolution of consciousness so that it would be very artificial to restrict the discussion to brain, neurons, or microtubules.

1.4.1 Basic physical ideas

The following list gives the basic elements of TGD inspire quantum biology.

1. Many-sheeted space-time allows the interpretation of the structures of macroscopic world around us in terms of space-time topology. Magnetic/field body acts as intentional agent using biological body as a sensory receptor and motor instrument and controlling biological body and inheriting its hierarchical fractal structure. Fractal hierarchy of EEGs and its variants can be seen as communication and control tools of magnetic body. Also collective levels of consciousness have a natural interpretation in terms of magnetic body. Magnetic body

makes also possible entanglement in macroscopic length scales. The braiding of magnetic flux tubes makes possible topological quantum computations and provides a universal mechanism of memory. One can also undersand the real function of various information molecules and corresponding receptors by interpreting the receptors as addresses in quantum computer memory and information molecules as ends of flux tubes which attach to these receptors to form a connection in quantum web.

2. Magnetic body carrying dark matter and forming an onion-like structure with layers characterized by large values of Planck constant is the key concept of TGD inspired view about Quantum Mind to biology. Magnetic body is identified as intentional agent using biological body as sensory receptor and motor instrument. EEG and its fractal variants are identified as a communication and control tool of the magnetic body and a fractal hierarchy of analogs of EEG is predicted. Living system is identified as a kind of Indra's net with biomolecules representing the nodes of the net and magnetic flux tubes connections between then.

   The reconnection of magnetic flux tubes and phase transitions changing Planck constant and therefore the lengths of the magnetic flux tubes are identified as basic mechanisms behind DNA replication and analogous processes and also behind the phase transitions associated with the gel phase in cell interior. The braiding of magnetic flux makes possible universal memory representation recording the motions of the basic units connected by flux tubes. Braiding also defines topological quantum computer programs updated continually by the flows of the basic units. The model of DNA as topological quantum computer is discussed as an application. In zero energy ontology the braiding actually generalize to 2-braiding for string world sheets in 4-D space-time and brings in new elements.

3. Zero energy ontology (ZEO) makes possible the proposed p-adic description of intentions and cognitions and their transformations to action. Time mirror mechanism (see fig. `http://www.tgdtheory.fi/appfigures/timemirror.jpg` or fig. 24 in the appendix of the book) based on sending of negative energy signal to geometric past would apply to both long term memory recall, remote metabolism, and realization of intentional acting as an activity beginning in the geometric past in accordance with the findings of Libet. ZEO gives a precise content to the notion of negative energy signal in terms of zero energy state for which the arrow of geometric time is opposite to the standard one.

   The associated notion of causal diamond (CD) is essential element and assigns to elementary particles new fundamental time scales which are macroscopic: for electron the time scale is .1 seconds, the fundamental biorhythm. An essentially new element is time-like entanglement which allows to understand among other things the quantum counterparts of Boolean functions in terms of time-like entanglement in fermionic degrees of freedom.

4. The assignment of dark matter with a hierarchy of Planck constants gives rise to a hierarchy of macroscopic quantum phases making possible macroscopic and macrotemporal quantum coherence and allowing to understand evolution as a gradual increase of Planck constant. The model for dark nucleons leads to a surprising conclusion: the states of nucleons correspond to DNA, RNA, tRNA, and amino-acids in a natural manner and vertebrate genetic code as correspondence between DNA and amino-acids emerges naturally. This suggests that genetic code is realized at the level of dark hadron physics and living matter in the usual sense provides a secondary representation for it.

   The hierarchy of Planck constants emerges from basic TGD under rather general assumptions. The key element is the huge vacuum degeneracy which implies that preferred non-vacuum extremals of Kähler action form a 4-D spin glass phase. The basic implications following from the extreme non-linearity of Kähler action is that normal derivatives of imbedding space coordinates at 3-D light-like orbits of partonic 2-surfaces and at space-like 3-surfaces at ends of CDs are many-valued functions of canonical momentum densities: this is one of the reasons that forced to develop physics as an infinite-D Kähler geometry vision instead of trying to develop path integral formalism or canonical quantization. A convenient manner to treat the situation is to introduce local many-sheeted covering of imbedding space such that the sheets are completely degenerate at partonic 2-surfaces. This leads in natural manner

to the hierarchy of Planck constants as effective hierarchy hierarchy and integer multiples of Planck constants emerge naturally.

5. p-Adic physics can be identified as physics of cognition and intentionality. The hierarchy of p-adic length scales predicts a hierarchy of universal metabolic quanta as increments of zero point kinetic energies. Negentropic entanglement(see fig. `http://www.tgdtheory.fi/appfigures/cat.jpg` or fig. 21 in the appendix of this book) possible for number theoretic entanglement entropy makes sense for rational (and even algebraic) entanglement and leads to the identification of life as something residing in the intersection of real and p-adic worlds. NMP respects negentropic entanglement and the attractive idea is that the experience of understanding and positively colored emotions relate to negentropic entanglement.

6. Living matter as conscious hologram is one of the basic ideas of TGD inspired biology and consciousness theory. The basic objection against TGD is that the interference of classical fields is impossible in the standard sense for the reason that that classical fields are not primary dynamical variables in TGD Universe. The resolution is based on the observation that only the interference of the effects caused by these fields can be observed experimentally and that many-sheeted space-time allows to realized the summation of effects in terms of multiple topological condensations of particles to several parallel space-time sheets. One concrete implication is fractality of qualia. Qualia appear in very wide range of scales: our qualia could in fact be those of magnetic body. The proposed mechanism for the generation of qualia realizes the fractality idea.

1.4.2 Brain in TGD Universe

Brain cognizes and one should find physical correlates for cognition. Also the precise role of brain in information processing and its relationship to metabolism should be understood. Here magnetic body brings as a third player to the couple formed by environment and organism.

1. An attractive idea is that the negentropic entanglement can be assigned with magnetic flux tubes somehow and that ATP serves as a correlate for negentropic entanglement. This leads to a rather detailed ideas about the role of phosphate bond and provides interpretation for the fact that the number of valence bonds tend to be maximized in living matter. In a loose sense one could even call ATP a consciousness molecule. The latest view encourages to consider the possibility that negentropic entanglement with what might be called Mother Gaia is what is transferred in metabolism.

2. The view about the function of brain differs from the standard view. The simplest option is that brain is a builder of symbolic representations building percepts and giving them names rather than the seat of primary qualia relevant to our conscious experience. Sensory organs would carry our primary qualia and brain would build sensory percepts as standardized mental images by using virtual sensory input to the sensory organs. The new view about time is absolutely essential for circumventing the objections against this vision. The prediction is that also neuronal and even cell membranes define sensory maps with primary qualia assignable to the lipids serving as pixels of the sensory screen. These qualia would not however represent our qualia but lower level qualia. At this moment it is not possible to choose between these two options.

3. The role of EEG and its various counterparts at fractally scaled frequency ranges is to make possible communications to the various onion-like layers of the magnetic body and the control by magnetic body. Dark matter at these layers could be seen as the intentional agent and sensory perceiver.

1.4.3 Anomalies

Various anomalies of living matter have been in vital role in the development of not only TGD view about living matter but also TGD itself.

1. TGD approach to living matter was strongly motivated by the findings about strange behavior of cell membrane and of cellular water, and gel behavior of cytoplasm. Also the findings about effects of ELF em fields on vertebrate brain were decisive and led to the proposal of the hierarchy of Planck constants found later to emerge naturally from the non-determinism of Kähler action. Rather satisfactorily, the other manner to introduce the hierarchy of Planck constants is in terms of gravitational Planck constant: at least in microscopic scales the equivalence of these approaches makes sense and leads to highly non-trivial predictions. The basic testable prediction is that dark photons have cyclotron frequencies inversely proportional to their massess but universal energy spectrum in visible and UV range which corresponds to the transition energies for biomolecules so that they are ideal for biocontrol at the level of both magnetic bodies and at the level of biochemistry.

2. Water is in key role in living matter and also in TGD inspired view about living matter. The anomalies of water lead to a model for dark nuclei as dark proton strings with the surprising prediction that DNA, RNA, anino-acids and even tRNA are in one-one correspondence with the resulting 3-quark states and that vertebrate genetic code emerges naturally. This leads to a vision about water as primordial life form still playing a vital role in living organisms. The model of water memory and homeopathy in turn generalizes to a vision about how immune system might have evolved.

3. Metabolic energy is necessary for conscious information processing in living matter. This suggests that metabolism should be basically transfer of negentropic entanglement from nutrients to the organism. ATP could be seen as a molecule of consciousness in this picture and high energy phosphate bond would make possible the transfer of negentropy.

1.5   Sources

The eight online books about TGD [K96, K71, K117, K83, K55, K116, K115, K82] and nine online books about TGD inspired theory of consciousness and quantum biology [K88, K11, K62, K9, K35, K42, K46, K81, K109] are warmly recommended for the reader willing to get overall view about what is involved.

My homepage (`http://www.tgdtheory.com/curri.html`) contains a lot of material about TGD. In particular, there is summary about TGD and its applications using CMAP representation serving also as a TGD glossary [L35, L36] (see `http://www.tgdtheory.fi/cmaphtml.html` and `http://www.tgdtheory.fi/tgdglossary.pdf`).

I have published articles about TGD and its applications to consciousness and living matter in *Journal of Non-Locality* (`http://journals.sfu.ca/jnonlocality/index.php/jnonlocality` founded by Lian Sidorov and in *Prespacetime Journal* (`http://prespacetime.com`), *Journal of Consciousness Research and Exploration* (`https://www.createspace.com/4185546`), and *DNA Decipher Journal* (`http://dnadecipher.com`), all of them founded by Huping Hu. One can find the list about the articles published at `http://www.tgdtheory.com/curri.html`. I am grateful for these far-sighted people for providing a communication channel, whose importance one cannot overestimate.

1.6   The contents of the book

1.6.1   PART I: TGD Inspired Theory of Consciousness

Topological Geometrodynamics: Basic Visions

In this article I will discuss three basic visions about quantum Topological Geometrodynamics (TGD). It is somewhat matter of taste which idea one should call a vision and the selection of these three in a special role is what I feel natural just now.

1. The first vision is generalization of Einstein's geometrization program based on the idea that the Kähler geometry of the world of classical worlds (WCW) with physical states identified as classical spinor fields on this space would provide the ultimate formulation of physics.

2. Second vision is number theoretical and involves three threads. The first thread relies on the idea that it should be possible to fuse real number based physics and physics associated with various p-adic number fields to single coherent whole by a proper generalization of number concept. Second thread is based on the hypothesis that classical number fields could allow to understand the fundamental symmetries of physics and and imply quantum TGD from purely number theoretical premises with associativity defining the fundamental dynamical principle both classically and quantum mechanically. The third threadrelies on the notion of infinite primes whose construction has amazing structural similarities with second quantization of super-symmetric quantum field theories. In particular, the hierarchy of infinite primes and integers allows to generalize the notion of numbers so that given real number has infinitely rich number theoretic anatomy based on the existence of infinite number of real units.

3. The third vision is based on TGD inspired theory of consciousness, which can be regarded as an extension of quantum measurement theory to a theory of consciousness raising observer from an outsider to a key actor of quantum physics.

The basic aspects of quantum classical correspondence are discussed. Strong form of General Coordinate Invariance implies strong form of holography and effective 2-dimensionality. Weak form of electric magnetic duality and simple general condition on preferred extremals of Kähler action imply that TGD indeed reduces to almost topological QFT defined by Chern-Simons terms located at space-like at ends of CDs and light-like 3-surfaces defined by the orbits of partonic 2-surfaces defining wormhole throats at which the signature of induced metric changes. A further reduction of action to sum of areas of minimal surfaces is conjectured on basis of effective 2-dimensionality. Feynman diagrams have direct interpretation in terms of space-time topology and ZEO leads to a dramatic simplification of the Feynman diagrammatics and suggest a close connection with twistorial diagrams. Induced gauge field concept makes impossible the superposition of classical fields in TGD Universe. This is a grave objection circumvented by simple observation: only the superposition of their effects is observed and many-sheeted space-time implies it.

Quantum Mind in TGD Universe

The basic difficulties and challenges of Quantum Mind program are analyzed. The conclusion is that the recent form of quantum theory is not enough to overcome the challenges posed by the philosophical problems of quantum physics and quantum mind theories, and the puzzles of quantum biology and quantum neuroscience. Certain anomalies of recent day biology giving hints about how quantum theory should be generalized serve as an introduction to the summary of the aspects of quantum TGD especially relevant to the notion of Quantum Mind. These include the notions of many-sheeted space-time and field (magnetic) body, zero energy ontology, the identification dark matter as a hierarchy of phases with large value of Planck constant, and p-adic physics proposed to define physical correlates for cognition and intentionality.

Especially relevant is the number theoretic generalization of Shannon entropy: this entropy is well defined for rational or even algebraic entanglement probabilities and its minimum as a function of the prime defining p-adic norm appearing in the definition of the entropy is negative. Therefore the notion of negentropic entanglement makes sense in the intersection of real and p-adic worlds and is negative: this motivates the proposal that living matter resides in this intersection.

TGD inspired theory of consciousness is introduced as a generalization of quantum measurement theory. The notions of quantum jump and self defining the generalization of the notion of observer are introduced and it is argued that the notion of self reduces to that for quantum jump. Negentropy Maximization Principle reproduces standard quantum measurement theory for ordinary entanglement but respects negentropic entanglement so that the outcome of state function reduction is not random for negentropic entanglement. The new view about the relationship of experienced time and geometric time combined with zero energy ontology is claimed to solve the basic philosophical difficulties of quantum measurement theory and consciousness theory. The identification of the quantum correlates of sensory qualia and Boolean cognition, emotions, cognition and intentionality and self-referentiality of consciousness is discussed.

Comparison of TGD Inspired Theory of Consciousness with Some Other Theories of Consciousness

This work has been inspired by two books. The first book "On intelligence" is by Jeff Hawkins. The second book "Consciousness: the science of subjectivity" is by Antti Revonsuo.

Jeff Hawkins has developed a highly interesting and inspiring vision about neo-cortex, one of the few serious attempts to build a unified view about what brain does and how it does it. Since key ideas of Hawkins have quantum analogs in TGD framework, there is high motivation for developing a quantum variant of this vision. The vision of Hawkins is very general in the sense that all parts of neo-cortex would run the same fundamental algorithm, which is essentially checking whether the sensory input can be interpreted in terms of standard mental images stored as memories. This process occurs at several abstraction levels and involve massive feedback. If it succeeds at all these levels the sensory input is fully understood.

TGD suggests a generalization of this process. Quantum jump defining moment of consciousness would be the fundamental algorithm realized in all scales defining an abstraction hierarchy. Negentropy Maximization Principle (NMP) would be the variational principle driving this process and in optimal case lead to an experience of understanding at all levels of the scale hierarchy realized in terms of generation of negentropic entanglement. The analogy of NMP with second law suggests strongly thermodynamical analogy and p-adic thermodynamics used in particle mass calculations might be also seen as effective thermodynamics assignable to NMP.

In the following I will first discuss the ideas of Hawkins and then summarize some relevant aspects of quantum TGD and TGD inspired theory of consciousness briefly in the hope that this could make representation comprehensible for the reader having no background in TGD (I hope I have achieved this). The representation involves some new elements: reduction of the old idea about motor action as time reversal of sensory perception to the anatomy of quantum jump in zero energy ontology (ZEO); interaction free measurement for photons and photons as a non-destructive reading mechanism of memories and future plans (time reversed memories) represented 4-dimensionally as negentropically entangled states approximately invariant under quantum jumps (this resolves a basic objection against identifying quantum jump as moment of consciousness) leading to the identification of analogs of imagination and internal speech as fundamental elements of cognition; and a more detailed quantum model for association and abstraction processes.

I will also compare various theories and philosophies of consciousness with TGD approach following the beautifully organized representation of Revonsuo. Also anomalies of consciousness are briefly discussed. My hope is that this comparison would make explicit that TGD based ontology of consciousness indeed circumvents the difficulties against monistic and dualistic approaches and also survives the basic objections that I have been able to invent hitherto.

1.6.2   PART II: Quantum Biology in TGD Universe

Quantum Mind, Magnetic Body, and Biological Body

The chapter is devoted to some applications of TGD inspired view about Quantum Mind to biology. Magnetic body carrying dark matter and forming an onionlike structure with layers characterized by large values of Planck constant is the key concept. Magnetic body is identified as intentional agent using biological body as sensory receptor and motor instrument. EEG is identified as a communication and control tool of the magnetic body and a fractal hierarchy of analogs of EEG is predicted. Living system is identified as a kind of Indra's net with biomolecules representing the nodes of the net and magnetic flux tubes connections between then. The reconnection of magnetic flux tubes and phase transitions changing Planck constant and therefore the lengths of the magnetic flux tubes are identified as basic mechanisms behind DNA replication and analogous processes and also behind the phase transitions associated with the gel phase in cell interior. The braiding of magnetic flux makes possible universal memory representation recording the motions of the basic units connected by flux tubes. Braiding also defines topological quantum computer programs updated continually by the flows of the basic units. The model of DNA as topological quantum computer is discussed as an application.

A vision about quantum metabolism in TGD Universe is proposed. The new element is the idea that the presence of ATP at magnetic flux tube is a necessary prerequisite for negentropic

entanglement between its ends. ATP could be seen as a molecule of consciousness in this picture. Also a possible modification of second law to take into account negentropic entanglement is discussed. TGD approach to living matter was strongly motivated by the findings about strange behavior of cell membrane and of cellular water, and gel behavior of cytoplasm. These findings are briefly discussed in TGD framework by bringing in magnetic flux tubes as a new element. Water is in key role in living matter and TGD inspired view about water and its anomalies is discussed.

Quantum Mind and Neuro Science

The article discusse some applications of TGD inspired view about Quantum Mind to neuroscience. Magnetic body carrying dark matter and forming an onionlike structure with layers characterized by large values of Planck constant is the key concept.

A general model for qualia is introduced. The identification of the correlates of the fundamental qualia as quantum number increments for a subsystem is in a complete analogy with the identification of quantum numbers as characterizers of physical states. A general classification of qualia based on thermodynamical notions is discussed and a mechanism generating sensory qualia is proposed. Also the question whether some qualia could correspond also to those of magnetic body is raised.

The interaction of subsystem S representing self with environment E is assumed to generate a negentropic entanglement between S and environment E. As long as this negentropic entanglement lasts, qualia are experienced. After the state function reduction eliminating this entanglement, there can be only a memory of qualia. There is clearly a resemblance with Orhc OR of Penrose and Hameroff. During negentropic entanglement there is polarization in scale of $S \otimes E$ and S and E carry opposite quantum numbers. After the state function reduction negentropic entanglement and polarization prevail only in the scale S and S has vanishing net quantum numbers. "Quantum number increments ΔQ in quantum jump" therefore correspond to the reduction of charges of subsystem in the state function reduction process. The system is analogous to a capacitor whose size scale is that of $S \otimes E$ during the sensation of quale and that of S after it. In ZEO one can consider states of S at both upper and lower boundaries of CD and assign ΔQ with this time evolution so that quantum classical correspondence is realized.

The capacitor model for sensory receptor based on the idea that sensory qualia are generated in the analog of di-electric breakdown introducing a flow of large number of particles with quantum numbers characterizing the quale. A model for the cell membrane as sensory receptor and as qualia chart with lipids serving as its pixels is developed. Although sensory organs are assumed to define the seats if the fundamental qualia, also neurons would define sensory homunculi not necessarily responsible for sensory mental images at our level of self hierarchy. Cell membrane is assumed to be a quantum critical system taken to mean that it is near to a vacuum extremal of so called Kähler action. This explains large parity breaking in living matter (chiral selection) very difficult to understand in standard model. The model explains the peak frequencies of visible light for photoreceptors and predicts that biophotons and bunches of EEG photons result as decay products of same dark photons with energies mostly in visible range.

The model of nerve pulse relies on the hypothesis that axonal membrane defines a Josephson junction. The ground state of the axon corresponds to a propagating soliton sequence for the phase difference over the membrane mathematically analogous to a sequence of coupled gravitational penduli with a constant phase difference between neighboring penduli. Nerve pulse is generated as one kicks one of the oscillating penduli. The model of nerve pulse explains the generation of EEG. The resonance frequencies of EEG can be understood as sums and differences of the harmonics of cyclotron frequencies of biologically important dark ions and of Josephson frequency.

A model of bio-photons is discussed. The motivation comes from the observations that biophotons could be interpreted as decay products of large $\hbar$ EEG photons resulting in the energy conserving transformation to ordinary photons at visible and UV energies.

Comments on the recent experiments by the group of Michael Persinger

Michael Persinger's group reports three very interesting experimental findings related to EEG, magnetic fields, photon emissions from brain, and macroscopic quantum coherence. The findings also provide support for the proposal of Hu and Wu that nerve pulse activity could induce spin flips

of spin networks assignable to cell membrane. In this article I analyze the experiments from TGD point of view. It turns out that the experiments provide support for several TGD inspired ideas about living matter - namely, magnetic flux quanta as generators of macroscopic quantum entanglement, dark matter as a hierarchy of macroscopic quantum phases with large effective Planck constant, DNA-cell membrane system as a topological quantum computer with nucleotides and lipids connected by magnetic flux tubes with ends assignable to phosphate containing molecules, and the proposal that "dark" nuclei consisting of dark proton strings could provide a representation of the genetic code. The proposal of Hu and Wu translates into the assumption that lipids of the two layers of the cell membrane are accompanied by dark protons which arrange themselves to dark protonic strings defining a dark analog of DNA double strand.

Are dark photons behind bio-photons?

TGD approach leads to a prediction that biophotons result when dark photons with large value of effective Planck constant and large wavelength transform to ordinary photons with same energy. The recent progress in understanding the implications of basic vision behind TGD inspired theory of consciousness served as a particular motivation for developing a more detailed view about biophotons.

1. The anatomy of quantum jump in zero energy ontology (ZEO) allows one to understand basic aspects of sensory and cognitive processing in the brain without ever mentioning the brain. Sensory perception - motor action cycle with motor action interpreted as time-reversed sensory perception directly reflects the fact that state function reductions occur alternately to the two opposite boundaries of causal diamond (CD) (which itself or rather, quantum superposition of CDs, changes in the process such that either the upper or lower boundaries of all CDs involved are localized at the same light-cone boundary).

2. Also the abstraction and de-abstraction processes in various scales which are essential for neural processing emerge already at the level of quantum jump. The formation of associations is one aspect of abstraction since it combines different manners to experience the same object. Negentropic entanglement of two or more mental images (CDs) gives rise to rules in which superposed n-particle states correspond to instances of the rule or association of n events. Schrödinger cat serves as an example: the superposition of living cat-closed bottle and dead-cat-open bottle gives a quantum representation for the rule that it is not good idea to open the bottle. Cat attending to/quantum entangling with the bottle is conscious about the rule. Tensor product formation generating negentropic entanglement between new mental images and earlier ones generates longer sequences of memory mental images and gives rise to negentropy gain generating experience of understanding, recognition, something which has positive emotional coloring. Quantum superposition of perceptively equivalent zero energy states in given resolution gives rise to averaging. Increasing the abstraction level means poorer resolution so that the insignificant details are not perceived.

3. Various memory representations should be approximately invariant under the sequence of quantum jumps. Negentropic entanglement gives rise to this kind of stabilization. The assumption that self model is a negentropically entangled system which does not change in state function reduction, leads to a problem. If the conscious information about this kind of subself corresponds to change of negentropy in quantum jump, it seems impossible to get this information. Quite generally, if moment of consciousness corresponds to quantum jump and thus *change*, how is it possible to carry conscious information about *quantum state*? Interaction free measurement however allows to circumvent the problem: non-destructive reading of memories and future plans becomes possible in arbitrary good approximation.

   This memory reading mechanism can be formulated for both photons and phonons and these two reading mechanisms could correspond to visual memories as imagination and auditory memories as internal speech. Therefore dark photons decaying to biophotons could be crucial element of imagination. The notion of bio-phonon could also make sense and even follow as a prediction. The identification of dark photons responsible for the reading of memories with EEG is suggested by the strong correlation of latter with the contents consciousness. This would also suggest a correlation of biophoton emission with EEG for which there is a

considerable evidence. The indications that biophotons are associated only with the right hemisphere suggests that at least some parts of right hemisphere prefer dark photons and are thus specialized to visual imagination: spatial relationships are the speciality of the right hemisphere. Some parts the of left hemisphere at least might prefer dark photons in IR energy range transforming to ordinary phonons in ear or dark phonons: left hemisphere is indeed the verbal hemisphere specialized to linear linguistic cognition.

In the following I shall discuss biophotons in TGD Universe as decay products of dark photons and propose among other things an explanation for the hyperbolic decay law in terms of quantum coherence and echo-like mechanism guaranteeing replication of memory representations. Applications to biology, neuroscience, and consciousness are discussed and also the possible role of biophotons for remote mental interactions is considered. Also the phenomenon of Taos hum is discussed as a possible evidence for biophonons.

About concrete realization of remote metabolism

The idea of "remote metabolism" (or quantum credit card, as I have also called it) emerged more than a decade ago - and zero energy ontology (ZEO) provides the justification for it. The idea is that the system needing energy sends negative energy to a system able to receive the negative energy and make a transition to a lower energy state. This kind of mechanism would be ideal for biology, where rapid reactions to a changing environment are essential for survival. Originally this article was intended to summarize a more detailed model of remote metabolism but the article expanded to a considerably more detailed view about TGD inspired biology than the earlier vision.

It is shown that the basic notions of the theory of Ling about cell metabolism inspired by various anomalies have natural counterparts in TGD based model relying on the notion of magnetic body. Remote metabolism can be considered as a universal metabolic mechanism with magnetic body of ATP, or system containing it, carrying the metabolic energy required by the biological user. In particular, the role of ATP is discussed in Ling's theory and from the point of view of TGD-inspired theory of consciousness.

It is easy to imagine new technologies relying on negative energy signals propagating to the geometric past and ZEO justifies these speculations. Remote metabolism could make possible a new kind of energy technology. The discoveries of Tesla made more than a century ago plus various free energy anomalies provide excellent material for developing these ideas, and one ends up with a concrete proposal for how dark photons and dark matter could be produced in capacitor-like systems analogous to cell membranes and acting as Josephson junctions and how energy could be extracted from "large" magnetic bodies.

The model identifies Josephson frequency with the subharmonic of the frequency characterizing the periodicity of a periodic voltage perturbation assumed to correspond to cyclotron frequency in biological applications. Together with quantization conditions for charge and effective Planck constant it leads to precise quantitative predictions for capacitor-like systems acting as dark capacitors. Also a relationship between the magnetic field at the magnetic body of the system and the voltage of the capacitor-like Josephson junction emerges.

The predictions allow new quantitative insights about biological evolution as emergence of Josephson junctions realized as capacitor-like systems both at the level of cell, DNA and proteins, and brain. h_{eff} can be related to Josephson frequency and cyclotron frequency and thus to measurable parameters. h_{eff} serves as a kind of intelligence quotient and its maximization requires the maximization of both the voltage and area of the membrane-like capacitor system involved. This is what has happened during evolution. Indeed, the internal cell membranes, cortical layers and DNA double strand in chromosomes are strongly folded, and the value of membrane electric field is roughly twice the value of the electric field for which di-electric breakdown occurs in air. Even 40 Hz thalamocortical resonance frequency can be understood in the framework of the model.

The claimed properties of Tesla's "cold electricity" strongly suggest interpretation in terms of dark matter in TGD sense. This leads to a proposal that a transition to dark phase occurs when the value of voltage equals the rest mass of charged particle involved. This criterion generalizes to the case of cell membrane and relates the values of h_{eff}, p-adic prime p, and threshold potential for various charged particles to each other. The idea that nerve pulse corresponds to the breakdown of super-conductivity as a transition from dark to ordinary phase receives additional support. The

resulting picture conforms surprisingly well with the earlier speculations involving dark matter and p-adically scaled variants of weak and color interactions in biologically relevant length scales. An extremely simple mechanism producing ATP involving only the kicking of two protonic Cooper pairs through the cell membrane by Josephson photon as a basic step is proposed. Also the proposal that neutrino Cooper pairs could be highly relevant not only for cognition and but also metabolism finds support.

1.6.3 PART III: Remote Mental Interactions

TGD inspired view about remote mental interactions and paranormal

I have proposed a general vision about what remote mental interactions and related phenomena could be in TGD Universe around 2003. A lot of progress that has taken place since then, and this motivates the reconsideration of this vision. The general vision is that both biology, consciousness, and remote mental interactions and related phenomena labelled as paranormal are predicted to share the same basic mechanisms, and that the proposed vision provides basic concepts and the language allowing to speculate and build simple models. One cannot of course take the proposed models too seriously at the level of details.

The new ideas that have emerged since 2003 are summarized and parapsychological phenomena are discussed at general level. Also some applications of the basic vision are discussed. The notion of conscious hologram is discussed from the point of view of remote mental interactions. The notion of magnetic body is in decisive role as it is also in the understanding of quantum biology in TGD framework. TGD inspired model for OBEs relying on the notion of magnetic body is summarized. The idea is that OBEs could correspond to sensory experiences assignable to magnetic body rather than real body. Also the connections with the work of other researchers, such as Shnoll, Persinger, and Tiller are discussed briefly. The challenge of testing the vision is also considered.

How to test TGD based vision about living matter and remote mental interactions?

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Hypnosis as remote mental interaction

In TGD framework one can argue that hypnosis represents an example about the fact that brain is not "private property": hypnotist uses the biological body and brain of the subject as instrument. Therefore remote mental interaction is in question. This idea generalizes: if one accepts self hierarchy, one can assign to any kind of higher level structure - family, organization, species, ... - a higher level self and magnetic body carrying dark matter, and these magnetic bodies can use lower level magnetic bodies as their instruments to realize their intentions. Biological bodies would be an important level in the hierarchy, which would continue down to cellular, molecular, and perhaps to even lower levels.

This view challenges the prevailing views about brain as a sole seat of consciousness and the assumption that conscious entities assigned with brains are completely isolated. Given magnetic body can use several biological bodies although one can assign to it the one providing the sensory

input - at least during wake-up state. Note however that it is easy to produce illusion that some foreign object is part of biological body.

For more than decade ago I proposed a model for so called bicamerality based on the notion of semitrance. In semitrance the brain of subject becomes partially entangled with a higher level self - in this case the self of family or more general social group uses the biological body of member for its purposes. Higher level self gives its commands and advice interpreted by the bicameral as "God's voice". The consciousness of schizophrenic might be basically bicameral. Also hypnotic state and dream consciousness are candidates for bicameral consciousness.

In this article I develop essentially this idea but using as input the recent understanding of about TGD inspired theory of consciousness and quantum biology and end up with a proposal for a detailed mechanism for how the magnetic body hijacks some parts of the brain of the subject: prefrontal cortex and anterior cingulate cortex are argued to be the most plausible targets of hijacking. Also a mechanism explaining how the sensory hallucinations and motor actions are induced by hypnotist by inhibiting a halting mechanism preventing imagined motor actions to become real and sensory imagination to become "qualiafied".

Meditation, Mind-Body Medicine and Placebo: TGD point of view

The chapter represents TGD inspired answers to Lian Sidorov's questions concerning meditation, mind-body medicine and placebo in quantum biology framework. To help the reader, some aspects of TGD inspired theory of consciousness and quantum biology are summarized since several new insights inspired by the notions of magnetic body and dark matter have emerged lately. This includes improved views about quantum metabolism and prebiotic life: the basic input comes from the claimed free energy phenomena interpreted in TGD framework. Water structures representing simplified analogs of basic biomolecules suggested by water splitting producing so called Brown's gas might be highly relevant also for the ordinary metabolism. The main new input concerning remote mental interactions comes from a possible answer to the question whether TGD based ontology of physics could allow the "shamanistic" view that the experiences (say encounters with strange life forms assigned with distant civilizations) induced by various psychedelics used in the spiritual practices of indigenous people could be genuine remote sensory perceptions rather than hallucinations. Affirmative answer would mean a direct and testable connection between neuropharmacology and remote sensory perception with serotonin defining the crucial neurotransmitter and pineal gland ("third eye") serving as a candidate for the brain area of special importance in this respect.

Concerning the questions about meditation, mind-body medicine and placebo, the key concept is that of magnetic body. Usually organism and environment are seen as members of an interacting pair: organism receives sensory data from environment and controls it. Now magnetic body appears as a third party, "intentional agent" using biological body as a kind of interface between magnetic body and environment. Various "motor actions" of the magnetic body are highly relevant for both consciousness and biochemistry. The pairs formed by various information molecules and corresponding receptors could define plug-ins to the Indra's net (or Internet) defined by the magnetic bodies and Josephson radiation emitted by Josephson currents assignable to receptors would propagate along flux tubes. Meditation can be seen as "bodily exercise" of the magnetic body and a method to improve the communications between magnetic body and biological body. In healing magnetic body would be the active participant and healing would be also the healing of magnetic body. The placebo effect could be seen as an outcome of intentions of magnetic body affecting biological body.

Part I

TGD INSPIRED THEORY OF CONSCIOUSNESS

Chapter 2

Topological Geometrodynamics: Basic Visions

2.1 Introduction

Originally Topological Geometrodynamics (TGD) was proposed as a solution of the problems related to the definition of conserved four-momentum in General Relativity. It was assumed that physical space-times are representable as 4-D surfaces in certain higher-dimensional space-time having symmetries of the empty Minkowski space of Special Relativity. This is guaranteed by the decomposition $H = M^4 \times S$, where S is some compact internal space. It turned out that the choice $S = CP_2$ is unique in the sense that it predicts the symmetries of the standard model and provides a realization for Einstein's dream of geometrizing of fundamental interactions at classical level. TGD can be also regarded as a generalization of super string models obtained by replacing strings with light-like 3-surfaces or equivalently with space-like 3-surfaces: the equivalence of these identification implies quantum holography.

The construction of quantum TGD turned out to be much more than mere technical problem of deriving S-matrix from path integral formalism. A new ontology of physics (many-sheeted space-time, zero energy ontology, generalization of the notion of number, and generalization of quantum theory based on spectrum of Planck constants giving hopes to understand what dark matter and dark energy are) and also a generalization of quantum measurement theory leading to a theory of consciousness and model for quantum biology providing new insights to the mysterious ability of living matter to circumvent the constraints posed by the second law of thermodynamics were needed. The construction of quantum TGD involves a handful of different approaches consistent with a similar overall view, and one can say that the construction of M-matrix, which generalizes the S-matrix of quantum field theories, is understood to a satisfactory degree although it is not possible to write even in principle explicit Feynman rules except at quantum field theory limit [K60, K26].

In this article I will discuss three basic visions about quantum Topological Geometrodynamics (TGD). It is somewhat matter of taste which idea one should call a vision and the selection of these three in a special role is what I feel natural just now.

1. The first vision is generalization of Einstein's geometrization program based on the idea that the Kähler geometry of the world of classical worlds (WCW) with physical states identified as classical spinor fields on this space would provide the ultimate formulation of physics [K71].

2. Second vision is number theoretical [K83] and involves three threads.

    (a) The first thread [K85] relies on the idea that it should be possible to fuse real number based physics and physics associated with various p-adic number fields to single coherent whole by a proper generalization of number concept.

    (b) Second thread [K86] is based on the hypothesis that classical number fields could allow to understand the fundamental symmetries of physics and and imply quantum TGD from purely number theoretical premises with associativity defining the fundamental dynamical principle both classically and quantum mechanically.

(c) The third thread [K84] relies on the notion of infinite primes whose construction has amazing structural similarities with second quantization of super-symmetric quantum field theories. In particular, the hierarchy of infinite primes and integers allows to generalize the notion of numbers so that given real number has infinitely rich number theoretic anatomy based on the existence of infinite number of real units. This implies number theoretical Brahman=Atman identity or number theoretical holography when one consider hyper-octonionic infinite primes.

(d) The third vision is based on TGD inspired theory of consciousness [K88], which can be regarded as an extension of quantum measurement theory to a theory of consciousness raising observer from an outsider to a key actor of quantum physics. The basic notions at quantum jump identified as as a moment of consciousness and self. Negentropy Maximization Principle (NMP) defines the fundamental variational principle and reproduces standard quantum measurement theory and predicts second law but also some totally new physics in the intersection of real and p-adic worlds where it is possible to define a hierarchy of number theoretical variants of Shannon entropy which can be also negative. In this case NMP favors the generation of entanglement and state function reduction does not mean generation of randomness anymore. This vision has obvious almost applications to biological self-organization.

My aim is to provide a bird's eye of view and my hope is that reader would take the attitude that details which cannot be explained in this kind of representation are not essential for the purpose of getting a feeling about the great dream behind TGD. I have also commented various ideas from the point of view of Quantum Mind program.

The appendix of the book gives a summary about basic concepts of TGD with illustrations. There are concept maps about topics related to the contents of the chapter prepared using CMAP realized as html files. Links to all CMAP files can be found at `http://www.tgdtheory.fi/cmaphtml.html` [L35]. Pdf representation of same files serving as a kind of glossary can be found at `http://www.tgdtheory.fi/tgdglossary.pdf` [L36]. The topics relevant to this chapter are given by the following list.
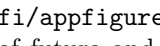
- Overall view about TGD [L55]

- What TGD is [L71]

- TGD as unified theory of fundamental interactions [L67]

- Key notions and ideas of TGD [L51]

- Basic TGD [L40]

- Space-time as 4-surface in $M^4 x CP_2$ [L66]

- Geometrization of fields [L49]

2.2 Quantum physics as infinite-dimensional geometry

The first vision in its original form is a the generalization of Einstein's program for the geometrization of physics by replacing space-time with the WCW identified roughly as the space of 4-surfaces in $H = M^4 \times CP_2$. Later generalization due to replacement of H with book like structures from by real and p-adic variants of H emerged. A further book like structure of imbedding space emerged via the introduction of the hierarchy of Planck constants. These generalizations do not however add anything new to the basic geometric vision.

2.2.1 World of the classical worlds as the arena of quantum physics

Physics as the classical spinor field geometry of WCW consisting of light-like 3-surfaces in 8-D imbedding space $H = M^4 \times CP_2$ (to be referred as WCW CH or WCW in the sequel) is the oldest and best developed approach to TGD and means generalization of Einstein's program of geometrizing classical physics so that it applies to entire quantum physics [K71]. There are two natural identifications for the 3-surfaces.

1. By general coordinate invariance light-like 3-surfaces can be identified as orbits of wormhole throats at which the signature of the induced metric changes from a Minkowskian signature of space-time sheet to that of deformed CP_2 type vacuum extremal representing elementary particle. One can interpret so called CP_2 type vacuum extremals as lines of generalized Feynman diagrams so that geometrization and generalization of the notion of Feynman diagram emerges.

2. In zero energy ontology causal diamonds (CDs, (see fig. **??** in `thttp://www.tgdtheory.fi/appfigures/heappendixofthisbook)of$M^4$defined.jpg`, which is also as intersection of future and past directed light-cones become define basic building bricks of WCW. The space-time surfaces belonging to CD having their 3-D future and past ends at the light-like boundaries of CD become the basic objects. The ends are 3-surfaces are space-like and come in pairs. WCW decomposes into a union over sub-WCWs associated with various CDs and their unions and the space-like ends of the space-time sheets at future and past boundaries of CD become very natural fundamental objects.

The condition that the two identifications of 3-surfaces are equivalent implies that all information about the geometry of WCW and quantum physics is coded by the 2-dimensional intersections of the space-like and light-like 3-surfaces at the boundaries of CDs plus the information about the distribution of 4-D tangent spaces of the space-time sheet at these surfaces. I have christened partonic 2-surfaces since they are carriers of various quantum numbers. Therefore 4-D General Coordinate invariance implies effective 2-dimensionality and quantum holography. The effective two-dimensionality is implies also by general consistency conditions related to conformal symmetries: this became obvious much before the emergence of zero energy ontology and led to interpretational difficulties at that time. The non-determinism of Kähler action defining space-time dynamics in the standard sense of the word implies that effective 2-dimensionality holds only locally.

WCW is endowed with Kähler metric guaranteeing the geometrization of hermitian conjugation of quantum theory.

1. The conjecture inspired by the geometry of loop spaces [A12] is that H is fixed from the mere requirement that the infinite-dimensional Kähler geometry exists. WCW must reduce to a union of symmetric spaces having infinite-dimensional isometry groups and labeled by zero modes having interpretation as classical dynamical variables. This requires infinite-dimensional symmetry groups. At space-time level super-conformal symmetries are possible only if the basic dynamical objects can be identified as light-like or space-like 3-surfaces. At imbedding space level there are extended super-conformal symmetries assignable to the light-cone of H if the Minkowski space factor is four-dimensional.

   Equivalence Principle seems obvious in the stringy picture provided by recent view about TGD and might indeed reduce to a mere tautology. My belief has been however that the EP is non-trivial. The question whether it is possible to define gravitational and inertial masses and understand their equivalence has been however a continual headache in TGD. The proper realization of EP at quantum level seems to be based on the identification of classical Noether charges in Cartan algebra with the eigenvalues of their quantum counterparts assignable to Kähler-Dirac action. At classical level EP follows at GRT limit obtained by lumping many-sheeted space-time to M^4 with effective metric satisfying Einstein's equations as a reflection of the underlying Poincare invariance [K92].

   One can consider also the possibility that their generalization holds true for preferred extremals in all scales. Generalization would involve cosmological constant or even two of them and depending on position. A string model type description emerges in a finite measurement resolution when light-like 3-surfaces are replaced by braids. This means also quantum holography. In positive energy ontology General Coordinate Invariance implies that classical space-time physics becomes an exact part of quantum theory in the sense that space-time sheets are analogous to Bohr orbits. In zero energy ontology (ZEO) 3-surfaces are untions of the space-like ends of space-time surface at the opposite boundaries of CD and in this kind of situation it might be that there is no need to talk about preferred extremals. The non-determinism of Kähler action might however change the situation.

2. The condition that the symmetries of standard model are realized geometrically and that one can understand the known quantum numbers characterizing elementary particles in terms of the geometry of the imbedding space, leads to a unique choice for the imbedding space as $H = M^4 \times CP_2$. The challenge is to understand what makes this choice so special and number theoretic approach based on classical number fields allows to interpret this choice number theoretically so that the standard model symmetries find a number theoretical interpretation.

2.2.2 Geometrization of fermionic statistics in terms of WCW spinor structure

The great vision has been that the second quantization of the induced spinor fields can be understood geometrically in terms of the WCW spinor structure in the sense that the anti-commutation relations for WCW gamma matrices require anti-commutation relations for the oscillator operators for free second quantized induced spinor fields defined at space-time surface.

1. One must identify the counterparts of second quantized fermion fields as objects closely related to the configuration space spinor structure. Ramond model [B14] has as its basic field the anti-commuting field $\Gamma^k(x)$, whose Fourier components are analogous to the gamma matrices of the configuration space and which behaves like a spin 3/2 fermionic field rather than a vector field. This suggests that the are analogous to spin 3/2 fields and therefore expressible in terms of the fermionic oscillator operators so that their naturally derives from the anti-commutativity of the fermionic oscillator operators.

   WCW spinor fields can have arbitrary fermion number and there are good hopes of describing the whole physics in terms of WCW spinor field. Clearly, fermionic oscillator operators would act in degrees of freedom analogous to the spin degrees of freedom of the ordinary spinor and bosonic oscillator operators would act in degrees of freedom analogous to the 'orbital' degrees of freedom of the ordinary spinor field. One non-trivial implication is bosonic emergence: elementary bosons correspond to fermion anti-fermion bound states associated with the wormhole contacts (pieces of CP_2 type vacuum extremals) with throats carrying fermion and anti-fermion numbers. Fermions correspond to single throats associated with topologically condensed CP_2 type vacuum extremals.

2. The classical theory for the bosonic fields is an essential part of WCW geometry. It would be very nice if the classical theory for the spinor fields would be contained in the definition of the WCW spinor structure somehow. The properties of the associated with the induced spinor structure are indeed very physical. The modified massless Dirac equation for the induced spinors predicts a separate conservation of baryon and lepton numbers. The differences between quarks and leptons result from the different couplings to the CP_2 Kähler potential. In fact, these properties are shared by the solutions of massless Dirac equation of the imbedding space.

3. Since TGD should have a close relationship to the ordinary quantum field theories it would be highly desirable that the second quantized free induced spinor field would somehow appear in the definition of the WCW geometry. This is indeed true if the complexified WCW gamma matrices are linearly related to the oscillator operators associated with the second quantized induced spinor field on the space-time surface and its boundaries. There is actually no deep reason forbidding the gamma matrices of WCW to be spin half odd-integer objects whereas in the finite-dimensional case this is not possible in general. In fact, in the finite-dimensional case the equivalence of the spinorial and vectorial vielbeins forces the spinor and vector representations of the vielbein group $SO(D)$ to have same dimension and this is possible for $D = 8$-dimensional Euclidian space only. This coincidence might explain the success of 10-dimensional super string models for which the physical degrees of freedom effectively correspond to an 8-dimensional Euclidian space.

4. It took a long time to realize that the ordinary definition of the gamma matrix algebra in terms of the anti-commutators $\{\gamma_A, \gamma_B\} = 2g_{AB}$ must in TGD context be replaced with

$$\{\gamma_A^\dagger, \gamma_B\} = iJ_{AB} \quad ,$$

where J_{AB} denotes the matrix elements of the Kähler form of WCW. The presence of the Hermitian conjugation is necessary because WCW gamma matrices carry fermion number. This definition is numerically equivalent with the standard one in the complex coordinates. The realization of this delicacy is necessary in order to understand how the square of the WCW Dirac operator comes out correctly.

2.2.3 Construction of WCW Clifford algebra in terms of second quantized induced spinor fields

The construction of WCW spinor structure must have a direct relationship to quantum physics as it is usually understood. The second quantization of the space-time spinor fields is needed to define the anti-commutative gamma matrices of WCW: this means a geometrization of Fermi statistics [K15] in the sense that free fermionic quantum fields at space-time surface correspond to purely classical Clifford algebra of WCW. This is in accordance with the idea that physics at WCW level is purely classical apart from the notion of quantum jump.

The identification of the correct variational principle for the dynamics of space-time spinor fields identified as induced spinor fields has involved many trials. Ironically, the final outcome was almost the most obvious guess. The so called Kähler-Dirac action with Chern-Simons-Dirac term at partonic orbits and corresponding Chern-Simons term in Kähler action cancelling the partonic Chern-Simons terms coming from Kähler action is the starting point. C-S-D action defines fermionic propagators as massless propagators if the spinor modes are eigenstates of the C-S-D operator with generalized eigenvalues $p^k \gamma_k$ representing virtual momenta.

Quantum classical correspondence suggests with measurement interaction term defined as Lagrange multiplier terms stating that classical charges belonging to Cartan algebra are equal to their quantal counterparts after state function reduction for space-time surfaces appearing in quantum superposition [K25]. This makes sense if classical charges parametrize zero modes. State function reduction would mean state function collapse in zero modes.

Kähler function which equals to the real part of Kähler action coming from Euclidian space-time regions for a preferred extremal. The conjecture is that preferred extremals by internal consistency conditions is critical in the sense that it allows infinite number of vanishing second variations having interpretation as conformal deformations respecting light-likeness of the partonic orbits. This realizes the notion of quantum criticality-one of guiding principles of quantum TGD-at space-time level.

Number theoretical approach in turn leads to the conclusion that space-time surfaces are either associative or co-associative in the sense that the modified gamma matrices at each point of space-time surface in their octonionic representation reduces to a quaternionic or co-quaternionic algebra and therefore have matrix representation. The conjecture is that these identifications of space-time dynamics are consistent or even equivalent.

The recent understanding of the modified Dirac action has emerged through a painful process and has strong physical implications.

1. Stringy propagators and emerge naturally thanks to the measurement interaction term in the modified Dirac action coupling to four-momentum and color hyper-charge and isospin.

2. The space-time super-symmetry generalizes to what might be called $\mathcal{N} = \infty$ supersymmetry which however effectively reduces to $\mathcal{N} = 1$ broken super-symmetry [K26]. The generators of the super-symmetry correspond to the modes of the induced spinor field at space-time sheet. Bosonic emergence means dramatic simplifications in the formulation of QFT limit of TGD. This formulation should generalize also to the level of the fundamental theory.

3. It is also possible to generalize the twistor program to TGD framework if one accepts the use of octonionic representation of the gamma matrices of imbedding space and hyper-quaternionicity of space-time surfaces [K98].

2.2.4 Zero energy ontology and WCW geometry

In the zero energy ontology quantum states have vanishing net values of conserved quantum numbers and decompose to superposition of pairs of positive and negative energy states defining coun-

terparts of initial and final states of a physical event in standard ontology.

Zero energy ontology

Zero energy ontology was forced by the interpretational problems created by the vacuum extremal property of Robertson-Walker cosmologies imbedded as 4-surfaces in $M^4 \times CP_2$ meaning that the density of inertial mass (but not gravitational mass) for these cosmologies was vanishing meaning a conflict with Equivalence Principle. The most feasible resolution of the conflict comes from the realization that GRT space-time is obtained by lumping the sheets of many-sheeted space-time to M^4 endowed with effective metric. Vacuum extremals could however serve as models for GRT space-times such that the effective metric is identified with the induced metric [K92]. This is true if space-time is genuinely single-sheeted. In the models of astrophysical objects and cosmology vacuum extremals have been used [K80].

In zero energy ontology physical states are replaced by pairs of positive and negative energy states assigned to the past *resp.* future boundaries of causal diamonds defined as pairs of future and past directed light-cones ($\delta M^4_\pm \times CP_2$). The net values of all conserved quantum numbers of zero energy states vanish. Zero energy states are interpreted as pairs of initial and final states of a physical event such as particle scattering so that only events appear in the new ontology. It is possible to speak about the energy of the system if one identifies it as the average positive energy for the positive energy part of the system. Same applies to other quantum numbers.

The matrix ("M-matrix") representing time-like entanglement coefficients between positive and negative energy states unifies the notions of S-matrix and density matrix since it can be regarded as a complex square root of density matrix expressible as a product of real squared of density matrix and unitary S-matrix. The system can be also in thermal equilibrium so that thermodynamics becomes a genuine part of quantum theory and thermodynamical ensembles cease to be practical fictions of the theorist. In this case M-matrix represents a superposition of zero energy states for which positive energy state has thermal density matrix.

Zero energy ontology combined with the notion of quantum jump resolves several problems. For instance, the troublesome questions about the initial state of universe and about the values of conserved quantum numbers of the Universe can be avoided since everything is in principle creatable from vacuum. Communication with the geometric past using negative energy signals and time-like entanglement are crucial for the TGD inspired quantum model of memory and both make sense in zero energy ontology. Zero energy ontology leads to a precise mathematical characterization of the finite resolution of both quantum measurement and sensory and cognitive representations in terms of inclusions of von Neumann algebras known as hyperfinite factors of type II$_1$. The space-time correlate for the finite resolution is discretization which appears also in the formulation of quantum TGD.

Causal diamonds

The imbedding space correlates for zero energy ontology are causal diamonds (CDs) CD serves as the correlate zero energy state at imbedding space-level whereas space-time sheets having their ends at the light-like boundaries of CD are the correlates of the system at the level of 4-D space-time. Zero energy state can be regarded as a quantum superposition of space-time sheets with fermionic and other quantum numbers assignable to the partonic 2-surfaces at the ends of the space-time sheets.

1. The basic construct in the zero energy ontology is the space $CD \times CP_2$, where the causal diamond CD is defined as an intersection of future and past directed light-cones with time-like separation between their tips regarded as points of the underlying universal Minkowski space M^4. In zero energy ontology physical states correspond to pairs of positive and negative energy states located at the boundaries of the future and past directed light-cones of a particular CD.

2. CDs form a fractal hierarchy and one can glue smaller CDs within larger CDs. Also unions of CDs are possible.

3. Without any restrictions CDs would be parametrized by the position of say lower tip of CD and by the relative M^4 coordinates of the upper tip with respect to the lower one so that

the moduli space would be $M^4 \times M_+^4$. p-Adic length scale hypothesis follows if the values of temporal distance T between tips of CD come in powers of 2^n: $T = 2^n T_0$. This would reduce the future light-cone M_+^4 reduces to a union of hyperboloids with quantized value of light-cone proper time. A possible interpretation of this distance is as a quantized cosmic time. Also the quantization of the hyperboloids to a lattices of discrete points classified by discrete sub-groups of Lorentz group is an attractive proposal and the quantization of cosmic redshifts provides some support for it.

Zero energy ontology forces to replaced the original WCW by a union of WCWs associated with CDs and their unions. This does not however mean any problems of principle since Clifford algebras are simply tensor products of the Clifford algebras of CDs for the unions of CDs.

Generalization of S-matrix in ZEO

ZEO forces the generalization of S-matrix with a triplet formed by U-matrix, M-matrix, and S-matrix. The basic vision is that quantum theory is at mathematical level a complex square roots of thermodynamics. What happens in quantum jump was already discussed.

1. U-matrix as has its rows M-matrices , which are matrices between positive and negative energy parts of the zero energy state and correspond to the ordinary S-matrix. M-matrix is a product of a hermitian square root - call it H - of density matrix ρ and universal S-matrix S commuting with H: $[S, H] = 0$. There is infinite number of different Hermitian square roots H_i of density matrices which are assumed to define orthogonal matrices with respect to the inner product defined by the trace: $Tr(H_i H_j) = 0$. Also the columns of U-matrix are orthogonal. One can interpret square roots of the density matrices as a Lie algebra acting as symmetries of the S-matrix.

2. One can consider generalization of M-matrices so that they would be analogous to the elements of Kac-Moody algebra. These M-matrices would involve all powers of S.

   (a) The orthogonality with respect to the inner product defined by $\langle A|B \rangle = Tr(AB)$ requires the conditions $Tr(H_1 H_2 S^n) = 0$ for $n \neq 0$ and H_i are Hermitian matrices appearing as square root of density matrix. $H_1 H_2$ is hermitian if the commutator $[H_1, H_2]$ vanishes. It would be natural to assign n:th power of S to the CD for which the scale is n times the CP_2 scale.

   (b) Trace - possibly quantum trace for hyper-finite factors of type II_1) is the analog of integration and the formula would be a non-commutative analog of the identity $\int_{S^1} exp(in\phi)d\phi = 0$ and pose an additional condition to the algebra of M-matrices.

   (c) It might be that one must restrict M matrices to a Cartan algebra for a given U-matrix and also this choice would be a process analogous to state function reduction. Since density matrix becomes an observable in TGD Universe, this choice could be seen as a direct counterpart for the choice of a maximal number of commuting observables which would be now hermitian square roots of density matrices. Therefore ZEO gives good hopes of reducing basic quantum measurement theory to infinite-dimensional Lie-algebra.

   1. The first guess is wrong

The definition of U-matrix elements as a matrix inducing a change of basis requires two natural state basis. The first guess is that the following two state basis are natural and unitarily related.

1. The pairs of positive and negative energy states with same quantum numbers.

2. The states obtained by entangling positive and negative energy states with various M-matrices.

If these state basics are in one-one correspondence then the orthogonality of the rows of U-matrix means that different M-matrices are orthogonal. The orthogonality of columns of U-matrix means that for the pair $|m_1\rangle_+|n_1\rangle_-$ and $|m_2\rangle_+|n_2\rangle_-$ of zero energy states gives

$$\sum_K M^K_{m_1 n_1} \overline{M^K}_{m_2 n_2} = \delta_{m_1,m_2} \delta_{n_1,n_2} \quad .$$

The first guess is however not physically acceptable. The assumption that all pairs $|m_1\rangle_+ |n_1\rangle_-$ are allowed as a complete set of states would mean complete non-determinism since correlations between the counterparts of initial and finals states would be absent apart from those induced by zero energy property.

2. Second guess for the two state basis

A better guess is that the collections of M-matrices defined as time reversals of each other define the sought for two natural state basis.

1. As for ordinary S-matrix, one can construct the states in such a manner that either positive or negative energy part of the state has well defined particle numbers, spin, etc... resulting in state function preparation. Therefore one has two kinds of M-matrices: $M^{\pm}_K$ and for both of these the above orthogonality relations hold true. This implies also two kinds of U-matrices call them $U^{\pm}$. The natural assumption is that the two M-matrices differ only by Hermitian conjugation so that one would have $M^-_K = (M^+_K)^{\dagger}$.

   One can assign opposite arrows of geometric time to these states and the proposal is that the arrow of time is a result of a process analogous to spontaneous magnetization. The possibility that the arrow of geometric time could change in quantum jump has been already discussed.

2. Unitary U-matrix $U^{\pm}$ is induced from a projector to the zero energy state basis $|K^{\pm}\rangle$ acting on the state basis $|K^{\mp}\rangle$ and the matrix elements of U-matrix are obtained by acting with the representation of identity matrix in the space of zero energy states as $I = \sum_K |K^+\rangle\langle K^+|$ on the zero energy state $|K^-\rangle$ (the action on K^+ is trivial!) and gives

$$U^+_{KL} = Tr(M^+_K M^+_L) \quad .$$

   Note that finite measurement resolution requires that the trace operation is q-trace rather than ordinary trace.

3. As the detailed discussion of the anatomy of quantum jump demonstrated, the first step in state function reduction is the choice of $M^{\pm}_K$ meaning the choice of the hermitian square root of a density matrix. A quantal selection of the measured observable takes place. This step is followed by a choice of "initial" state analogous to state function preparation and a choice of the "final state" analogous to state function reduction. The net outcome is the transition $|K^{\pm}\rangle \to |L^{\pm}\rangle$. It could also happen that instead of state function reduction as third step unitary process $U^{\mp}$ (note the change of the sign factor!) takes place and induces the change of the arrow of geometric time.

4. As noticed, one can imagine even higher level choices and this would correspond to the choice of the commuting set of hermitian matrices H defining the allowed square roots of density matrices as a set of mutually commuting observables. This would fix the choices of U.

2.2.5 Hierarchy of Planck constants and WCW geometry

The motivations for introducing the hierarchy of Planck constants interpreted in terms of phases of dark matter came from astrophysics [E8] [K79, K57] and biology [K66] and led to a generalization of the imbedding space to a book like structure [K24]. This implies additional richness of structure at the level of geometry of WCW. In the following the recent view about structure of imbedding space forced by the quantization of Planck constant is summarized.

The evolution of physical ideas about hierarchy of Planck constants

The evolution of the physical ideas related to the hierarchy of Planck constants and dark matter as a hierarchy of phases of matter with non-standard value of Planck constants was much faster than the evolution of mathematical ideas and quite a number of applications have been developed during last five years [K24, K61, K79].

1. The starting point was the proposal of Nottale [E8] that the orbits of inner planets correspond to Bohr orbits with Planck constant $\hbar_{gr} = GMm/v_0$ and outer planets with Planck constant $\hbar_{gr} = 5GMm/v_0$, $v_0/c \simeq 2^{-11}$. The basic proposal [K79] was that ordinary matter condenses around dark matter which is a phase of matter characterized by a non-standard value of Planck constant whose value is gigantic for the space-time sheets mediating gravitational interaction. The interpretation of these space-time sheets could be as magnetic flux quanta or as massless extremals assignable to gravitons.

2. Ordinary particles possibly residing at these space-time sheet have enormous value of Compton length meaning that the density of matter at these space-time sheets must be very slowly varying. The string tension of string like objects implies effective negative pressure characterizing dark energy so that the interpretation in terms of dark energy might make sense [K80]. TGD predicted a one-parameter family of Robertson-Walker cosmologies with critical or over-critical mass density and the "pressure" associated with these cosmologies is negative.

3. The quantization of Planck constant does not make sense unless one modifies the view about standard space-time is. Particles with different Planck constant must belong to different worlds in the sense local interactions of particles with different values of $\hbar$ are not possible. This inspires the idea about the book like structure of the imbedding space obtained by gluing almost copies of H together along common "back" and partially labeled by different values of Planck constant.

4. Darkness is a relative notion in this framework and due to the fact that particles at different pages of the book like structure cannot appear in the same vertex of the generalized Feynman diagram. The phase transitions in which partonic 2-surface X^2 during its travel along X_l^3 leaks to another page of book are however possible and change Planck constant. Particle (say photon -) exchanges of this kind allow particles at different pages to interact. The interactions are strongly constrained by charge fractionization and are essentially phase transitions involving many particles. Classical interactions are also possible. It might be that we are actually observing dark matter via classical fields all the time and perhaps have even photographed it [K90].

5. The realization that non-standard values of Planck constant give rise to charge and spin fractionization and anyonization led to the precise identification of the prerequisites of anyonic phase [K61]. If the partonic 2-surface, which can have even astrophysical size, surrounds the tip of CD, the matter at the surface is anyonic and particles are confined at this surface. Dark matter could be confined inside this kind of light-like 3-surfaces around which ordinary matter condenses. If the radii of the basic pieces of these nearly spherical anyonic surfaces - glued to a connected structure by flux tubes mediating gravitational interaction - are given by Bohr rules, the findings of Nottale [E8] can be understood. Dark matter would resemble to a high degree matter in black holes replaced in TGD framework by light-like partonic 2-surfaces with a minimum size of order Schwartschild radius r_S of order scaled up Planck length $l_{Pl} = \sqrt{\hbar_{gr}G} = GM$. Black hole entropy is inversely proportional to $\hbar$ and predicted to be of order unity so that dramatic modification of the picture about black holes is implied.

6. Perhaps the most fascinating applications are in biology. The anomalous behavior ionic currents through cell membrane (low dissipation, quantal character, no change when the membrane is replaced with artificial one) has a natural explanation in terms of dark supra currents. This leads to a vision about how dark matter and phase transitions changing the value of Planck constant could relate to the basic functions of cell, functioning of DNA and amino-acids, and to the mysteries of bio-catalysis. This leads also a model for EEG interpreted as a communication and control tool of magnetic body containing dark matter and using biological body as motor instrument and sensory receptor. One especially amazing outcome is the emergence of genetic code of vertebrates from the model of dark nuclei as nuclear strings [L10, K90].

The most general option for the generalized imbedding space

Simple physical arguments pose constraints on the choice of the most general form of the imbedding space.

1. The fundamental group of the space for which one constructs a non-singular covering space or factor space should be non-trivial. This is certainly not possible for M^4, CD, CP_2, or H. One can however construct singular covering spaces. The fixing of the quantization axes implies a selection of the sub-space $H_4 = M^2 \times S^2 \subset M^4 \times CP_2$, where S^2 is geodesic sphere of CP_2. $\hat{M}^4 = M^4 \backslash M^2$ and $\hat{CP}_2 = CP_2 \backslash S^2$ have fundamental group Z since the codimension of the excluded sub-manifold is equal to two and homotopically the situation is like that for a punctured plane. The exclusion of these sub-manifolds defined by the choice of quantization axes could naturally give rise to the desired situation.

2. CP_2 allows two geodesic spheres which left invariant by $U(2$ *resp.* $SO(3)$. The first one is homologically non-trivial. For homologically non-trivial geodesic sphere $H_4 = M^2 \times S^2$ represents a straight cosmic string which is non-vacuum extremal of Kähler action (not necessarily preferred extremal). One can argue that the many-valuedness of $\hbar$ is un-acceptable for non-vacuum extremals so that only homologically trivial geodesic sphere S^2 would be acceptable. One could go even further. If the extremals in $M^2 \times CP_2$ can be preferred non-vacuum extremals, the singular coverings of M^4 are not possible. Therefore only the singular coverings and factor spaces of CP_2 over the homologically trivial geodesic sphere S^2 would be possible. This however looks a non-physical outcome.

   (a) The situation changes if the extremals of type $M^2 \times Y^2$, Y^2 a holomorphic surface of CP_3, fail to be hyperquaternionic. The tangent space M^2 represents hypercomplex sub-space and the product of the modified gamma matrices associated with the tangent spaces of Y^2 should belong to M^2 algebra. This need not be the case in general.

   (b) The situation changes also if one reinterprets the gluing procedure by introducing scaled up coordinates for M^4 so that metric is continuous at $M^2 \times CP_2$ but CDs with different size have different sizes differing by the ratio of Planck constants and would thus have only piece of lower or upper boundary in common.

3. For the more general option one would have four different options corresponding to the Cartesian products of singular coverings and factor spaces. These options can be denoted by $C - C$, $C - F$, $F - C$, and $F - F$, where C (F) signifies for covering (factor space) and first (second) letter signifies for CD (CP_2) and correspond to the spaces $(\hat{CD} \hat{\times} G_a) \times (\hat{CP}_2 \hat{\times} G_b)$, $(\hat{CD} \hat{\times} G_a) \times \hat{CP}_2 / G_b$, $\hat{CD} / G_a \times (\hat{CP}_2 \hat{\times} G_b)$, and $\hat{CD} / G_a \times \hat{CP}_2 / G_b$.

4. The groups G_i could correspond to cyclic groups Z_n. One can also consider an extension by replacing M^2 and S^2 with its orbit under more general group G (say tetrahedral, octahedral, or icosahedral group). One expects that the discrete subgroups of $SU(2)$ emerge naturally in this framework if one allows the action of these groups on the singular sub-manifolds M^2 or S^2. This would replace the singular manifold with a set of its rotated copies in the case that the subgroups have genuinely 3-dimensional action (the subgroups which corresponds to exceptional groups in the ADE correspondence). For instance, in the case of M^2 the quantization axes for angular momentum would be replaced by the set of quantization axes going through the vertices of tetrahedron, octahedron, or icosahedron. This would bring non-commutative homotopy groups into the picture in a natural manner.

About the phase transitions changing Planck constant

There are several non-trivial questions related to the details of the gluing procedure and phase transition as motion of partonic 2-surface from one sector of the imbedding space to another one.

1. How the gluing of copies of imbedding space at $M^2 \times CP_2$ takes place? It would seem that the covariant metric of CD factor proportional to $\hbar^2$ must be discontinuous at the singular manifold since only in this manner the idea about different scaling factor of CD metric can make sense. On the other hand, one can always scale the M^4 coordinates so that the metric

is continuous but the sizes of CDs with different Planck constants differ by the ratio of the Planck constants.

2. One might worry whether the phase transition changing Planck constant means an instantaneous change of the size of partonic 2-surface in M^4 degrees of freedom. This is not the case. Light-likeness in $M^2 \times S^2$ makes sense only for surfaces $X^1 \times D^2 \subset M^2 \times S^2$, where X^1 is light-like geodesic. The requirement that the partonic 2-surface X^2 moving from one sector of H to another one is light-like at $M^2 \times S^2$ irrespective of the value of Planck constant requires that X^2 has single point of M^2 as M^2 projection. Hence no sudden change of the size X^2 occurs.

3. A natural question is whether the phase transition changing the value of Planck constant can occur purely classically or whether it is analogous to quantum tunnelling. Classical non-vacuum extremals of Chern-Simons action have two-dimensional CP_2 projection to homologically non-trivial geodesic sphere S_I^2. The deformation of the entire S_I^2 to homologically trivial geodesic sphere S_{II}^2 is not possible so that only combinations of partonic 2-surfaces with vanishing total homology charge (Kähler magnetic charge) can in principle move from sector to another one, and this process involves fusion of these 2-surfaces such that CP_2 projection becomes single homologically trivial 2-surface. A piece of a non-trivial geodesic sphere S_I^2 of CP_2 can be deformed to that of S_{II}^2 using 2-dimensional homotopy flattening the piece of S^2 to curve. If this homotopy cannot be chosen to be light-like, the phase transitions changing Planck constant take place only via quantum tunnelling. Obviously the notions of light-like homotopies (cobordisms) are very relevant for the understanding of phase transitions changing Planck constant.

How one could fix the spectrum of Planck constants?

The question how the observed Planck constant relates to the integers n_a and n_b defining the covering and factors spaces, is far from trivial and I have considered several options. The basic physical inputs are the condition that scaling of Planck constant must correspond to the scaling of the metric of CD (that is Compton lengths) on one hand and the scaling of the gauge coupling strength $g^2/4\pi\hbar$ on the other hand.

1. One can assign to Planck constant to both CD and CP_2 by assuming that it appears in the commutation relations of corresponding symmetry algebras. Algebraist would argue that Planck constants $\hbar(CD)$ and $\hbar(CP_2)$ must define a homomorphism respecting multiplication and division (when possible) by G_i. This requires $r(X) = \hbar(X)\hbar_0 = n$ for covering and $r(X) = 1/n$ for factor space or vice versa.

2. If one assumes that $\hbar^2(X)$, $X = M^4$, CP_2 corresponds to the scaling of the covariant metric tensor g_{ij} and performs an over-all scaling of H-metric allowed by the Weyl invariance of Kähler action by dividing metric with $\hbar^2(CP_2)$, one obtains the scaling of M^4 covariant metric by $r^2 \equiv \hbar^2/\hbar_0^2 = \hbar^2(M^4)/\hbar^2(CP_2)$ whereas CP_2 metric is not scaled at all.

3. The condition that $\hbar$ scales as n_a is guaranteed if one has $\hbar(CD) = n_a\hbar_0$. This does not fix the dependence of $\hbar(CP_2)$ on n_b and one could have $\hbar(CP_2) = n_b\hbar_0$ or $\hbar(CP_2) = \hbar_0/n_b$. The intuitive picture is that n_b- fold covering gives in good approximation rise to $n_a n_b$ sheets and multiplies YM action action by $n_a n_b$ which is equivalent with the $\hbar = n_a n_b \hbar_0$ if one effectively compresses the covering to $CD \times CP_2$. One would have $\hbar(CP_2) = \hbar_0/n_b$ and $\hbar = n_a n_b \hbar_0$. Note that the descriptions using ordinary Planck constant and coverings and scaled Planck constant but contracting the covering would be alternative descriptions.

   This gives the following formulas $r \equiv \hbar/\hbar_0 = r(M^4)/r(CP_2)$ in various cases.

	$C - C$	$F - C$	$C - F$	$F - F$
r	$n_a n_b$	$\frac{n_a}{n_b}$	$\frac{n_b}{n_a}$	$\frac{1}{n_a n_b}$

Preferred values of Planck constants

Number theoretic considerations favor the hypothesis that the integers corresponding to Fermat polygons constructible using only ruler and compass and given as products $n_F = 2^k \prod_s F_s$, where $F_s = 2^{2^s} + 1$ are distinct Fermat primes, are favored. The reason would be that quantum phase $q = exp(i\pi/n)$ is in this case expressible using only iterated square root operation by starting from rationals. The known Fermat primes correspond to $s = 0, 1, 2, 3, 4$ so that the hypothesis is very strong and predicts that p-adic length scales have satellite length scales given as multiples of n_F of fundamental p-adic length scale. $n_F = 2^{11}$ corresponds in TGD framework to a fundamental constant expressible as a combination of Kähler coupling strength, CP_2 radius and Planck length appearing in the expression for the tension of cosmic strings, and the powers of 2^{11} seem to be especially favored as values of n_a in living matter [K20].

How Planck constants are visible in Kähler action?

$\hbar(M^4)$ and $\hbar(CP_2)$ appear in the commutation and anti-commutation relations of various super-conformal algebras. Only the ratio of M^4 and CP_2 Planck constants appears in Kähler action and is due to the fact that the M^4 and CP_2 metrics of the imbedding space sector with given values of Planck constants are proportional to the corresponding Planck constants [K24]. This implies that Kähler function codes for radiative corrections to the classical action, which makes possible to consider the possibility that higher order radiative corrections to functional integral vanish as one might expect at quantum criticality. For a given p-adic length scale space-time sheets with all allowed values of Planck constants are possible. Hence the spectrum of quantum critical fluctuations could in the ideal case correspond to the spectrum of $\hbar$ coding for the scaled up values of Compton lengths and other quantal lengths and times. If so, large $\hbar$ phases could be crucial for understanding of quantum critical superconductors, in particular high T_c superconductors.

Implications for the construction WCW geometry

1. In the realization of the hierarchy of Planck constants $CD \times CP_2$ is replaced with a Cartesian product of book like structures formed by almost copies of CDs and CP_2s defined by singular coverings and factors spaces of CD and CP_2 with singularities corresponding to intersection $M^2 \cap CD$ and homologically trivial geodesic sphere S^2 of CP_2 for which the induced Kähler form vanishes. The coverings and factor spaces of CDs are glued together along common $M^2 \cap CD$. The coverings and factors spaces of CP_2 are glued together along common homologically non-trivial geodesic sphere S^2. The choice of preferred M^2 as subspace of tangent space of X^4 at all its points and interpreted as space of non-physical polarizations, brings M^2 into the theory also in different manner. S^2 in turn defines a subspace of the much larger space of vacuum extremals as surfaces inside $M^4 \times S^2$.

2. WCW (the world of classical worlds, WCW) decomposes into a union of sub-WCWs corresponding to different choices of M^2 and S^2 and also to different choices of the quantization axes of spin and energy, color isospin and hyper-charge for each choice of this kind. This means breaking down of the isometries to a subgroup. This can be compensated by the fact that the union can be taken over the different choices of this subgroup.

3. This means extension of the moduli space of CDs from $M^4 \times X$, where $X \subset M^4_+$ is suggested to be identifiable as a discrete lattice for the relative positions of the tips of CD. What is added is the space characterizing the choice of the quantization axes for energy and spin on one hand and color hypercharge and isospin on the other hand. This choice is part of a statefunction reduction process and means localization in this space. In the case of color charges the moduli space is the flag-manifold $SU(3)/U(1) \times U(1)$.

2.2.6   Hyper-finite factors and the notion of measurement resolution

The work with TGD inspired model [K97, K23] for topological quantum computation [K97] led to the realization that von Neumann algebras [A10], in particular so called hyper-finite factors of type II_1 [A18], seem to provide the mathematics needed to develop a more explicit view about the construction of S-matrix. Later came the realization that the Clifford algebra of WCW defines a

canonical representation of hyper-finite factors of type II_1 and that WCW spinor fields give rise to HFFs of type III_1 encountered also in relativistically invariant quantum field theories [K100].

Philosophical ideas behind von Neumann algebras

The goal of von Neumann was to generalize the algebra of quantum mechanical observables. The basic ideas behind the von Neumann algebra are dictated by physics. The algebra elements allow Hermitian conjugation $*$ and observables correspond to Hermitian operators. Any measurable function $f(A)$ of operator A belongs to the algebra and one can say that non-commutative measure theory is in question.

The predictions of quantum theory are expressible in terms of traces of observables. Density matrix defining expectations of observables in ensemble is the basic example. The highly non-trivial requirement of von Neumann was that identical a priori probabilities for a detection of states of infinite state system must make sense. Since quantum mechanical expectation values are expressible in terms of operator traces, this requires that unit operator has unit trace: $tr(Id) = 1$.

In the finite-dimensional case it is easy to build observables out of minimal projections to 1-dimensional eigen spaces of observables. For infinite-dimensional case the probably of projection to 1-dimensional sub-space vanishes if each state is equally probable. The notion of observable must thus be modified by excluding 1-dimensional minimal projections, and allow only projections for which the trace would be infinite using the straightforward generalization of the matrix algebra trace as the dimension of the projection.

The non-trivial implication of the fact that traces of projections are never larger than one is that the eigen spaces of the density matrix must be infinite-dimensional for non-vanishing projection probabilities. Quantum measurements can lead with a finite probability only to mixed states with a density matrix which is projection operator to infinite-dimensional subspace. The simple von Neumann algebras for which unit operator has unit trace are known as factors of type II_1 [A18].

The definitions of adopted by von Neumann allow however more general algebras. Type I_n algebras correspond to finite-dimensional matrix algebras with finite traces whereas I_∞ associated with a separable infinite-dimensional Hilbert space does not allow bounded traces. For algebras of type III non-trivial traces are always infinite and the notion of trace becomes useless being replaced by the notion of state which is generalization of the notion of thermodynamical state. The fascinating feature of this notion of state is that it defines a unique modular automorphism of the factor defined apart from unitary inner automorphism and the question is whether this notion or its generalization might be relevant for the construction of M-matrix in TGD.

Von Neumann, Dirac, and Feynman

The association of algebras of type I with the standard quantum mechanics allowed to unify matrix mechanism with wave mechanics. Note however that the assumption about continuous momentum state basis is in conflict with separability but the particle-in-box idealization allows to circumvent this problem (the notion of space-time sheet brings the box in physics as something completely real).

Because of the finiteness of traces von Neumann regarded the factors of type II_1 as fundamental and factors of type III as pathological. The highly pragmatic and successful approach of Dirac [K25] based on the notion of delta function, plus the emergence of generalized Feynman graphs [K33], the possibility to formulate the notion of delta function rigorously in terms of distributions [A26, A17], and the emergence of path integral approach [A23] meant that von Neumann approach was forgotten by particle physicists.

Algebras of type II_1 have emerged only much later in conformal and topological quantum field theories [A33, A24] allowing to deduce invariants of knots, links and 3-manifolds. Also algebraic structures known as bi-algebras, Hopf algebras, and ribbon algebras [A20, A19] relate closely to type II_1 factors. In topological quantum computation [K97] based on braid groups [A34] modular S-matrices they play an especially important role.

In algebraic quantum field theory [A14] defined in Minkowski space the algebras of observables associated with bounded space-time regions correspond quite generally to the type III_1 hyper-finite factor [A25, A6].

Hyper-finite factors in quantum TGD

The following argument suggests that von Neumann algebras known as hyper-finite factors (HFFs) of type II_1 and III_1- the latter appearing in relativistic quantum field theories provide also the proper mathematical framework for quantum TGD.

1. The Clifford algebra of the infinite-dimensional Hilbert space is a von Neumann algebra known as HFF of type II_1. There also the Clifford algebra at a given point (light-like 3-surface) of WCW is therefore HFF of type II_1. If the fermionic Fock algebra defined by the fermionic oscillator operators assignable to the induced spinor fields (this is actually not obvious!) is infinite-dimensional it defines a representation for HFF of type II_1. Super-conformal symmetry suggests that the extension of the Clifford algebra defining the fermionic part of a super-conformal algebra by adding bosonic super-generators representing symmetries of WCW respects the HFF property. It could however occur that HFF of type II_∞ results.

2. WCW is a union of sub-WCWs associated with causal diamonds (CD) defined as intersections of future and past directed light-cones. One can allow also unions of CDs and the proposal is that CDs within CDs are possible. Whether CDs can intersect is not clear.

3. The assumption that the M^4 proper distance a between the tips of CD is quantized in powers of 2 reproduces p-adic length scale hypothesis but one must also consider the possibility that a can have all possible values. Since $SO(3)$ is the isotropy group of CD, the CDs associated with a given value of a and with fixed lower tip are parameterized by the Lobatchevski space $L(a) = SO(3,1)/SO(3)$. Therefore the CDs with a free position of lower tip are parameterized by $M^4 \times L(a)$. A possible interpretation is in terms of quantum cosmology with a identified as cosmic time [K80]. Since Lorentz boosts define a non-compact group, the generalization of so called crossed product construction strongly suggests that the local Clifford algebra of WCW is HFF of type III_1. If one allows all values of a, one ends up with $M^4 \times M^4_+$ as the space of moduli for WCW.

Hyper-finite factors and M-matrix

HFFs of type III_1 provide a general vision about M-matrix [K100].

1. The factors of type III allow unique modular automorphism Δ^{it} (fixed apart from unitary inner automorphism). This raises the question whether the modular automorphism could be used to define the M-matrix of quantum TGD. This is not the case as is obvious already from the fact that unitary time evolution is not a sensible concept in zero energy ontology.

2. Concerning the identification of M-matrix the notion of state as it is used in theory of factors is a more appropriate starting point than the notion modular automorphism but as a generalization of thermodynamical state is certainly not enough for the purposes of quantum TGD and quantum field theories (algebraic quantum field theorists might disagree!). Zero energy ontology requires that the notion of thermodynamical state should be replaced with its "complex square root" abstracting the idea about M-matrix as a product of positive square root of a diagonal density matrix and a unitary S-matrix. This generalization of thermodynamical state -if it exists- would provide a firm mathematical basis for the notion of M-matrix and for the fuzzy notion of path integral.

3. The existence of the modular automorphisms relies on Tomita-Takesaki theorem [A30], which assumes that the Hilbert space in which HFF acts allows cyclic and separable vector serving as ground state for both HFF and its commutant. The translation to the language of physicists states that the vacuum is a tensor product of two vacua annihilated by annihilation oscillator type algebra elements of HFF and creation operator type algebra elements of its commutant isomorphic to it. Note however that these algebras commute so that the two algebras are not hermitian conjugates of each other. This kind of situation is exactly what emerges in zero energy ontology: the two vacua can be assigned with the positive and negative energy parts of the zero energy states entangled by M-matrix.

4. There exists infinite number of thermodynamical states related by modular automorphisms. This must be true also for their possibly existing "complex square roots". Physically they would correspond to different measurement interactions giving rise to Kähler functions of WCW differing only by a real part of holomorphic function of complex coordinates of WCW and arbitrary function of zero mode coordinates and giving rise to the same Kähler metric of WCW.

The concrete construction of M-matrix utilizing the idea of bosonic emergence (bosons as fermion anti-fermion pairs at opposite throats of wormhole contact) meaning that bosonic propagators reduce to fermionic loops identifiable as wormhole contacts leads to generalized Feynman rules for M-matrix in which modified Dirac action containing measurement interaction term defines stringy propagators [K18]. This M-matrix should be consistent with the above proposal.

Connes tensor product as a realization of finite measurement resolution

The inclusions $\mathcal{N} \subset \mathcal{M}$ of factors allow an attractive mathematical description of finite measurement resolution in terms of Connes tensor product [A9] but do not fix M-matrix as was the original optimistic belief.

1. In zero energy ontology $\mathcal{N}$ would create states experimentally indistinguishable from the original one. Therefore $\mathcal{N}$ takes the role of complex numbers in non-commutative quantum theory. The space $\mathcal{M}/\mathcal{N}$ would correspond to the operators creating physical states modulo measurement resolution and has typically fractal dimension given as the index of the inclusion. The corresponding spinor spaces have an identification as quantum spaces with non-commutative $\mathcal{N}$-valued coordinates.

2. This leads to an elegant description of finite measurement resolution. Suppose that a universal M-matrix describing the situation for an ideal measurement resolution exists as the idea about square root of state encourages to think. Finite measurement resolution forces to replace the probabilities defined by the M-matrix with their $\mathcal{N}$ "averaged" counterparts. The "averaging" would be in terms of the complex square root of $\mathcal{N}$-state and a direct analog of functionally or path integral over the degrees of freedom below measurement resolution defined by (say) length scale cutoff.

3. One can construct also directly M-matrices satisfying the measurement resolution constraint. The condition that $\mathcal{N}$ acts like complex numbers on M-matrix elements as far as $\mathcal{N}$-"averaged" probabilities are considered is satisfied if M-matrix is a tensor product of M-matrix in $\mathcal{M}(\mathcal{N}$ interpreted as finite-dimensional space with a projection operator to $\mathcal{N}$. The condition that $\mathcal{N}$ averaging in terms of a complex square root of $\mathcal{N}$ state produces this kind of M-matrix poses a very strong constraint on M-matrix if it is assumed to be universal (apart from variants corresponding to different measurement interactions).

Number theoretical braids as space-time correlates for finite measurement resolution

Finite measurement resolution has discretization as a space-time counterpart. In the intersection of real and p-adic worlds defines as partonic 2-surfaces with a mathematical representation allowing interpretation in terms of real or p-adic number fields one can identify points common to real and p-adic worlds as rational points and common algebraic points (in preferred coordinates dictated by symmetries of imbedding space). Quite generally, one can identify rational points and algebraic points in some extension of rationals as points defining the initial points of what might be called number theoretical braid beginning from the partonic 2-surface at the past boundary of CD and connecting it with the future boundary of CD. The detailed definition of the braid inside light-like 3-surface is not relevant if only the information at partonic 2-surface is relevant for quantum physics.

Number theoretical braids are especially relevant for topological QFT aspect of quantum TGD. The topological QFT associated with braids accompanying light-like 3-surfaces having interpretation as lines of generalied Feynman diagrams should be important part of the definition of amplitudes assigned to generalized Feynman diagrams. The number theoretic braids relate also

closely to a symplectic variant of conformal field theory emerges very naturally in TGD framework (symplectic symmetries acting on $\delta M_\pm^4 \times CP_2$ are in question) and this leads to a concrete proposal for how to to construct n-point functions needed to calculate M-matrix [K18]. The mechanism guaranteeing the predicted absence of divergences in M-matrix elements can be understood in terms of vanishing of symplectic invariants as two arguments of n-point function coincide.

Quantum spinors and fuzzy quantum mechanics

The notion of quantum spinor leads to a quantum mechanical description of fuzzy probabilities [K100]. For quantum spinors state function reduction to spin eigenstates cannot be performed unless quantum deformation parameter $q = exp(i2\pi/n)$ equals to $q = 1$. The reason is that the components of quantum spinor do not commute: it is however possible to measure the commuting operators representing moduli squared of the components giving the probabilities associated with 'true' and 'false'. Therefore the probability for either spin state becomes a quantized observable. The universal eigenvalue spectrum for probabilities does not in general contain (1,0) so that quantum qbits are inherently fuzzy. State function reduction would occur only after a transition to q=1 phase and de-coherence is not a problem as long as it does not induce this transition.

2.2.7 Twistor revolution and TGD

During last decade so called twistor revolution has revived theoretical physics and has also had strong impact on TGD.

Twistor revolution

There are classical papers by several authors such as Witten and Nima Arkani-Hamed who is one of the leading theoreticians driving the twistor revolution [B8, B13, B6, B7] .

1. The notion of twistor is due to Penrose and is very convenient notion in theories describing massless particles and therefore possessing conformal invariance extending Poincare symmetries by the inclusion of scalings and so called special conformal transformation which is analogous to reflections in spherical mirror.

2. Twistor kinematics means that one can express massless four-momentum and helicity in terms of two massless spinors combining to a twistor living in 4-D complex space which reduces to CP_3 because of projective invariance of the description. The beauty of the twistor kinematics is that non-linear action of special conformal transformations linearizes in CP_3. What one does is to replace light-like geodesic in Minkowski space with points in the twistor space CP_3 whereas the complex lines of CP_3 correspond to points of Minkowski space. To be honest, complexified Minkowski space is in question and this is one of the technical difficulties involved.

3. Gauge theories without fermions and scalar fields are such theories and the applications of twistorial methods to $\mathcal{N} = 4$ super-symmetric Yang-Mills theory has produced amazingly strong results demonstrating that Feynman diagrams sum up to stunningly single twistorial expressions. The key idea is that four-dimensional integrals over loop momenta are interpreted as residue integrals in the complexified space of four-momenta so that they reduce to residues from poles. The surprising discovery is that using Yangian invariants one can express the planar loop amplitudes for given number of external states with given helicities and momenta in terms of on mass shell amplitudes for smaller number of particles and with smaller number of loops by using recursion formulas.

4. Twistor revolution has led to a discovery of what is known as dual twistors. The massless momenta associated with incoming states of twistor diagram and expressible in terms of ordinary twistors, can be also expressed as differences of so called region momenta propagating in the edges of polygon characterizing twistor diagram. The massless momenta correspond to intersections of complex lines in what is called momentum twistor space so that one diagram has interpretation also as a diagram in momentum twistor space. The theory possesses conformal invariance also in the momentum twistor space and the two conformal symmetries

combine to form a large infinite-dimensional symmetry known as Yangian symmetry [A4] associated with the conformal group of Minkowski space.

5. The work of Nima Arkani-Hamed and others [B7] has revealed that the integrands for the twistor amplitudes for planar diagrams can be expressed as residue integrals over Grassmannians $G(n,k)$ where n is the number of massless external particles (gluons or gluinos) and k is the number of negative (say) helicities. The integrands appearing in these integrals are Yangian invariants and there are recipes for their construction. The generalization of BCFW formula gives a recursion formula allowing to deduce the l-loop construction to the scattering of n particles with k negative helicities. The vision of Arkani-Hamed is that this approach allows to get rid of space-time altogether.

The impact of twistor approach on TGD

Twistor revolution has had also a strong impact on TGD [K98, K102, K34].

1. The study of the modified Dirac equations for induced spinors [K25] motivated the proposal that the fermions associated with the braid strands accompanying wormhole throats are massless and on mass shell always - even for the internal lines of generalized Feynman diagrams. Since the sign of the energy of internal line can be also negative, wormhole contacts identified as building bricks of virtual bosons can carry space-like virtual momentum. The condition that all wormhole throats appearing in the loops of generalized Feynman diagrams are on mass shell and massless poses enormously strong constraints on loops and with additional restrictions coming from the geometric picture and Uncertainty Principle one can expect that only finite number of diagrams contributes to a given scattering amplitude so that the diagrammatics should be extremely simple, perhaps much simpler than in twistorial diagrammatics involving infinite number of diagrams labelled by the number of loops.

2. The masslessness of all fermionic braid strands appearing in the diagram makes twistorial approach extremely natural. The problem is only the treatment of massive external particles expressible as bound states of massless fermions and anti-fermions at wormhole throats. The idea is that the vertices of generalized Feynman diagrams can be interpreted as 3-gons of twistorial diagrams with region momenta describing momentum exchanges between the throats of wormhole contacts. This picture allows to consider the possibility that 3-vertices could be expressible using the same general formulas as used in Grassmannian approach to $\mathcal{N} = 4$ SYM. Kinematical constraints would imply that only a finite number of diagrams would contribute to a give reaction meaning also upper bound on the number of loops.

3. One might of course argue that the massless propagators on mass shell braid strands make the amplitudes infinite. This is not the case since the momentum appearing in the propagators is M^2 projection of the momentum for a preferred $M^2 \subset M^4$.

   Generalized Feynman diagrammatics - or rather given CD - involve however a selection of preferred $M^2 \subset M^4$. M^2 is forced by number theoretical vision as complex and thus commutative subspace of octonions. Physically M^2 is forced by the construction of massless states as the sub-space containing non-physical polarizations. M^2 fixes the quantization axes of energy and spin. In generalized Feynman diagrams the propagators for on mass shell states contain only the M^2 projection of four-momentum so that the propagators are finite. The modification of gauge conditions to statement that M^2 projection of momentum is orthogonal to polarization vector allows massive states for gauge bosons. Lorentz invariance is not broken since one must integrate over all the choices of M^2.

Could TGD circumvent the difficulties of twistor approach?

The twistor approach has also some problems and TGD allows also to consider solutions to the difficulties of twistorial approach.

1. Twistor approach to $\mathcal{N} = 4$ SYM applies only to planar Feynman diagrams containing no intersecting lines and this restriction interpreted as approximation becomes exact only at the limit when the gauge group becomes infinite-dimensional. One could argue that in TGD

string like objects defined by the Kähler magnetic flux tubes are the basic objects and the stringy character makes planar approximation exact. One could also argue that infinite-dimensional symplectic group takes the role of gauge group in TGD. A more convincing argument is that non-planar diagrams are possible but that generalized Feynman diagrams can be regarded as generalizations of knot diagrams. The crossings of the lines are the problem and for knot diagrams there is a recipe for removing the crossings gradually completely and in this manner obtain an expression for knot invariant. Similar un-knotting procedure could make sense also in TGD framework.

2. $\mathcal{N} = 4$ SYM is believed to be ultraviolet finite but twistor approach does not remove the infrared divergences. In TGD framework external particles are bound states of massless particles and this brings in IR cutoff naturally. The upper bound for the size for CDs brings this cutoff in the case of photons, gluons, and gravitons. One implication is that Higgs like states are not needed in TGD framework.

   The recent considerations [K34] suggest a more refined view about particle masses. It seem that it is M^2 mass squared which is given by stringy mass formula fixed by conformal invariance. If so, p-adic thermodynamics allows to calculate thermal M^2 mass squared and this mass squared wold defining the observed mass of the elementary fermion. Fermionic braid strands would be massless in M^4 sense. The situation is obviously tricky and the understanding of the role of M^2 in TGD framework is one of the basic challenges of the theory.

3. In twistor approach there are also problems with the understanding of renormalization group, which involves momentum scale: this is understandable since conformal invariance does not allow a preferred scale. One should be able to to bring in massive particles without losing the conformal invariance. The fractal hierarchy of CDs within CDs with quantized size scales leads to a detailed proposal for how the vision about p-adic coupling constant evolution is realized for generalized Feynman diagrams [K34].

4. The beauty of Feynman graphs is their ability to code unitarity in an elegant manner by using analyticity. Unitarity conditions are obtained simply by considering the discontinuities of the amplitude at cuts associated with on mass shell configurations of momenta. These discontinuities are expressible by putting internal lines on mass shell so that integral over intermediate on mass shell states is obtained. Unitarity is however not manifest in twistor approach.

   The situation is more complex in TGD framework. M-matrices are not unitary and S-matrix is analogous to the phase of a complex number where as the hermitian square root of the density matrix is analogous to its modulus. Therefore unitary is not required at this level. Different M-matrices (allowing also integer powers of S) must form an infinite-dimensional Kac Moody type algebra and this gives strong constraints on the amplitudes. How to take into account these constraints should be understood.

5. Locality is not manifest in twistor approach. In other words, for Grassmannian amplitudes the poles do not correspond to single particle propagator poles associated with internal lines as they do in Feynman graphs. TGD is manifestly non-local theory since zero energy states involve partonic 2-surfaces at both light-like boundaries of CD. Also partonic 2-surfaces and braids are non-local objects. Yangian symmetry is manifestly non-local since the generators are multilocal objects and in TGD framework this multilocality generalized since the n points of multilocal generator of Yangian algebra are replaced by n partonic 2-surfaces. Also this aspect should be understand in detail.

Twistor approach combined with the requirement of number theoretic universality realized in terms of quantum arithmetics leads to a rather detailed view about generalized Feynman diagrams [K34].

1. One can understand how p-adic length scale hypothesis (stating that primes near powers of two are physically preferred) emerges. This has been one of the main challenges of quantum TGD since 1995 when I performed p-adic mass calculations for the first time.

2. A deep connection with adeles used in Langlands program emerges since the amplitudes can be understood as having values in the tensor product of quantum rationals corresponding to various values of p-adic prime and real amplitudes are obtained by using canonical identification mapping powers of p with their inverses.

3. One implication is that for large primes assignable to elementary particles the convergence in powers of p is extremely fast (one has $p = M_{127} = 2^{127} - 1$ for electron and $p = M_{89}$ for weak gauge bosons!).

2.3 Physics as a generalized number theory

Physics as a generalized number theory vision involves actually three threads: p-adic ideas [K85], the ideas related to classical number fields [K86], and the ideas related to the notion of infinite prime [K84].

2.3.1 Fusion of real and p-adic physics to a coherent whole

p-Adic number fields were not present in the original approach to TGD. The success of the p-adic mass calculations (summarized in the first part of [K52]) made however clear that one must generalize the notion of topology also at the infinitesimal level from that defined by real numbers so that the attribute "topological" in TGD gains much more profound meaning than intended originally. It took a decade to get convinced that the identification of p-adic physics as a correlate of cognition and intentionality is the most plausible interpretation discovered hitherto [K53], and that p-adic topology of p-adic space-time sheets somehow induces the effective p-adic topology of real space-time sheets. The discovery of the properties of number theoretic variants of Shannon entropy led to the idea that living matter could be seen as as something in the intersection of real and p-adic worlds and gave additional support for this interpretation. If even elementary particles reside in this intersection and effective p-adic topology applies for real partonic 2-surfaces, the success of p-adic mass calculations can be understood.

The original view about physics as the geometry of WCW is not enough to meet the challenge of unifying real and p-adic physics to a single coherent whole. This inspired "physics as a generalized number theory" approach [K83].

1. The first element is a generalization of the notion of number obtained by "gluing" reals and various p-adic number fields and their algebraic extensions along common rationals and algebraics to form a larger structure (see fig. `http://www.tgdtheory.fi/appfigures/book.jpg`, which is also in the appendix of this `http://www.tgdtheory.fi/appfigures/book.jpg`, which is also).

2. At the level of imbedding space this gluing corresponds to a gluing of real and p-adic variants of the imbedding space together along rational and common algebraic points (the number of which depends on algebraic extension of p-adic numbers used) to what could be seen as a book like structure. General Coordinate Invariance restricted to rationals or their extension requires preferred coordinates for $CD \times CP_2$ and this kind coordinates can be fixed by isometries of H. The coordinates are however not completely unique since non-rational isometries produce new equally good choices. Whether this can be seen as an objection against the approach is not clear.

3. The analogous gluing of real and various p-adic physics to a larger structure forces to ask what are the common points of WCWs associated with real and various p-adic worlds. What it is to be a partonic 2-surface belonging to the intersection of real and p-adic variants of WCW? The natural answer is that partonic 2-surfaces which have a mathematical representation making sense both for real numbers and p-adic numbers or their algebraic extensions can be regarded as "common points" or identifiable points of p-adicity and reality. This of course applies also to partonic 2-surfaces corresponding to two different p-adic number fields. This mathematical property means a representability in terms of ratios of polynomials with rational (or possibly even algebraic) coefficients in the preferred imbedding space coordinates.

4. The intersections of WCWs and partonic 2-surfaces in different number fields are involved. An attractive idea is that only the information about common points of surfaces belonging to different number fields code for physics so that number-theoretically universal part of physics is number theoretical physics relying only on rationals and their algebraic extensions. For instance, the transition amplitudes between p-adic and real variants of partonic 2-surface can involve only the data at these points. This suggests the existence of what might be called number theoretical QFT. At space-time level this extension of introduce a discretization at space-time level in terms of rational and algebraic points common to real space-time sheets and their p-adic variants. The number of these points is in general finite for a given CD and the proposed interpretation is in terms of cognitive representations. The discrete intersections would define the initial and final points of number theoretical braids central for the formulation of the theory in finite measurement resolution.

5. Much later came the realization that living matter or what makes living matter living could be interpreted as something in this intersection of real and p-adic worlds so that number theoretic QFT might apply to crucial aspects of living matter.

The interpretation for discretization could be in terms of cognitive, sensory, and measurement resolutions rather than fundamental discreteness of the space-time. What looks rather counter intuitive first is that transcendental points of p-adic space-time sheets are at spatiotemporal infinity in real sense so that the correlates of cognition and intentionality cannot be localized to any finite spatiotemporal volume unlike those of sensory experience. The description of intentionality and cognition in this manner predicts p-adic fractality of real physics meaning chaos in short scales combined with long range correlations: p-adic mass calculations represent one example of p-adic fractality.

The realization of this program at the level of WCW is far from trivial. Modified Dirac equation and classical field equations make sense but quantities expressible as space-time integrals - in particular Kähler action- do not make sense p-adically. Therefore one can ask whether only the partonic surfaces in the intersection of real and p-adic worlds should be allowed. Also this restricted theory would be highly non-trivial physically.

2.3.2   Classical number fields and associativity and commutativity as fundamental law of physics

The dimensions of classical number fields appear as dimensions of basic objects in quantum TGD. Imbedding space has dimension 8, space-time has dimension 4, light-like 3-surfaces are orbits of 2-D partonic surfaces. If conformal QFT applies to 2-surfaces (this is questionable), one-dimensional structures would be the basic objects. The lowest level would correspond to discrete sets of points identifiable as intersections of real and p-adic space-time sheets. This suggests that besides p-adic number fields also classical number fields (reals, complex numbers, quaternions, octonions [A5]) are involved [K86] and the notion of geometry generalizes considerably. In the recent view about quantum TGD the dimensional hierarchy defined by classical number field indeed plays a key role. $H = M^4 \times CP_2$ has a number theoretic interpretation and standard model symmetries can be understood number theoretically as symmetries of hyper-quaternionic planes of hyper-octonionic space.

The associativity condition $A(BC) = (AB)C$ suggests itself as a fundamental physical law of both classical and quantum physics. Commutativity can be considered as an additional condition. In conformal field theories associativity condition indeed fixes the n-point functions of the theory. At the level of classical TGD space-time surfaces could be identified as maximal associative (hyper-quaternionic) sub-manifolds of the imbedding space whose points contain a preferred hyper-complex plane M^2 in their tangent space and the hierarchy finite fields-rationals-reals-complex numbers-quaternions-octonions could have direct quantum physical counterpart [K86]. This leads to the notion of number theoretic compactification analogous to the dualities of M-theory: one can interpret space-time surfaces either as hyper-quaternionic 4-surfaces of M^8 or as 4-surfaces in $M^4 \times CP_2$. As a matter fact, commutativity in number theoretic sense is a further natural condition and leads to the notion of number theoretic braid naturally as also to direct connection with super string models.

At the level of modified Dirac action the identification of space-time surface as a hyper-quaternionic sub-manifold of H means that the modified gamma matrices of the space-time surface defined in terms of canonical momentum currents of Kähler action using octonionic representation for the gamma matrices of H span a hyper-quaternionic sub-space of hyper-octonions at each point of space-time surface (hyper-octonions are the subspace of complexified octonions for which imaginary units are octonionic imaginary units multiplied by commuting imaginary unit). Hyper-octonionic representation leads to a proposal for how to extend twistor program to TGD framework [K25, K98].

2.3.3 Infinite primes and quantum physics

The hierarchy of infinite primes (and of integers and rationals) [K84] was the first mathematical notion stimulated by TGD inspired theory of consciousness. The construction recipe is equivalent with a repeated second quantization of a super-symmetric arithmetic quantum field theory with bosons and fermions labeled by primes such that the many-particle states of previous level become the elementary particles of new level. At a given level there are free many particles states plus counterparts of many particle states. There is strong structural analogy with polynomial primes. For polynomials with rational coefficients free many-particle states would correspond to products of first order polynomials and bound states to irreducible polynomials with non-rational roots.

The hierarchy of space-time sheets with many particle states of space-time sheet becoming elementary particles at the next level of hierarchy. For instance, the description of proton as an elementary fermion would be in a well defined sense exact in TGD Universe. Also the hierarchy of n:th order logics are possible correlates for this hierarchy.

This construction leads also to a number theoretic generalization of space-time point since a given real number has infinitely rich number theoretical structure not visible at the level of the real norm of the number a due to the existence of real units expressible in terms of ratios of infinite integers. This number theoretical anatomy suggest a kind of number theoretical Brahman=Atman identity stating that the set consisting of number theoretic variants of single point of the imbedding space (equivalent in real sense) is able to represent the points of WCW or maybe even quantum states assignable to causal diamond. One could also speak about algebraic holography.

The correspondence between the quantum states defined by WCW spinor fields and wave functions in the infinite-dimensional discrete space of hyper-octonionic units can be made more concrete [K84]. These wave functions must transforming irreducibly under discrete subgroup SU(3) of octonion automorpisms transforming ordinary hyper-octonionic prime to a new hyper-octonionic prime. SU(3) has interpretation as color group. One can assign standard model quantum numbers to these wave functions and prime property in principle fixes the spectrum of possible quantum states- in particular the spectrum of masses. Therefore the extremely esoteric looking notion of infinite prime might turn out to be very practical calculational tool.

2.3.4 Quantum Mathematics and Quantum Mechanics

Quantum Mathematics replaces numbers with Hilbert spaces and arithmetic operations $+$ and $\times$ with direct sum $\oplus$ and tensor product $\otimes$.

1. The original motivation comes from quantum TGD where direct sum and tensor product are naturally assigned with the two basic vertices analogous to stringy 3-vertex and 3-vertex of Feynman graph. This suggests that generalized Feynman graphs could be analogous to sequences of arithmetic operations allowing also co-operations of $\oplus$ and $\otimes$.

2. One can assign to natural numbers, integers, rationals, algebraic numbers, transcendentals and their p-adic counterparts for various prime p Hilbert spaces with formal dimension given by the number in question. Typically the dimension of these Hilbert spaces in the ordinary sense is infinite. Von Neuman algebras known as hyper-finite factors of type II_1 assume as a convention that the dimension of basic Hilbert space is one although it is infinite in the standard sense of the word. Therefore this Hilbert space has sub-spaces with dimension which can be any number in the unit interval. Now however also negative and even complex, quaternionic and octonionic values of Hilbert space dimension become possible.

3. The decomposition to a direct sum matters unlike for abstract Hilbert space as it does also in the case of physical systems where the decomposition to a direct sum of representations of symmetries is standard procedure with deep physical significance. Therefore abstract Hilbert space is replaced with a more structured objects. For instance, the expansion $\sum_n x_n p^n$ of a p-adic number in powers of p defines decomposition of infinite-dimensional Hilbert space to a direct sum $\oplus_n x_n \otimes p^n$ of the tensor products $x_n \otimes p^n$. It seems that one must modify the notion of General Coordinate Invariance since number theoretic anatomy distinguishes between the representations of space-time point in various coordinates. The interpretation would be in terms of cognition. For instance, the representation of Neper number requires infinite number of pinary digits whereas finite integer requires only a finite number of them so that at the level of cognitive representations general coordinate invariance is broken.

   Note that the number of elements of the state basis in p^n factor is p^n and $m \in \{0, ..., p-1\}$ in the factor x_n. Therefore the Hilbert space with dimension $p^n > x_n$ is analogous to the Hilbert space of a large effectively classical system entangled with the microscopic system characterized by x_n. p-Adicity of this Hilbert space in this example is for the purpose of simplicity but raises the question whether the state function reduction is directly related to cognition.

4. On can generalize the concept of real numbers, the notions of manifold, matrix group, etc... by replacing points with Hilbert spaces. For instance, the point $(x_1, .., x_n)$ of E^n is replaced with Cartesian product of corresponding Hilbert spaces. What is of utmost importance for the idea about possible connection with the multiverse idea is that also this process can be also repeated indefinitely. This process is analogous to a repeated second quantization since intuitively the replacement means replacing Hilbert space with Hilbert space of wave functions in Hilbert space. The finite dimension and its continuity as function of space-time point must mean that there are strong constraints on these wave functions. What does this decomposition to a direct sum mean at the level of states? Does one have super-selection rules stating that quantum interference is possible only inside the direct summands?

5. Could one find a number theoretical counterpart for state function reduction and preparation and unitary time evolution? Could zero energy ontology have a formulation at the level of the number theory as earlier experience with infinite primes suggest? The proposal was that zero energy states correspond to ratios of infinite integers which as real numbers reduce to real unit. Could zero energy states correspond to states in the tensor product of Hilbert spaces for which formal dimensions are inverses of each other so that the total space has dimension 1?

The fractal character of the Quantum Mathematics is what makes it a good candidate for understanding the self-referentiality of consciousness. The replacement of the Hilbert space with the direct sum of Hilbert spaces defined by its points would be the basic step and could be repeated endlessly corresponding to a hierarchy of statements about statements or hierarchy of nth order logics. The construction of infinite primes leads to a similar structure.

What about the step leading to a deeper level in hierarchy and involving the replacement of each point of Hilbert space with Hilbert space characterizing it number theoretically? What could it correspond at the level of states?

1. Suppose that state function reduction selects one point for each Hilbert space $x_n \times p^n$. The key step is to replace this direct sum of points of these Hilbert spaces with direct sum of Hilbert spaces defined by the points of these Hilbert spaces. After this one would select point from this very big Hilbert space. Could this point be in some sense the image of the Hilbert space state at previous level? Should one imbed Hilbert space $x_n \times p^n$ isometrically to the Hilbert space defined by the preferred state $x_n \times p^n$ so that one would have a realization of holography: part would represent the whole at the new level. It seems that there is a canonical manner to achieve this. The interpretation as the analog of second quantization suggest the identification of the imbedding map as the identification of the many particle states of previous level as single particle states of the new level.

2. Could topological condensation be the counterpart of this process in many-sheeted space-time of TGD? The states of previous level would be assigned to the space-time sheets topologically

condensed to a larger space-time sheet representing the new level and the many-particle states of previous level would be the elementary particles of the new level.

3. If this vision is correct, second quantization performed by theoreticians would not be a mere theoretical operation but a fundamental physical process necessary for cognition! The above proposed unitary imbedding would imbed the states of the previous level as single particle states to the new level. It would seem that the process of second quantization, which is indeed very much like self-reference, is completely independent from state function reduction and unitary process. This picture would conform with the fact that in TGD Universe the theory about the Universe is the Universe and mathematician is in the quantum jumps between different solutions of this theory.

Unitary process and state function reduction in ZEO

The minimal view about unitary process and state function reduction is provided by ZEO [K6].

1. Zero energy states correspond to a superposition of pairs of positive and negative energy states. The M-matrix defining the entanglement coefficients is product of Hermitian square root of density matrix and unitary S-matrix, and various M-matrices are orthogonal and form rows of a unitary U-matrix. Quantum theory is square root of thermodynamics. This is true even at single particle level. The square root of the density matrix could be also interpreted in terms of finite measurement resolution.

2. It is natural to assume that zero energy states have well-defined single particle quantum numbers at the either end of CD as in particle physics experiment. This means that state preparation has taken place and the prepared end represents the initial state of a physical event. Since either end of CD can be in question, both arrows of geometric time identifiable as the Minkowski time defined by the tips of CD are possible.

3. The simplest identification of the U-matrix is as the unitary U-matrix relating to each other the state basis for which M-matrices correspond to prepared states at two opposite ends of CD. Let us assume that the preparation has taken place at the "lower" end, the initial state. State function reduction for the final state means that one measures the single particle observables for the "upper" end of CD. This necessarily induces the loss of this property at the "lower" end. Next preparation in turn induces localization in the "lower" end. One has a kind of time flip-flop and the breaking of time reversal invariance would be absolutely essential for the non-triviality of the process.

The basic idea of Quantum Mathematics is that M-matrix is characterized by Feynman diagrams representing sequences of arithmetic operations and their co-arithmetic counterparts. The latter ones give rise to a superposition of pairs of direct summands (factors of tensor product) giving rise to same direct sum (tensor product). This vision would reduce quantum physics to generalized number theory. Universe would be calculating and the consciousness of the mathematician would be in the quantum jumps performing the state function reductions to which preparations reduce.

Note that direct sum, tensor product, and the counterpart of second quantization for Hilbert spaces in the proposed sense would be quantum mathematics counterpart for set theoretic operations, Cartesian product and formation of the power set in set theory.

ZEO, state function reduction, unitary process, and quantum mathematics

State function reduction acts in a tensor product of Hilbert spaces. In the p-adic context to be discussed n the following $x_n \otimes p^n$ is the natural candidate for this tensor product. One can assign a density matrix to a given entangled state of this system and calculate the Shannon entropy. One can also assign to it a number theoretical entropy if entanglement coefficients are rationals or even algebraic numbers, and this entropy can be negative. One can apply Negentropy Maximization Principle to identify the preferred states basis as eigenstates of the density matrix. For negentropic entanglement (see fig. `http://www.tgdtheory.fi/appfigures/cat.jpg` or fig. 21 in the appendix of this book) the state function reduction tends to preserve the entanglement.

Could the state function reduction take place separately for each subspace $x_n \otimes p^n$ in the direct sum $\oplus_n x_n \otimes p^n$ so that one would have quantum parallel state function reductions? This is an old proposal motivated by the many-sheeted space-time. The direct summands in this case would correspond to the contributions to the states localizable at various space-time sheets assigned to different powers of p defing a scale hierarchy. The powers p^n would be associated with zero modes by the previous argument so that the assumption about independent reduction would reflect the super-selection rule for zero modes. Also different values of p-adic prime are present and tensor product between them is possible if the entanglement coefficients are rationals or even algebraics. In the formulation using adeles the needed generalization could be formulated in a straightforward manner.

How can one select the entangled states in the summands $x_n \otimes p^n$? Is there some unique choice? How do unitary process and state function reduction relate to this choice? Could the dynamics of Quantum Mathematics be a structural analog for a sequence of state function reductions taking place at the opposite ends of CD with unitary matrix U relating the state basis for which single particle states have well defined quantum numbers either at the upper or lower end of CD? Could the unitary process and state function reduction be identified solely from the requirement that zero energy states correspond to tensor products Hilbert spaces, which correspond to inverses of each other as numbers? Could the extension of arithmetics to include co-arithmetics make the dynamics in question unique?

2.4 Physics as extension of quantum measurement theory to a theory of consciousness

TGD inspired theory of consciousness could be seen as a generalization of quantum measurement theory to make observer, which in standard quantum measurement theory remains an outsider, a genuine part of physical system subject to laws of quantum physics. The basic notions are quantum jump identified as moment of consciousness and the notion of self [K47]: in zero energy ontology these notions might however reduce to each other. Negentropy Maximization Principle [K49] defines the dynamics of consciousness and as a special case reproduces standard quantum measurement theory.

2.4.1 Quantum jump as moment of consciousness

TGD suggests that the quantum jump between quantum histories could identified as moment of consciousness and could therefore be for consciousness theory what elementary particle is for physics [K47].

This means that subjective time evolution corresponds to the sequence of quantum jumps $\Psi_i \to U\Psi_i \to \Psi_f$ consisting of unitary process followed by state function process. Originally U was thought to be the TGD counterpart of the unitary time evolution operator $U(-t, t)$, $t \to \infty$, associated with the scattering solutions of Schrödinger equation. It seems however impossible to assign any real Schrödinger time evolution with U. In zero energy ontology U defines a unitary matrix between zero energy states and is naturally assignable to intentional actions whereas the ordinary S-matrix telling what happens in particle physics experiment (for instance) generalizes to M-matrix defining time-like entanglement between positive and negative energy parts of zero energy states. One might say that U process corresponds to a fundamental act of creation creating a quantum superposition of possibilities and the remaining steps generalizing state function reduction process select between them.

2.4.2 Negentropy Maximization Principle and the notion of self

U-process is followed by a sequence of state function reductions. Negentropy Maximization Principle (NMP [K49]) states that in a given quantum state the most quantum entangled subsystem-complement pair can perform the quantum jump. More precisely: the reduction of the entanglement entropy in the quantum jump is as large as possible. This selects the pair in question and in case of ordinary entanglement entropy leads the selected pair to a product state. The interpretation of the reduction of the entanglement entropy as conscious information gain makes sense. The

sequence of state function reductions decomposes at first step the entire system to two parts in such a manner that the reduction entanglement entropy is maximal. This process repeats itself for subsystems. If the subsystem in question cannot be divided into a pair of entangled free system the process stops since energy conservation does not allow it to occur (binding energy).

The original definition of self was as a subsystem able to remain unentangled under state function reductions associated with subsequent quantum jumps. Everything is consciousness but consciousness can be lost if self develops bound state entanglement during U process so that state function reduction to smaller un-entangled pieces is impossible.

The existence of number theoretical entanglement entropies in the intersection of real and various p-adic worlds force to modify this picture. The reduction process can stop also if the self in question allows only decompositions to pairs systems with negentropic entanglement. This does not require that that the system forms a bound state for any pair of subsystems so that the systems decomposing it can be free (no binding energy). This defines a new kind of bound state not describable as a jail defined by the bottom of a potential well. Subsystems are free but remain correlated by negentropic entanglement (see fig. `http://www.tgdtheory.fi/appfigures/cat.jpg` or fig. 21 in the appendix of this book).

The ordinary state function reductions imply dissipation crucial for self organization and quantum jump could be regarded as the basic step of an iteration like process leading to the asympotic self-organization patterns. One could regard dissipation as a Darwinian selector as in standard theories of self-organization. NMP thus predicts that self organization and hence presumably also fractalization can occur inside selves. NMP would favor the generation of negentropic entanglement. This notion is highly attractive since it could allow to understand how quantum self-organization generates larger coherent structures. Note that state function reduction for negentropic entanglement is highly deterministic since the number of degenerate states with same negative entanglement entropy is expected to be small. This could allow to understand how living matter is able to develop almost deterministic cellular automaton like behaviors.

A further implication of NMP is that Universe generates information about itself represented in terms of negentropic enanglement: if one is not afraid of esoteric associations one could call this information Akashich records. This is not in conflict with second law since the entropy in the case of second law is ensemble entropy assignable to single particle in thermodynamical description.

2.4.3 Life as islands of rational/algebraic numbers in the seas of real and p-adic continua?

The observation that Shannon entropy allows an infinite number of number theoretic variants for which the entropy can be negative in the case that probabilities are algebraic numbers leads to the idea that living matter in a well-defined sense corresponds to the intersection of real and p-adic worlds. This would mean that the mathematical expressions for the space-time surfaces (or at least 3-surfaces or partonic 2-surfaces and their 4-D tangent planes) make sense in both real and p-adic sense for some primes p. Same would apply to the expressions defining quantum states. In particular, entanglement probabilities would be rationals or algebraic numbers so that entanglement can be negentropic and the formation of bound states in the intersection of real and p-adic worlds generates information and is thus favored by NMP.

This picture has also a direct connection with consciousness [K49].

1. Algebraic entanglement is a prerequisite for the realization of intentions as transformations of p-adic space-time sheets to real space-time sheets representing actions. Essentially a leakage between p-adic and real worlds is in question and makes sense only in zero energy ontology. Since various quantum numbers in real and p-adic sectors are not in general comparable in positive energy ontology so that conservation laws would be broken in positive energy ontology. Algebraic entanglement could be also called cognitive since it is something between real and p-adic worlds. The transformation can occur if the partonic 2-surfaces and their 4-D tangent space-distributions are representable using rational functions with rational coefficients in preferred coordinates for the imbedding space dictated by symmetry considerations. Intentional systems must live in the intersection of real and p-adic worlds. For the minimal option life would be also effectively 2-dimensional phenomenon and essentially a boundary phenomenon as also number theoretical criticality suggests.

2. What happens that the Universe corresponding to given CD decomposes to two un-entangled subsystems, which in turn decompose, and the process continues until all subsystems have only entropic bound state entanglement or negentropic algebraic entanglement with the external world. If the sub-system generates entropic bound state entanglement in the process, it loses consciousness. The generation of negentropic entanglement means expansion of consciousness.

3. One can ask whether the entanglement entropy of the sub-system should be defined as a sum over entanglement entropies over all subsystems involved or whether the levels are independent. This hierarchy of subsystems corresponds to the hierarchy if sub-CDs so that for the first option the survival without a loss of consciousness depends on what happens at all levels below the highest level for a given self is this is assumed. In more concrete terms, ability to stay conscious depends on what happens at cellular level too. For the first option the stable evolution of systems having algebraic entanglement is expected to be a process proceeding from short to long length scales as the evolution of life indeed is.

4. U-process generates a superposition of states in which any sub-system can have both real and algebraic entanglement with the external world. This would suggest that the choice of the type of entanglement is a volitional selection. A possible interpretation is as a choice between good and evil. The hedonistic complete freedom resulting as the entanglement entropy is reduced to zero on one hand, and the algebraic bound state entanglement implying correlations with the external world and meaning giving up the maximal freedom on the other hand. The hedonistic option is risky since it can lead to non-algebraic bound state entanglement implying a loss of consciousness. The second option means expansion of consciousness - a fusion to the ocean of consciousness as described by spiritual practices.

5. This formulation means a sharpening of the earlier statement "Everything is conscious and consciousness can be only lost" with the additional statement "This happens when non-algebraic bound state entanglement is generated". Clearly, the quantum criticality of TGD Universe seems to have many aspects and life as a critical phenomenon in the number theoretical sense is only one of them besides the criticality of the space-time dynamics and the criticality with respect to phase transitions changing the value of Planck constant and other more familiar criticalities. How closely these criticalities relate remains an open question [K73].

A good guess is that algebraic entanglement is essential for quantum computation, which therefore might correspond to a conscious process. Hence cognition could be seen as a quantum computation like process, a more appropriate term being quantum problem solving. Living-dead dichotomy could correspond to rational-irrational or to algebraic-transcendental dichotomy: this at least when life is interpreted as intelligent life. Life would in a well defined sense correspond to islands of rationality/algebraicity in the seas of real and p-adic continua.

The view about the crucial role of rational and algebraic numbers as far as intelligent life is considered, could have been guessed on very general grounds from the analogy with the orbits of a dynamical system. Rational numbers allow a predictable periodic decimal/pinary expansion and are analogous to one-dimensional periodic orbits. Algebraic numbers are related to rationals by a finite number of algebraic operations and are intermediate between periodic and chaotic orbits allowing an interpretation as an element in an algebraic extension of any p-adic number field. The projections of the orbit to various coordinate directions of the algebraic extension represent now periodic orbits. The decimal/pinary expansions of transcendentals are un-predictable being analogous to chaotic orbits. The special role of rational and algebraic numbers was realized already by Pythagoras, and the fact that the ratios for the frequencies of the musical scale are rationals supports the special nature of rational and algebraic numbers. The special nature of the Golden Mean, which involves $\sqrt{5}$, conforms the view that algebraic numbers rather than only rationals are essential for life.

2.4.4 Two times

The basic implication of the proposed view is that subjective time and geometric time of physicist are not the same [K47]. This is not a news actually. Geometric time is reversible, subjective time

irreversible. Geometric future and past are in completely democratic position, subject future does not exist at all yet. One can say that the non-determinism of quantum jump is completely outside space-time and Hilbert space since quantum jumps replaces entire 4-D time evolution (or rather, their quantum superposition) with a new one, re-creates it. Also conscious existence defies any geometric description. This new view resolves the basic problem of quantum measurement theory due to the conflict between determinism of Schrödinger equation and randomness of quantum jump. The challenge is to understand how these two times correlate so closely as to lead to their erratic identification.

With respect to geometric time the contents of conscious experience is naturally determined by the space-time region inside CD in zero energy ontology. This geometro-temporal integration should have subjecto-temporal counterpart. The experiences of self are determined by the mental images assignable to sub-selves (having sub-CDs as imbedding space correlates) and the quantum jump sequences associated with sub-selves define a sequence of mental images. The hypothesis is that self experiences these sequences of mental images as a continuous time flow. In absence of mental images self would have experience of "timelessness" in accordance with the reports of practitioners of various spiritual practices. Self would lose consciousness in quantum jump generating entropic entanglement and experience expansion of consciousness if the resulting entanglement is negentropic. The assumption that the integration of experiences of self involves a kind of averaging over sub-selves of sub-selves guarantees that the sensory experiences are reliable despite the fact that quantum nondeterminism is involved with each quantum jump.

Thus the measurement of density matrix defined by the $MM^{\dagger}$, where M is the M-matrix between positive and negative energy parts of the zero energy state would correspond to the passive aspects of consciousness such as sensory experiencing. U would represent at the fundamental level volition as a creation of a quantum superposition of possibilities. What follows it would be a selection between them. The volitional choice between macroscopically differing space-time sheets representing different maxima of Kähler function could be basically responsible for the active aspect of consciousness. The fundamental perception-reaction feedback loop of biosystems would result from the combination of the active and passive aspects of consciousness represented by U and M.

2.4.5 General view about psychological time and intentionality

The recent TGD inspired attempts to understand the arrow of psychological time and the localization of the contents of conscious sensory experience and experienced volition to a rather narrow time interval of .1 seconds rely on zero energy ontology. The most argument below summarizes the most recent view [K6].

Why sensory experience is about so short time interval?

The picture based on CDs implies automatically the 4-D character of conscious experience and memories form part of conscious experience even at elementary particle level. Amazingly, the secondary p-adic time scale of electron characterizing the time scale of electronic CD is $T = 0.1$ seconds defining a fundamental time scale in living matter. The problem is to understand why the sensory experience is about a short time interval of geometric time rather than about the entire personal CD with temporal size of order life-time. The explanation would be that sensory input corresponds to sub-selves (mental images) with $T \simeq .1$ s at the upper light-like boundary of CD in question. This requires a strong asymmetry between upper and lower light-like boundaries of CDs.

The localization of the contents of the sensory experience to the upper light-cone boundary and local arrow of time could emerge as a consequence of self-organization process involving conscious intentional action. Sub-CDs would be in the interior of CD and self-organization process would lead to a distribution of CDs concentrated near the upper or lower boundary of CD. The local arrow of geometric time would depend on CD and even differ for CD and sub-CDs.

1. The localization of contents of sensory experience to a narrow time interval would be due to the concentration of sub-CDs representing mental images near the either boundary of CD representing self.

2. Phase conjugate signals identifiable as negative energy signals to geometric past are important when the arrow of time differs from the standard one in some time scale. If the arrow of time establishes itself as a phase transition, this kind of situations are rare. Negative energy signals as a basic mechanism of intentional action and transfer of metabolic energy would explain why living matter is so special.

3. Geometric memories would correspond to sub-selves in the interior of CD, the oldest of them to the regions near "lower" boundaries of CD. Since the density of sub-CDs is small there geometric memories would be rare and not sharp. A temporal sequence of mental images, say the sequence of digits of a phone number, would correspond to a temporal sequence of sub-CDs.

4. Sharing of mental images corresponds to a fusion of sub-selves/mental images to single sub-self by quantum entanglement: the space-time correlate could be flux tubes connecting space-time sheets associated with sub-selves represented also by space-time sheets inside their CDs.

Arrow of time

TGD forces a new view about the relationship between experienced and geometric time. Although the basic paradox of quantum measurement theory disappears the question about the arrow of geometric time remains. There are actually two times involved. The geometric time assignable to the space-time sheets and the M^4 time assignable to the imbedding space.

Consider first the the geometric time assignable to the space-time sheets.

1. Selves correspond to CDs. The CDs and their projections to the imbedding space do not move anywhere. Therefore the standard explanation for the arrow of geometric time cannot work.

2. The only plausible interpretation at classical level relies on quantum classical correspondence and the fact that space-times are 4-surfaces of the imbedding space. If quantum jump corresponds to a shift for a quantum superposition of space-time sheets towards geometric past in the first approximation (as quantum classical correspondence suggests), one can understand the arrow of time. Space-time surfaces simply shift backwards with respect to the geometric time of the imbedding space and therefore to the 8-D perceptive field defined by the CD. This creates in the materialistic mind a temporal variant of train illusion. Space-time as 4-surface and macroscopic and macro-temporal quantum coherence are absolutely essential for this interpretation to make sense.

Why this shifting should always take place to the direction of geometric past of the imbedding space? Does it so always? The proposed mechanism for the localization of sensory experience to a short time interval suggests an explanation in terms of intentional action.

1. CD defines the perceptive field for self. Selves are curious about the space-time sheets outside their perceptive field and perform quantum jumps tending to shift the superposition of the space-time sheets so that unknown regions of space-time sheets emerge to the perceptive field. Either the upper or lower boundary of CD wins in the competition and the arrow of time results as a spontaneous symmetry breaking. The arrow of time can depend on CD but tends to be the same for CD and its sub-CDs. Global arrow of time could establish itself by a phase transitions establishing the same arrow of time globally by a mechanism analogous to percolation phase transition.

2. Since the news come from the upper boundary of CD, self concentrates its attention to this region and improves the resolution of sensory experience. The sub-CDs generated in this manner correspond to mental images with contents about this region. Hence the contents of conscious experience, in particular sensory experience, tends to be about the region near the upper boundary.

The emergence of the arrow of time at the level of imbedding space reduces to a modification of the oldest TGD based argument for the arrow of time which is wrong as such. If physical objects

correspond to 3-surfaces inside future directed light-cone then the sequence of quantum jumps implies a diffusion to the direction of increasing value of light-cone proper time. The challenge has been to give a precise formulation for this. In zero energy ontology the most recent formulation goes like this.

1. What seems clear now is the decisive role of ZEO and hierarchy of CDs, and the fact that the quantum arrow of geometric time is coded into the structure of zero energy states to a high extent. The still questionable but attractively simple hypothesis is that U matrix two basis with opposite quantum arrows of geometric time: is this assumption really consistent with what we know about the arrow of time? If this is the case, the question is how the relatively well-defined quantum arrow of geometric time implies the experienced arrow of geometric time. Should one assume the arrow of geometric time separately as a basic property of the state function reduction cascade or more economically- does it follow from the arrow of time for zero energy states?

2. The state function reductions occur alternately at the two boundaries of CD. If the reduction occurs at given boundary is immediately followed by a reduction at the opposite boundary, the arrow of time alternates: this does not conform with intuitive expectations: for instance, this would imply that there are two selves assignable to the opposite boundaries!

   Zero energy states are however de-localized in the moduli space CDs (size of CD plus discrete subgroup of Lorentz group defining boosts of CD leaving second tip invariant). One has quantum superposition of CDs with difference scales but with fixed upper or lower boundary belonging to the same light-cone boundary after state function reduction. In standard quantum measurement theory the repetition of state function reduction does not change the state but now it would give rise to the experienced flow of time. Zeno effect indeed requires that state function reductions can occur repeatedly at the same boundary. In these reductions the wave function in moduli degrees of freedom of CD changes. This implies "dispersion" in the moduli space of CDs experienced as flow of time with definite arrow.

3. This approach codes also the arrow of time at the space-time level: the average space-time sheet in quantum superposition increases in size as the average position of the "upper boundary" of CDs drifts towards future state function reduction by state function reduction.

4. In principle the arrow of time can temporarily change but it would seem that this can occur in very special circumstances and probably takes place in living matter. Phase conjugate laser beam is a non-biological example in this respect.

2.5 Implications of Quantum Classical Correspondence

Quantum Classical Correspondence has been of the guiding principles in the construction of Quantum TGD. Recall that at the level of WCW Quantum TGD is a theory of purely classical spinor fields. In ZEO the modes of sub-WCW spinor fields associated with a given CD have by effective 2-dimensionality as their arguments collections of partonic 2-surfaces and their 4-D tangent space data. U-matrix, M-matrices, and S-matrix are in principle reducible to the properties of the basis of WCW spinor fields.

Quantum classical correspondence assumes that classical dynamics defined by the preferred extremals of Kähler action define an exact part of Quantum TGD. More generally, all quantum notions - even the quantum jump sequence characterizing contents of consciousness - must have space-time counterpart: this representation is analogous to written language.

The notion of WCW Kähler geometry combined with GCI allows to identify classical space-time surfaces as analogs of Bohr orbits as preferred extremals of Kähler action. What "preferred" means is of course a highly non-trivial question. Assuming that light-like 3-surfaces and space-like 3-surfaces at the ends of CDs give rise to same theory implies effective 2-dimensionality and strong form of holography having dramatic implications for the theory.

2.5.1 Strong form of holography and effective 2-dimensionality

Strong form of holography reduces to strong form of General Coordinate Invariance.

1. The starting point is the vision about geometrization of quantum physics in terms of the geometry of WCW, the space of 3-surfaces of H. Quantum states correspond to classical WCW spinor fields and WCW spinors (spinor field at given point of WVW, which is 3-surface!). No quantization occurs at WCW level: spinor fields are classical. WCW spinor corresponds to fermionic Fock states with fermionic oscillator operators associated with free second quantized induced spinor fields (spinor fields of H) at 3-surfaces and extended to 4-surfaces. This "second quantization" has purely geometric meaning and makes possible WCW spinor geometry.

2. General Coordinate Invariance is one of the fundamental symmetries and states that 4-D general coordinate transformations act as gauge symmetries. This requires that the definition of WCW metric assigns to 3-D surface a 4-D space-time surface. This space-time surface is analogous to Bohr orbit and defines the "classical physics" associated with the 3-surface but satisfying the analogs of Bohr quantization rules. This space-time surface is a preferred extremal of Kähler action and the value of Kähler action for the Euclidian regions of space-time surface defines Kähler function defining the Kähler metric of WCW.

   The value of Kähler action for Minkowskian regions of space-time surface defines a complex phase in vacuum functional and plays a role of Morse function and is also analogous to the action in ordinary quantum field theory: in particular it makes possible interference effects at the level of vacuum functional central in quantum field theories.

   Obviously the effective reduction of 4-D theory to 3-D theory corresponds to holography. In ordinary QFT approach to TGD this would not take place since one performs path integral over all space-time surfaces. In fact, the total failure of this approach led to the generalization of Einstein's geometrization program of classical physics to a geometrization of quantum physics in terms of WCW geometry.

   Characterizing the mathematical conditions satisfied by the preferred extremals of Kähler action precisely is still one of the basic mathematical challenges and several conjectures have been made during years.

3. GCI makes possible to fix the gauge by choosing the 3-surfaces in some especially convenient manner. One choice is as unions of space-like 3-surfaces at the light-like boundaries of CDs. Second choice is as wormhole throats which are light-like 3-surfaces at which the signature of the induced metric changes from Euclidian to Minkowskian and behaving in many respects like causal horizons and black hole horizons. Which of the choices is correct or are both correct? If both choices are correct one ends up with the strong form of GCI: the intersections of 3-D light-like wormhole throats with the 3-D space-like ends of space-time surface defining partonic 2-surfaces and their 4-D tangent space data carry information about quantum states.

   Strong form of GCI implies strong form of holography. Already partonic 2-surfaces and their 4-D tangent space data are enough. This does not mean genuine 2-dimensionality and reduction to a string theory since tangent space data are needed. Also the breaking of strict determinism for Kähler action implies that the effective 2-dimensionality is true only in some length scales.

2.5.2 Weak form of electric magnetic duality

The notion of electric-magnetic duality [B3] was proposed first by Olive and Montonen and is central in $\mathcal{N} = 4$ supersymmetric gauge theories. It states that magnetic monopoles and ordinary particles are two different phases of theory and that the description in terms of monopoles can be applied at the limit when the running gauge coupling constant becomes very large and perturbation theory fails to converge. The notion of electric-magnetic self-duality is more natural since for CP_2 geometry Kähler form is self-dual and Kähler magnetic monopoles are also Kähler electric monopoles and Kähler coupling strength is by quantum criticality renormalization group invariant rather than running coupling constant. The notion of electric-magnetic (self-)duality emerged already two decades ago in the attempts to formulate the Kähler geometric of WCW. Quite recently a considerable step of progress took place in the understanding of this notion [K17]. What seems to be essential is that one adopts a weaker form of the self-duality applying at partonic 2-surfaces [K18].

Every new idea must be of course taken with a grain of salt but the good sign is that this concept leads to precise predictions. The point is that elementary particles do not generate monopole fields in macroscopic length scales: at least when one considers visible matter. The first question is whether elementary particles could have vanishing magnetic charges: this turns out to be impossible. The next question is how the screening of the magnetic charges could take place and leads to an identification of the physical particles as string like objects identified as pairs magnetic charged wormhole throats connected by magnetic flux tubes.

1. The first implication is a new view about electro-weak massivation reducing it to weak confinement in TGD framework. The second end of the string contains particle having electroweak isospin neutralizing that of elementary fermion and the size scale of the string is electro-weak scale would be in question. Hence the screening of electro-weak force takes place via weak confinement realized in terms of magnetic confinement.

2. This picture generalizes to the case of color confinement. Also quarks correspond to pairs of magnetic monopoles but the charges need not vanish now. Rather, valence quarks would be connected by flux tubes of length of order hadron size such that magnetic charges sum up to zero. For instance, for baryonic valence quarks these charges could be $(2, -1, -1)$ and could be proportional to color hyper charge.

3. The highly non-trivial prediction making more precise the earlier stringy vision is that elementary particles are string like objects in the length scale defined by their Compton length. Since the other end of flux tube carries neutrino pair it is however essentially invisible at low energies so that there is no obvious conflict with experimental facts.

The hierarchy of Planck constants means that the Compton lengths of dark elementary particles can be macroscopic so that their character as magnetic flux tubes with monopoles at ends could make itself manifest in condensed and living matter.

2.5.3 TGD as almost topological QFT

TGD as almost topological QFT is one of those idea that one cannot be sure of. I think it emerged around 2005. I have been even ready to give it up but it experienced re-incarnation as I discovered the weak form of electric-magnetic duality.

1. Holography in the sense that data at 3-D surfaces code for the quantum state is an idea which emerged already at 1990 or so since 3-surfaces are indeed basic objects in quantum TGD. General Coordinate Invariance indeed implies this and the highly non-trivial implication is that space-time surface associated with a given 3-surface is analogous to Bohr orbit. Therefore semiclassical quantization is an exact part of quantum TGD.

2. The question is whether it is light-like 3-surfaces or space-like 3-surfaces at the ends of space-time sheet defined by CD can be identified as the 3-surfaces that carry the data. Strong form of General Coordinate Invariance states that both choices are equally good. Only the intersections of these surfaces at the boundaries of CDs and their 4-D tangent spaces carry the data. This implies effective 2-dimensionality and strongly suggests conformal invariance and coset representation meaning that the actions of conformal generators of light-like 3-surface and those associated with the boundary of CD cancel each other. This implies EP in generalized form.

3. Already effective 3-dimensionality suggests but does not imply that the Kähler action reduces to 3-D Chern-Simons term. If this occurs, the theory simplifies enormously calculationally and there are good hopes of calculating even without knowing details about preferred extremals. Chern-Simons action defines a topological QFT for braids and braids indeed replaced the 3-D light-like orbits of partonic 2-surfaces in TGD Universe in finite measurement resolution.

The reduction of Kähler action to 3-D integrals

To achieve reduction to Chern-Simons term the Kähler action for preferred extremals must reduce to a total divergence. This is achieved if in the decomposition of action to a total divergence and term $j \cdot A$, where j is Kähler current the latter term vanishes: $j \cdot A = 0$. This takes place in the following situations.

1. Empty space Maxwell equations $j = 0$ stating the vanishing of Kähler current hold true.

2. j and A are light-like and in the same direction so that their product vanishes. This is true for so called "massless extremals" (topological light rays).

3. j is proportional to the instanton current $j = \Phi j_I$, $j_I = \epsilon^{\alpha\beta\gamma\delta} A_\beta J_{\gamma\delta}$ so that $j \cdot A$ vanishes identically. Conservation of the Kähler current requires that the proportional factor Φ must satisfy $d\Phi \cdot j_I + \Phi I = 0$ where I is instanton density. $d\Phi$ is either orthogonal to j_I or both $d\Phi$ and j_I are light-like and have same direction.

   This kind of proportionality might hold true also for other isometry currents and would mean "topologicalization" of conserved currents in accordance with the idea about almost topological QFT.

   One also ends up with the proposal that preferred extremals are such that the flow lines of isometry currents integrate to coordinate lines globally. This kind of flow is known as Beltrami flow. This would mean that they define the analog of hydrodynamic flow in which the orbits of particles do not cross each other and there are no collisions. The analog of quantum flow (no collisions - no dissipation) would be in question and one could assign to the flow an order parameter of a supra phase varying only along the flow lines. The basic condition for a flow J to define Beltrami flow read as $J \wedge dJ = 0$, where J is the 1-form defined by the current (covariant form of current depending on induced metric).

Reduction to Chern-Simons term by the weak form of electric-magnetic duality

The proportionality of Kähler current to instanton current implies the reduction of action to 3-D terms but not yet a reduction to Chern-Simons terms implying almost topological QFT property.

1. This is guaranteed if one assumed what I have called weak form of electric-magnetic duality. This duality generalizes the Montonen-Olive electric-magnetic duality and would hold at wormhole throats and space-like 3-surfaces at the ends of space-time sheets but not necessarily elsewhere. It would imply that Kähler flux equals to magnetic flux so that Kähler electric charge is quantized. There are good reasons to assume that this charge corresponds to fermion number so that all wormhole throats carrying fermion number would be magnetic monopoles carrying Kähler magnetic charge equal to fermion number. Physical particles would correspond to multi-monopole states with vanishing total Kähler magnetic charge.

2. It is important to notice that the weak form of electric-magnetic duality at the space-like 3-surfaces and wormhole throats involves the induced metric of the space-time sheet so that metric does not disappear from the theory although Kähler action reduces to Chern-Simons term. This gives a precise content to the attribute "almost". The reduction to Chern-Simons terms would mean enormous calculational simplification of the theory and raises the hope that the theory could be calculable.

3. This also fixes to a high degree the view about leptons and hadrons. For instance, leptons should be string like objects formed by Kähler magnetically charged wormhole throats connected by magnetic flux tubes. Analogous picture applies to gauge bosons consisting of wormhole contacts with throats carrying fermion and anti-fermion numbers respectively. Hadrons could correspond multimonopole states.

Morse, Kähler, and me

First year physics student would immediately say that $\sqrt{g_4}$ is imaginary in the space-time regions with Minkowskian signature of the induced metric and real otherwise. For me it took 33 years to finally accept this trivial fact as a fact but finally I had to give up! This simple fact implies that Minkowskian regions give imaginary exponent of Chern-Simons term and Euclidian regions real exponent of Chern-Simons term [K103]. Under rather natural assumptions the two Chern-Simons terms are identical and would be obtained as an exponent of Chern-Simons term multiplied by complex number.

The imaginary exponent gives rise to interference effects typical for gauge theories and defining the core mechanism of quantum field theories and implies that stationary phase approximation makes sense. Stationary phase approximation is important also in topological QFTs and Chern-Simons term plays the role of Morse function in topological QFTs classifying the topological of 4-manifolds. The real exponent defines Kähler function and guarantees the convergence of the functional integral and guarantees that it exists as a genuine mathematical object.

Could Kähler action reduce to a 2-D integral?

Effective 2-dimensionality suggests a further dimensional reduction in the sense that Chern-Simons terms might allow expression as 2-dimensional integrals. If this idea is accepted, the only natural option is a reduction to a sum of areas of string world sheets with dynamical string tension. I have indeed developed a detailed proposal concerning the identification of this string world sheet [K102]. String world sheets indeed emerge naturally in quantum TGD and have as their boundary the space-like braid strands at the ends of space-time surfaces and light-like braid strands at the light-like 3-surfaces. Knotting of string world sheets is possible in 4-D space-time whereas braid strands link and knot at 3-surfaces so that quantum TGD would provide a theory of ordinary knots and 2-knots. This adds additional aspect to the statement that TGD is almost topological QFT.

2.5.4   Generalized Feynman diagrams and braids

The notion of generalized Feynman diagram [K38, K34] has been developing rapidly during last five years. This progress has been boosted by several developments. The basic observation is that the regions of space-time surface with Euclidian signature of induced metric can be identified as generalized Feynman diagrams. Same interpretation applies by holography also to the light-like 3-surfaces at which the signature of the induced metric changes from Euclidian to Minkowskian. Additional boosts are due to ZEO allowing to interpreted the Feynman diagrams as a characterization of zero energy states. Also strong form of holography, bosonic energence, finite measurement resolution realized as discretization allows to replaced space-time sheets with string world sheets with the ends of string world sheets realized as braid strands, the realization that knotting of these strings is possible and could play a key role, and the connection with twistor approach have been important stimuli. The special role of 10 Hz frequency assignable to electron suggests that generalized Feynman diagrams could be relevant also for TGD inspired biology.

ZEO together with the notion of bosonic emergence leads to a new view about Feynman diagrams. The new element is that all physical states consist basically of wormhole throats which carry light-like four-momentum. Even virtual momenta are light-like and space-like four-momenta are obtained for wormhole contacts for which the energies of light-like states are of opposite sign. This leads to very powerful constraints on loop diagrams and there are good reasons to believe that both UV and IR divergences are absent.

Finite measurement resolution allows to assign braid strands to the light-like 3-surfaces and string world sheets to the 4-surfaces and one can also identify the braid strands as lines of generalized Feynman diagrams. It is possible to distinguish between light-like braids assignable to the light-like 3-surfaces and space-like braids connecting different partonic 2-surfaces at the ends of the space-time surface at the boundary of CD. Braids have also direct biological significance. DNA as topological quantum computer [K23] utilizes both kinds of braidings.

2.5.5   The superposition of classical fields in TGD Universe

Living system as conscious hologram is one of the basic visions. What one means with classical fields, their interference, and their interaction with elementary particles is an very essential aspect of what it is to be a hologram and a clarification to this issued emerged only during last year. As a matter fact, basic objection against TGD is that the interference of classical fields in the usual sense is not possible in TGD Universe!

In TGD Universe gauge fields are replaced with topological field quanta. Examples are topological light rays, magnetic/electric flux tubes and sheets, and flux quanta carrying both magnetic and electric fields. Flux quanta form a fractal hierarchy in the sense that there are flux quanta inside flux quanta. It is natural to assume quantization of Kähler magnetic flux. Braiding and reconnection are the basic topological operations for flux quanta.

The basic question is how the basic notions assigned with the classical gauge and gravitational fields understood in standard sense generalize in TGD framework.

1. Superposition and interference of the classical fields is very natural in Maxwell electrodynamics and certainly experimentally verified phenomena. Also the notion of hologram relies crucially on the notion of interference. How can one describe the effects explained in terms of superposition of fields in a situation in which the theory is extremely non-linear and all classical gauge fields are expressible in terms of CP_2 coordinates and their gradients? It is also rather clear that the preferred extremals for Kähler action decompose to space-time regions representing space-time correlates for quanta. The superposition of classical fields in Maxwellian sense is impossible.

2. How can one cope with this situation? The answer is based on simple observation: only the *effects* of the classical fields superpose. There is no need for the fields to superpose. Together with the notion of many-sheeted space-time this leads to elegant description of interference effects without any need to assume that linearization is a good approximation.

3. Topological quantization brings in also braiding and reconnection of magnetic flux tubes as basic operations for classical fields. These operations for flux tubes have also Maxwellian counterparts at the level of field lines. Braiding and reconnection are in a central role in TGD Universe and especially so in in TGD inspired theory of consciousness and quantum biology. The challenge is to build a coherent overall phenomenological view about the role of topologically quantized classical fields in biology and neuroscience. For instance, one can ask what is the precise formulation for the notion of conscious hologram and whether magnetic flux tubes could serve as correlates of entanglement (or at least negentropic entanglement suggested by the number theoretic vision and identified as a basic signature of living matter).

4. Topological quantization and the notion of magnetic body are especially important in TGD inspired model of EEG. The attempt to understand the findings of Persinger from the study of what is known as God helmet leads to a considerable progress in the understanding the possible role of topologically quantized classical fields in biology and neuro-science.

The replacement of superposition of fields with superposition of their effects allows to understand also how the many-sheeted space-time of TGD relates to the space-time of general relativity. GRT space-time seen as an effective space-time obtained by replacing Minkowskian regions of many-sheeted space-time with a region of Minkowski space with effective metric determined as a sum of Minkowski metric and sum over the deviations of the induced metrics of space-time sheets from Minkowski metric. Poincare invariance suggests strongly classical form of Equivalence Principle realized in terms of Einstein's equation for the GRT limit in long length scales at least.

One can consider also other kinds of limits such as the analog of GRT limit for Euclidian space-time regions assignable to elementary particles. In this case deformations of CP_2 metric define a natural starting point and CP_2 indeed defines a gravitational instanton with very large cosmological constant in Einstein-Maxwell theory. Also the gauge potentials of the standard model correspond classically to superpositions of induced gauge potentials over space-time sheets and standard model follows naturally at the QFT limit of TGD. TGD can be seen as a microscopic theory with space-time sheets carrying extremely simple "archetypal" field patterns and arranged in complex manner

to many-sheeted space-time topologies whereas GRT and QFT represents long length scale limit with topological complexity replaced with the complexity of fields patterns.

For the induced gauge fields coupling constants are absorbed into the definition of gauge potentials so that coupling constant evolution does not make sense in TGD space-time. Coupling constant evolution characterizing quantum field theories makes in TGD framework sense as the dependence of various vertices on the size scale of causal diamond (CD). This discrete coupling constant evolution becomes at QFT and GRT limits continuous coupling constant evolution.

Chapter 3

Quantum Mind in TGD Universe

3.1 Introduction

The notion of Quantum Mind [J108] has become a respected branch of science during thirty years since Esalem conference. The basic vision is that quantum superposition, quantum entanglement and state function reduction (or some of its interpretational equivalents) are somehow highly relevant for the understanding of consciousness. Whether quantum entanglement or quantum jump or something else is identified as a correlate for consciousness depends on theorist.

The basic objections against Quantum Mind is that standard quantum physics - at least wave mechanics- leaves no room for quantum mind. Decoherence leading to a loss of entanglement is the basic enemy of quantum mind [J152]. Experimental work however suggests that macroscopic quantum coherence prevails in cell length scale: the findings about photosynthesis provide an example of this [I17]. There is also a growing evidence for macro-entanglement between different brains correlating closely with electromagnetic fields [J135, J101].

Of course, the idea that wave mechanics is enough to describe living matter and also the belief that quantum theory - as we know it - is something final are only beliefs. There are many other similar beliefs: the belief on reductionism coded to the statement that everything above intermediate boson length scale is understood in recent day physics; the belief that living matter differs from inanimate matter only because it is very complex; the belief that experienced time and the geometric time of physicist are one and the same thing; the pragmatic belief that the problems of quantum measurement theory can be forgotten by saying that quantum theory is just a calculational recipe;...

One could add one further not quite obvious item to the list. Dark matter and dark energy are one of the most notorious problems of recent day physics and it is just a belief that dark matter is nothing but some exotic X-ino having very weak interactions with visible matter and therefore does not have any relevance for the understanding of living matter.

The basic message of this article is that standard quantum theory is not enough if one wants to construct a theory of Quantum Mind. A profound re-evaluation of the belief system underlying the ontology of the recent day quantum physics is needed. My own proposal is following.

- The reductionistic dogma is replaced with fractality meaning infinite hierarchies both at the level of matter and mind. Consciousness is everywhere in a form of self hierarchy so that Quantum Mind involves more than brain. Biological bodies, cells, biomolecules, and even elementary particles correspond to the levels of the self hierarchy. Also higher collective levels are present.

- Topological field structures implied by the new fractal view about space-time - I speak about many-sheeted space-time- are essential parts of this hierarchy. The notion of field (or magnetic) body is one aspect of the many-sheeted space-time and one could even say that magnetic body is the intentional agent using biological body as a motor instrument and sensory receptor. EEG and its various fractal analogs can be seen as communication and control tools of of the magnetic body in this conceptual framework. The explanation for the strange time delays associated the the passive aspects of consciousness discovered by Libet [J71]

and the good hopes about understanding of fundamental biorhythms in terms of cyclotron frequencies of biologically important and Josephson frequencies assignable to cell membrane Josephson junctions [K20] provide support for this vision. This conforms with the proposals that spin and more generally angular momentum are central for understanding consciousness and living matter [J117, J135]. Biological evolution becomes evolution of consciousness and one cannot restrict Quantum Mind to microtubules, brain, or even biological body.

- Self hierarchy has two physical correlates: the hierarchy of p-adic length scales and the hierarchy of Planck constants: both hierarchies have experimental support. A number theoretical miracle occurs: the length scale range 10 nm-2.5 μm involves as many as four electron Compton scales assignable to Gaussian Mersennes. The effects of ELF em fields on vertebrate brain [J46] and the strange behavior of cell membrane and cell interior suggesting strongly quantal ionic currents [I86] provide physical support for both the hierarchy of Planck constants and p-adic length scale hypothesis.

- In TGD Universe zero energy ontology (ZEO) replaces the positive energy ontology of standard physics. The motivation comes both certain philosophical dilemma which is very frustrating for a theoretician, and the crossing symmetry of quantum field theory justifies ZEO. ZEO assigns new macroscopic time scale to each elementary particle. For electron and quarks these time scale coincide with fundamental biological time scales (for instance, the .1 second time scale predicted for electron corresponds to 10 Hz fundamental biorhythm). Elementary particle physics and biology are therefore strongly interrelated in ZEO.

- The identification of quantum jump as moment of consciousness and the notion of self emerge from a generalization of quantum measurement theory to a theory of consciousness. In this framework the experienced time identified as a sequence of quantum jumps and the geometric time of physicist cannot be identified [?]

  The fact that the contents of conscious experience is about a four-dimensional region of space-time implies a new interpretation of memories [K70]. Quantum jump replacing the entire geometric future and past with a new one: Libet's strange findings about active aspects of consciousness [J122] forcing in positive energy ontology the conclusion that free will is illusion provide support for this view. The challenge is to understand the arrow of time and why the contents of sensory experience is localized to a rather short time interval of about .1 second: this suggests a rather dramatic radical idea about how the arrow of subjective time emerges as a consequence of Negentropy Maximization Principle [K49] defining the basic variational principle of TGD inspired theory of consciousness.

- p-Adic physics extending reality to include also various p-adic levels is highly relevant for the understanding of the difference between living and inanimate matter. Negentropic entanglement is possible for p-adic variant of Shannon entropy making sense if entanglement probabilities are algebraic. One can say that this entanglement is possible in the intersection of real and p-adic worlds in which intentions could transform to actions by quantum jumps replacing p-adic space-time sheets with real ones (this makes sense only in ZEO!). Maybe this is the mathematical and information theoretical quintessence of life.

Before continuing a comment about the notion of consciousness is in order. This notion as also the notion of awareness implicitly codes for the assumption that consciousness is a property of a physical system- something mathematically analogous to mass or charge. The greek world "nous" and finnish word "tajunta" refer to activity rather than property and this meaning is more appropriate in TGD framework. Since it would sound rather artificial to talk about "TGD inspired theory of nous" I will will use the standard term in the sequel although it is misleading. It should be also emphasize that I represent only those aspects of a rather extensive work documented in the books at my homepage, which seem to be especially interesting just now. In the following representation I am forced to leave out all details. They can be found in the books about TGD inspired theory of consciousness at my homepage [K88, K11, K62, K35, K10, K42, K46, K81]. I have also summarized TGD inspired theory of consciousness in an issue of JCER [L20, L18, L19] but from different view point.

The appendix of the book gives a summary about basic concepts of TGD with illustrations. There are concept maps about topics related to the contents of the chapter prepared using CMAP

realized as html files. Links to all CMAP files can be found at `http://www.tgdtheory.fi/cmaphtml.html` [L35]. Pdf representation of same files serving as a kind of glossary can be found at `http://www.tgdtheory.fi/tgdglossary.pdf` [L36]. The topics relevant to this chapter are given by the following list.

- Magnetic body [L52]

- Basic Mechanisms associated with magnetic body [L39]

- Hierarchy of Planck constants [L50]

- Negentropy Maximization Principle [L54]

- Bio-anomalies [L41]

- Biophotons [L42]

- Cell membrane anomalies [L44]

- DC currents of Becker [L46]

- ELF effects on brain [L47]

- Microtubules [L53]

- Pollack's observations [L56]

3.2 What are the problems of quantum mind theories?

In the following I list briefly the basic problems of physics and quantum mind theories using a classification which is rather natural from the point of view of physics.

3.2.1 Some philosophical problems of quantum physics

- "Monism, dualism, or something else?" is the first basic question. Monism appears as two variants which are mirror images. Materialism has the problem that consciousness becomes something totally reducible to the state of material system so that free will must be an illusion if one believes in the deterministic laws of physics. This is in a sharp contrast to what we directly experience. In the idealistic framework one loses completely physics. The difficulty of dualism- pointed out very clearly by Chalmers [J55] - is that it is very difficult to achieve consistency with the basic laws of physics which do not allow free will. It seems that one must have something new allowing to achieve consistency of the determinism of field equations with (partially) free will.

- "Reductionism or not?" is second key question. For me personally the realization that reductionism is a mere dogma was a painful process although it was from the beginning clear that TGD based view about space-time forces to challenge this belief. It was especially painful to take seriously the fact that even the reduction of chemical bond to wave mechanics alone is nothing but a belief since it it is not yet testable by performing numerical calculations. Gradually I became conscious about the many non-existing bridges of reductionism: the bridge from quarks and gluons to hadrons; the bridge from nucleons to nuclei; the bridge from atoms to molecules; the bridges from inorganic chemistry to organic chemistry to biochemistry: all these bridges are just figments of wishful thinking and implications of the reductionistic dogma rather than support for it. Also the widely accepted argument about living matter as something which is just complex fails to be distinguishable from a rhetoric trick.

- "Determinism or not?" is the third question. Also here it took time to realize that the belief that free will is an illusion does not reflect the reality but our limited tools for describing it. The physicists of previous centuries did not have any conceptual and mathematical tools to describe free will without giving up the idea about laws of physics. Most importantly, they

did not know anything about quantum non-determinism. Perhaps it is some kind of cognitive inertia that physicists have been ready to give up even the very notion of objective reality instead of accepting the fact that non-determinism is real and concluding that one should find an ontology consistent with both quantum non-determinism and Schrödinger equation.

- The notion of time is highly problematic.

  - The relationship between experienced time and the geometric time of physicist is poorly understood. Subjective time is irreversible and has only recent moment and past, geometric time is reversible and spans entire eternity. The assignment of experienced time with a 3-D wave front shifting in the direction of geometric time direction is in conflict with Lorentz symmetry and general coordinate invariance, which do not allow to identify a unique time coordinate as the subjective time. The natural basic object in general relativity is 4-dimensional space-time region, not time=constant snapshot.

  - In physics conceptual difficulties are encountered already in the phenomenological description of dissipation by adding to the reversible field equations phenomenological dissipation terms. Rather remarkably, the quantum mechanical formulas for the reaction rates in terms used to calculated dissipation coefficients involve integral over entire space-time so that quantum events have at least formally an infinite duration. Finite duration is certainly necessary by Uncertainty Principle. Somehow quantum jump seems to involve entire geometric eternity: as if it would take place between two geometric eternities.

  - There is also the problem of initial state. If the dynamics is deterministic and conservation laws hold, only a single solution of field equations is realized in classical physics and theoretical physics becomes useless waste of time since it cannot be tested. If quantum non-determinism is allowed, conservation laws still restrict the physical states to those having fixed net values. "What was the initial state at the moment of Big Bang?" is the question which cannot be answered in the framework of physics alone and one ends up doing metaphysics. Indeed, the recent crisis of M-theory- meant to be the final jewel in the crown of materialistic and reductionistic science- has led to the landscape problem, and many colleagues have given up the hope that ultimate theory could predict anything so that anthropic principle would be the only manner to connect theory with experiment.

3.2.2 Basic philosophical problems of quantum mind theories

At least the following problems could be seen as basic philosophical problems of quantum mind theories.

- What are the quantum correlates for consciousness? Entanglement has been proposed as a correlate of consciousness. For instance, in the orchestrated reduction approach of Hameroff and Penrose the period of consciousness ends with a state function reduction and quantum gravitation is believed to play a fundamental role in the understanding of consciousness. The believer in free will could see state function reduction or its generalization as as a natural quantum correlate for a moment of consciousness. The basic objection is that the randomness of state function reduction does not allow genuine goal directed free will. One could also argue that state function reduction generates entropy at least at the level of ensemble whereas intentional action should do just the opposite. Here one must however remember that entropy generation at the level of aspect need not mean entropy generation at the level of the member of ensemble.

- How the determinism of field equations and Schrödinger equation can be consistent with the non-determinism of the state function reduction? This question must be answered unless one is ready to give up the notion of objective reality completely or to believe in multiverse interpretation. These manners to circumvent the basic problem do not however leave much room for quantum consciousness theorizing. The closely related question about the relationship between experienced time and time of physicist has been already mentioned.

- What is the quantum correlate for the notion of self? The quantum notion of self should be a generalization of the notion of observer which in quantum measurement theory still remains a structureless outsider.

- What conscious information is? Can one give it a mathematical measure? Can one measure physically the amount of conscious information? Unfortunately the recent day physics can only provide measure for dis-information as Shannon entropy and the best that subsystem can achieve is no information at all if this picture is accepted.

- There is a bundle of questions about the quantum correlates of various aspects of conscious experience. For instance, what is the quantum correlate of mental image, and what are the quantum correlates of cognition and intentionality, Boolean mind, sensory qualia, memory, and of emotions?

- An especially challenging question relates to the quantum correlate for the self referentiality of consciousness making possible reflective levels of consciousness. What it means physically to be conscious about what one is (or perhaps only "was") conscious? Jack Sarfatti was well aware about this problem and in his dualistic approach talked about feedback loop but still used a trick in which one divides various fields to matter-like and mind-like.

3.2.3 Basic problems of quantum biology and quantum neuroscience

The basic problems of quantum biology and neuroscience are closely related unless one is ready to believe that consciousness reduces to one particular function assignable to some particular part of brain ("consciousness module"). This kind of assignment can be imagined in engineerish neuroscience identifying brain as electric circuitry but does not have much sense in quantum mind approach.

The first list of first principle questions includes at least the following ones.

- What distinguishes between living and dead matter is certainly the fundamental question. In standard biology based on materialistic philosophy one tries to reduce the distinction to a list of properties which as such can be possessed by inanimate matter. Ability to replicate, to process information, to communicate, to form representations about the external world, the ability to self-organize to increasingly complex configurations, intentional behavior, ability to co-operate,.... could be properties of this kind. Up to self-organization the reduction seems plausible. It is easy to model self-organization (by say cell automatons) but it this dynamics is like the dynamics of traffic rules and neither classical nor quantum dynamics resembles it. Intentional behavior is impossible to understand in classical physics unless one claims that it is a mere illusion. This is the case also in quantum physics as we understand it since the randomness of the outcome of state function reduction seems to be in conflict with intentional behavior. Here one must however keep in mind that the individual subsystem performing a state function reduction could quite well experience it as an intentional action. In any case, standard view about state function reduction makes it difficult to co-operative behavior.

- What distinguishes between biochemistry and organic chemistry? For instance, how biomolecules can find themselves in the dense soup of biomolecules and how can one understand the effectiveness of bio-catalysts? One might think that these problems are well-understood since we have learned what happens in DNA replication, transcription, and translation and we know the complex reaction pathways. The dynamics involved is very much like the symbolic dynamics of society (one can predict the day of practicizing professional from knowing his profession but not from the knowledge of initial data of every possible elementary particle in his body). But what makes the soup of biomolecules a molecular society obeying a dynamics based on symbols? The description of biochemistry in terms of kinematics allows to construct complex reaction pathways based on the idea that each step of the reaction pathway requires a key which fits to a lock of a room containing a key to the lock to the next room [I93] but can one really deduce this kind of kinematics from standard quantum theory?

- Both biology and neuroscience characterizes subsystems of biological systems and brain in terms of functions they possess and one should also understand whether and how the quantum

counterparts of functions emerge. The identification of various functions as time evolution of standard self-organization patterns is certainly a part of the answer. But what self-organization means? Conscious information is certainly the key notion but is the existing quantum theory able to characterize it?

- At the level of brain one of the key questions concerns EEG. Since EEG correlates strongly with the contents of consciousness it is difficult to believe that it is random side product of neural activity. What is then the real role of neuronal activity and EEG and its variants? Why EEG is needed? Signalling related to communication and control is what comes first in mind. But why this kind of signalling would be needed. Brain sends (receives) information but who receives (sends) it?

- How macroscopic quantum coherence is achieved allowing quantum super-positions in long time scales? How stable quantum entanglement is achieved? These are difficult problems if one wants to understand quantum mind without generalizing quantum theory itself. Planck constant is simply too small so that dissipation rates are too high and coherence times and lengths are too short. Should physicists adopt a humbler attitude and consider seriously the possibility that the existing physics is not enough and try to learn from biology instead of saying that living systems are just complex?

3.2.4 Could anomalies help?

Anomalies are the best way to end up with a discovery of something new. Of course, living matter as such is a gigantic anomaly but this does not help much. One should pick up the anomalies which are in sharp conflict with the existing physics and give a clear hint about what is wrong with our cherished assumptions.

- In quantum mind approach EEG should be a quantal phenomenon since it correlates with consciousness. From the basic formula $E = hf$ of quantum mechanics the energies of EEG photons are however ridiculously small as compared to the thermal energy at physiological temperatures. The strange quantal looking effects of ELF photons on vertebrate (why just vertebrate?!) brain at frequencies which correspond to cyclotron frequencies of biologically important ions such as Ca^{++} are however an experimental fact (see for instance [J46]). The effects of magnetic field patterns on brain studied by Persinger and collaborators represent also an example of this kind of strange effects [J134]. The strange findings about the behavior of cell membrane [I86] suggest that ionic currents do not dissipate much. The recently discovered burning of water when irradiated by radio wave photons [D14, D1] suggests that energetically these photons behave like photons of visible light. The recent findings about photosynthesis [I17] suggest quantum coherence in cellular length scale.

  Is standard quantum theory able to explain these findings? Should one challenge the belief that Planck constant is just a conversion factor between units which can be put equal one with a suitable choice of units? Could Planck constant have a spectrum of discrete values? This would explain the strange findings since by $E = hf$ relation low frequencies could correspond to high energies and dissipation rates -in the first guess inversely proportional to $\hbar$- could be very small. Large values of Planck constant would also increase the spatial and time scales of quantum coherence and might solve the basic technical problem of quantum consciousness theories.

- Also bio-photons [I37] correlate with the state of living system but are poorly understood in the existing theoretical framework.

- Libet's findings about strange time delays associated with the passive aspects of consciousness serve also as a hint. Our sensory data has age which is a fraction of second and corresponds to a photon wavelength $\lambda = cT$ to a length scale, which is of order of Earth size. As if sensory data would be communicated somewhere. Where?

- Cyclotron frequencies of biologically important ions in a magnetic field .2 Gauss (smaller than the nominal value of .5 Gauss of the Earth's magnetic field) are involved with the effects of ELF radiation on vertebrate brain. Also Schumann resonances are reported to have

effects on brain. Are some kind of magnetic field structures involved? Earth's magnetic field and perhaps also the magnetic field patterns associated with biological system itself with $B = 2B_E/5$ for one important level in the hierarchy? As noticed in [J135], the cyclotron energy scale of electron in pT range is in EEG range and pT range indeed characterizes the magnetic field associated with brain activity. Do also these magnetic structures carry Cooper pairs of electrons?

- ADP-ATP machinery is the core of energy metabolism and its description involves the problematic notion of high energy phosphate bond [I8]. Does this notion really reduce to standard quantum theory?

- The chiral selection of biomolecules in living matter [I3, I83] means a large parity breaking. This is a complete mystery in standard model which predicts extremely small parity breaking effects. Therefore chiral selection is extremely valuable anomaly helping to guess what kind of new physics might be involved with living matter. Somehow it seems that the parity breaking effects which are large in electro-weak scale appear in immensely zoomed up scales (scaling factors of order 10^{10} would be involved)

3.3 Some aspects of quantum TGD

In the following I summarize very briefly those basic notions of TGD which are especially relevant for TGD inspired consciousness theory and quantum biology. The representation will be practically formula free. The article series published in Prespace-time Journal [L12, L13, L16, L17, L14, L11, L15, L21] describes the mathematical theory behind TGD. The seven books about TGD [K96, K71, K55, K52, K83, K72, K82] provide a detailed summary about the recent state of TGD.

3.3.1 New space-time concept

The physical motivation for TGD was what I have christened the energy problem of General Relativity. The notion of energy is ill-defined because the basic symmetries of empty space-time are lost in the presence of gravity. The way out is based on assumption that space-times are imbeddable as 4-surfaces to certain 8-dimensional space by replacing the points of 4-D empty Minkowski space with 4-D very small internal space. This space -call it S- is unique from the requirement that the theory has the symmetries of standard model: $S = CP_2$, where CP_2 is complex projective space with 4 real dimensions [L21], is the unique choice.

The replacement of the abstract manifold geometry of general relativity with the geometry of surfaces brings the shape of surface as seen from the perspective of 8-D space-time and this means additional degrees of freedom giving excellent hopes of realizing the dream of Einstein about geometrization of fundamental interactions.

The work with the generic solutions of the field equations assignable to almost any general coordinate invariant variational principle led soon to the realization that the space-time in this framework is much more richer than in general relativity.

1. Space-time decomposes into space-time sheets with finite size: this lead to the identification of physical objects that we perceive around us as space-time sheets. For instance, the outer boundary of the table is where that particular space-time sheet ends. Besides sheets also string like objects and elementary particle like objects appear so that TGD can be regarded also as a generalization of string models obtained by replacing strings with 3-D surfaces.

2. Elementary particles are identified as topological inhomogenuities glued to these space-time sheets. In this conceptual framework material structures and shapes are not due to some mysterious substance in slightly curved space-time but reduce to space-time topology just as energy- momentum currents reduce to space-time curvature in general relativity.

3. Also the view about classical fields changes. One can assign to each material system a field identity since electromagnetic and other fields decompose to topological field quanta. Examples are magnetic and electric flux tubes and flux sheets and topological light rays representing light propagating along tube like structure without dispersion and dissipation

making em ideal tool for communications [K56]. One can speak about field body or magnetic body of the system.

Field body indeed becomes the key notion distinguishing TGD inspired model of quantum biology from competitors. The magnetic body inherits from the biological body an onion-like fractal structure. Each part of the magnetic body can be seen as an intentional agent using the corresponding part of the biological body as a motor instrument and sensory receptor. The size scale of the magnetic body is in general much larger than that of biological body. Cyclotron frequency identified as frequency of photons able to exist as oscillations at magnetic body gives an estimate for the size of the magnetic body corresponding to a particular magnetic field strength. For 10 Hz frequency the size scale is of order Earth size. In this framework a fractal generalization of EEG and its variants provides a communication and control tool for magnetic body. The findings of Libet about time delays associated with the passive aspects and meaning that sensory data is a fraction of second old [J71] could be understood as delays due to the finite velocity of light: it takes finite time for the signal to propagate from biological body to the magnetic body.

This obviously means a profound modification of the views about what we are. The identification with the biological body could be understood as an illusion: a child looking a movie assimilates completely with the hero. There is a rich variety of illusions related to this identification of observer with the region of space from which the dominating contribution to consciousness comes from.

3.3.2 Zero energy ontology

In standard ontology of quantum physics physical states are assumed to have positive energy. In zero energy ontology physical states decompose to pairs of positive and negative energy states such that all net values of the conserved quantum numbers vanish. The interpretation of these states in ordinary ontology would be as transitions between initial and final states, physical events. By quantum classical correspondences zero energy states must have space-time and imbedding space correlates.

1. Positive and negative energy parts reside at future and past light-like boundaries of causal diamond (CD) defined as intersection of future and past directed light-cones and visualizable as double cone. The analog of CD in cosmology is big bang followed by big crunch. CDs for a fractal hierarchy containing CDs within CDs. Disjoint CDs are possible and CDs can also intersect.

2. p-Adic length scale hypothesis [?]otivates the hypothesis that the temporal distances between the tips of the intersecting light-cones come as octaves $T = 2^n T_0$ of a fundamental time scale T_0 defined by CP_2 size R as $T_0 = R/c$. One prediction is that in the case of electron this time scale is .1 seconds defining the fundamental biorhythm. Also in the case u and d quarks the time scales correspond to biologically important time scales given by 10 ms for u quark and by and 2.5 ms for d quark [K7]. This means a direct coupling between microscopic and macroscopic scales.

Zero energy ontology conforms with the crossing symmetry of quantum field theories meaning that the final states of the quantum scattering event are effectively negative energy states. As long as one can restrict the consideration to either positive or negative energy part of the state ZEO is consistent with positive energy ontology. This is the case when the observer characterized by a particular CD studies the physics in the time scale of much larger CD containing observer's CD as a sub-CD. When the time scale sub-CD of the studied system is much shorter that the time scale of sub-CD characterizing the observer, the interpretation of states associated with sub-CD is in terms of quantum fluctuations.

ZEO solves the problem of initial state since in principle any zero energy state is obtained from any other state by a sequence of quantum jumps without breaking of conservation laws. The fact that energy is not conserved in general relativity based cosmologies can be also understood since each CD is characterized by its own conserved quantities. As a matter fact, one must be speak about average values of conserved quantities since one can have a quantum superposition of zero energy states with the quantum numbers of the positive energy part varying over some range.

For thermodynamical states this is indeed the case and this leads to the idea that quantum theory in ZEO can be regarded as a "complex square root" of thermodynamics obtained as a product of positive diagonal square root of density matrix and unitary S-matrix. M-matrix defines time-like entanglement coefficients between positive and negative energy parts of the zero energy state and replaces S-matrix as the fundamental observable. In standard quantum measurement theory this time-like entanglement would be reduced in quantum measurement and regenerated in the next quantum jump if one accepts Negentropy Maximization Principle (NMP) [K49] as the fundamental variational principle. Various M-matrices define the rows of the unitary U matrix characterizing the unitary process part of quantum jump. From the point of view of consciousness theory the importance of ZEO is that conservation laws in principle pose no restrictions for the new realities created in quantum jumps: free will is maximal.

3.3.3   The hierarchy of Planck constants

The motivations for the hierarchy of Planck constants come from both astrophysics and biology. The biological motivations have been already discussed. In astrophysics the observation of Nottale [E8] that planetary orbits in solar system seem to correspond to Bohr orbits with a gigantic gravitational Planck constant motivated the proposal that Planck constant might not be constant after all [K79, K57].

This led to the introduction of the quantization of Planck constant as an independent postulate. It has however turned that quantized Planck constant in effective sense could emerge from the basic structure of TGD alone. Canonical momentum densities and time derivatives of the imbedding space coordinates are the field theory analogs of momenta and velocities in classical mechanics. The extreme non-linearity and vacuum degeneracy of Kähler action imply that the correspondence between canonical momentum densities and time derivatives of the imbedding space coordinates is 1-to-many: for vacuum extremals themselves 1-to-infinite.

A convenient technical manner to treat the situation is to replace imbedding space with its n-fold singular covering. Canonical momentum densities to which conserved quantities are proportional would be same at the sheets corresponding to different values of the time derivatives. At each sheet of the covering Planck constant is effectively $\hbar = n\hbar_0$. This splitting to multi-sheeted structure can be seen as a phase transition reducing the densities of various charges by factor $1/n$ and making it possible to have perturbative phase at each sheet (gauge coupling strengths are proportional to $1/\hbar$ and scaled down by $1/n$). The connection with fractional quantum Hall effect [D2] is almost obvious. At the more detailed level one finds that the spectrum of Planck constants would be given by $\hbar = n_a n_b \hbar_0$.

This has many profound implications, which are wellcome from Quantum Mind perspective.

1. Quantum coherence and quantum superposition become possible in arbitrary long length scales. One can speak about zoomed up variants of elementary particles and zoomed up sizes make it possible to satisfy the overlap condition for quantum length parameters used as a criterion for the presence of macroscopic quantum phases. In the case of quantum gravitation the length scale involved are astrophysical. This would conform with Penrose's intuition that quantum gravity is fundamental for the understanding of consciousness and also with the idea that consciousness cannot be localized to brain.

2. Photons with given frequency can in principle have arbitrarily high energies by $E = hf$ formula, and this would explain the strange anomalies associated with the interaction of ELF em fields with living matter [J46]. Quite generally the cyclotron frequencies which correspond to energies much below the thermal energy for ordinary value of Planck constant could correspond to energies above thermal threshold.

3. The value of Planck constant is a natural characterizer of the evolutionary level and biological evolution would mean a gradual increase of the largest Planck constant in the hierarchy characterizing given quantum system. Evolutionary leaps would have interpretation as phase transitions increasing the maximal value of Planck constant for evolving species. The space-time correlate would be the increase of both the number and the size of the sheets of the covering associated with the system so that its complexity would increase.

4. The phase transitions changing Planck constant change also the length of the magnetic flux tubes. The natural conjecture is that biomolecules form a kind of Indra's net connected by the flux tubes and $\hbar$ changing phase transitions are at the core of the quantum bio-dynamics. The contraction of the magnetic flux tube connecting distant biomolecules would force them near to each other making possible for the bio-catalysis to proceed. This mechanism could be central for DNA replication and other basic biological processes. Magnetic Indra's net could be also responsible for the coherence of gel phase and the phase transitions affecting flux tube lengths could induce the contractions and expansions of the intracellular gel phase. The reconnection of flux tubes would allow the restructuring of the signal pathways between biomolecules and other subsystems and would be also involved with ADP-ATP transformation inducing a transfer of negentropic entanglement [K27] (see fig. `http://www.tgdtheory.fi/appfigures/cat.jpg` or fig. 21 in the appendix of this book). The braiding of the magnetic flux tubes could make possible topological quantum computation like processes and analog of computer memory realized in terms of braiding patterns [K23].

5. p-Adic length scale hypothesis and hierarchy of Planck constants suggest entire hierarchy of zoomed up copies of standard model physics with range of weak interactions and color forces scaling like $\hbar$. This is not conflict with the known physics for the simple reason that we know very little about dark matter (partly because we might be making misleading assumptions about its nature).

   Dark matter would make possible the large parity breaking effects manifested as chiral selection of bio-molecules [I3]. What is required is that classical Z^0 and W fields responsible for parity breaking effects are present in cellular length scale. If the value of Planck constant is so large that weak scale is some biological length scale, weak fields are effectively massless below this scale and large parity breaking effects become possible.

   For the solutions of field equations which are almost vacuum extremals Z^0 field is non-vanishing and proportional to electromagnetic field. The hypothesis that cell membrane corresponds to a space-time sheet near a vacuum extremal (this corresponds to criticality very natural if the cell membrane is to serve as an ideal sensory receptor) leads to a rather successful model for cell membrane as sensory receptor with lipids representing the pixels of sensory qualia chart. The surprising prediction is that bio-photons [I37] and bundles of EEG photons can be identified as different decay products of dark photons with energies of visible photons. Also the peak frequencies of sensitivity for photoreceptors are predicted correctly [K66].

3.3.4 p-Adic physics and number theoretic universality

p-Adic physics [K86, K52] has become gradually a key piece of TGD inspired biophysics. Basic quantitative predictions relate to p-adic length scale hypothesis and to the notion of number theoretic entropy. Basic ontological ideas are that life resides in the intersection of real and p-adic worlds and that p-adic space-time sheets serve as correlates for cognition and intentionality.

p-Adic number fields

p-Adic number fields Q_p [A8] -one for each prime p- are analogous to reals in the sense that one can speak about p-adic continuum and that also p-adic numbers are obtained as completions of the field of rational numbers. One can say that rational numbers belong to the intersection of real and p-adic numbers. p-Adic number field Q_p allows also an infinite number of its algebraic extensions. Also transcendental extensions are possible. For reals the only extension is complex numbers.

p-Adic topology defining the notions of nearness and continuity differs dramatically from the real topology. An integer which is infinite as a real number can be completely well defined and finite as a p-adic number. In particular, powers p^n of prime p have p-adic norm (magnitude) equal to p^{-n} in Q_p so that at the limit of very large n real magnitude becomes infinite and p-adic magnitude vanishes.

p-Adic topology is rough since p-adic distance $d(x,y) = d(x-y)$ depends on the lowest pinary digit of $x-y$ only and is analogous to the distance between real points when approximated by taking

into account only the lowest digit in the decimal expansion of $x - y$. A possible interpretation is in terms of a finite measurement resolution and resolution of sensory perception. p-Adic topology looks somewhat strange. For instance, p-adic spherical surface is not infinitely thin but has a finite thickness and p-adic surfaces possess no boundary in the topological sense. Ultra-metricity is the technical term characterizing the basic properties of p-adic topology and is coded by the inequality $d(x - y) \leq Min\{d(x), d(y)\}$. p-Adic topology brings in mind the decomposition of perceptive field to objects.

Physical and biological motivations for p-adic number fields

The physical motivations for p-adic physics came from the observation that p-adic thermodynamics -not for energy but infinitesimal scaling generator of so called super-conformal algebra [A2] acting as symmetries of quantum TGD [K71]- predicts elementary particle mass scales and also masses correctly under very general assumptions [K52]. In particular, the ratio of proton mass to Planck mass, the basic mystery number of physics, is predicted correctly. The basic assumption is that the preferred primes characterizing the p-adic number fields involved are near powers of two: $p \simeq 2^k$, k positive integer. Those nearest to power of two correspond to Mersenne primes $M_n = 2^n - 1$. One can also consider complex primes known as Gaussian primes, in particular Gaussian Mersennes $M_{G,n} = (1 + i)^n - 1$.

It turns out that Mersennes and Gaussian Mersennes are in a preferred position physically in TGD based world order. What is especially interesting is that the p-adic length scale range 10 nm-5 μm contains as many as four scaled up electron Compton lengths $L_e(k) = \sqrt{5}L(k)$ assignable to Gaussian Mersennes $M_k = (1 + i)^k - 1$, $k = 151, 157, 163, 167$ [K66]. This number theoretical miracle supports the view that p-adic physics is especially important for the understanding of living matter.

p-Adic length scale hypothesis suggests the identification of metabolic energy currencies as energy quanta liberated as particle drops from space-time sheet to a larger one. These energy quanta correspond to increments of zero point kinetic energy. Metabolic energy currencies would be completely universal and exist already during the prebiotic era so that metabolic machinery would build up around this pre-existing structure. A simple (and also rough) model based on p-adic length scale hypothesis allows to estimate the increments of zero point kinetic energy. The quantum corresponding to about .5 eV has place in this hierarchy for which basic energies (those for which larger space-time sheet is very large) come as octaves of basic energy quantum [K7, K39]. These energy quanta do not have interpretation in terms of molecular transitions and there exist anomalous lines of radiation from interstellar space both in IR, visible, and UV region [K7].

p-Adic physics as correlate for cognition and intentionality

The philosophical for p-adic numbers fields come from the question about the possible physical correlates of cognition and intention [K53]. Cognition forms representations of the external world which have finite cognitive resolution and the decomposition of the perceptive field to objects is an essential element of these representations. Therefore p-adic space-time sheets could be seen as candidates of thought bubbles, the mind stuff of Descartes. One can also consider p-adic space-time sheets as correlates of intentions. The quantum jump in which p-adic space-time sheet is replaced with a real one could serve as a quantum correlate of intentional action. This process is forbidden by conservation laws in standard ontology: one cannot even compare real and p-adic variants of the conserved quantities like energy in the general case. In zero energy ontology the net values of conserved quantities for zero energy states vanish so that conservation laws allow these transitions.

Life as something in the intersection of real and p-adic worlds

Rational numbers belong to the intersection of real and p-adic continua. An obvious generalization of this statement applies to real manifolds and their p-adic variants. When extensions of p-adic numbers are allowed, also some algebraic numbers can belong to the intersection of p-adic and real worlds. The notion of intersection of real and p-adic worlds has actually two meanings.

1. The intersection could consist of the rational and possibly some algebraic points in the intersection of real and p-adic partonic 2-surfaces at the ends of CD. This set is in general

discrete. The interpretation could be as discrete cognitive representations.

2. The intersection could also have a more abstract meaning. For instance, the surfaces defined by rational functions with rational coefficients have a well-defined meaning in both real and p-adic context and could be interpreted as belonging to this intersection. There is strong temptation to assume that intentions are transformed to actions only in this intersection. One could say that life resides in the intersection of real and p-adic worlds in this abstract sense.

Additional support for the idea comes from the observation that Shannon entropy $S = -\sum p_n log(p_n)$ allows a p-adic generalization if the probabilities are rational numbers by replacing $log(p_n)$ with $-log(|p_n|_p)$, where $|x|_p$ is p-adic norm. Also algebraic numbers in some extension of p-adic numbers can be allowed. The unexpected property of the number theoretic Shannon entropy is that it can be negative and its unique minimum value as a function of the p-adic prime p it is always negative. Entropy transforms to information!

In the case of number theoretic entanglement entropy there is a natural interpretation for this. Number theoretic entanglement entropy would measure the information carried by the entanglement whereas ordinary entanglement entropy would characterize the uncertainty about the state of either entangled system. For instance, for p maximally entangled states both ordinary entanglement entropy and number theoretic entanglement negentropy are maximal with respect to R_p norm. Entanglement carries maximal information. The information would be about the relationship between the systems, a rule. Schrödinger cat would be dead enough to know that it is better to not open the bottle completely.

Negentropy Maximization Principle [K49] coding the basic rules of quantum measurement theory implies that negentropic entanglement can be stable against the effects of quantum jumps unlike entropic entanglement. Therefore living matter could be distinguished from inanimate matter also by negentropic entanglement possible in the intersection of real and p-adic worlds. In consciousness theory negentropic entanglement could be seen as a correlate for the experience of understanding or any other positively colored experience, say love.

Negentropically entangled states are stable but binding energy and effective loss of relative translational degrees of freedom is not responsible for the stability. Therefore bound states are not in question. The distinction between negentropic and bound state entanglement could be compared to the difference between unhappy and happy marriage. The first one is a social jail but in the latter case both parties are free to leave but do not want to. The special characterics of negentropic entanglement raise the question whether the problematic notion of high energy phosphate bond citebbioHEP central for metabolism could be understood in terms of negentropic entanglement. This would also allow an information theoretic interpretation of metabolism since the transfer of metabolic energy would mean a transfer of negentropy [K27].

3.4   Consciousness theory as extension of quantum measurement theory

TGD inspired theory of consciousness [K47] could be seen as a generalization of quantum measurement theory. The notions of quantum jump and self self are the key notions. Negentropy Maximization Principle (NMP) [K49] is the basic dynamical principle. NMP is mirror image for the second law of thermodynamics and states that the amount of conscious information gain in quantum jump is maximal. NMP reproduces standard quantum measurement theory for entropic entanglement and is in this case consistent with the second law since the non-determinism of state function reductions implies the increase of ensemble entropy.

3.4.1   Quantum jumps as moment of consciousness

The starting point of TGD inspired theory of consciousness was the identification of quantum jump as a moment of consciousness [K47].

1. Quantum jump has a complex anatomy which however simplifies in ZEO. Quantum jump involves unitary time evolution leading from a state resulting in state function reduction to

a quantum superposition of states: one could speak of multiverse. This step is described by the counterpart of the unitary process of Penrose and is coded by a unitary matrix U in the state space formed by zero energy states. U is therefore not identifiable directly as S-matrix of quantum field theories but contains as its rows all possible M-matrices which are what particle physicist tries to measure in laboratory. State function reduction and state preparation can be assigned to the opposite light-like boundaries of CD.

A good metaphor is Djinn in the bottle. In U-process bottle is opened and Djinn comes out and creates a quantum superposition of all possible worlds. The wish of the observer is fulfilled and leads to a state function reduction. Actually there is an entire cascade of state function reductions starting from the level of the entire universe which splits the entangleement sub-systems already obtained in a step-wise manner to pairs un-entangled sub-systems. The splitting for a given sub-system occurs only if it is consisent with NMP.

For the ordinary definition of entanglement entropy the process would lead to a completely unentangled situation. If the number theoretic entanglement entropy making sense for ratio-nal (and even algebraic) entanglement probabilities is allowed, the process stops unless the reduction of entanglement reduces the entanglement entropy. Therefore the number theoretic entanglement possible in the intersection of real and p-adic worlds can be stable and living systems are able to preserve their coherence.

2. Since the reduction cascade proceeds from top to bottom, one can speak about fractal formed by quantum jumps within quantum jumps. One cannot assign to the steps of this sequence any duration of geometric time. One can however associate to it an experienced duration and it is very tempting to assume that the experienced duration increases as one climbs up in the self hierarchy.

3. Quantum jump replaces the quantum superposition of classical histories (space-time surfaces, classical worlds) with a new one whereas ordinary state function reduction would do this for time=constant snapshot of Schrödinger evolution. Quantum jump does not spoil the determinism of classical dynamics or of Dirac equation since it occurs entirely outside space-time and Hilbert space. In quantum jump both the geometric future and past (defined only within measurement resolution) are replaced with new ones. The mysterious finding of Libet [J122] that intentional action is preceded by neural activity can be interpreted in this framework without giving up the notion of free will. This raises a fascinating question about time scales in which the geometric past can be affected in quantum jump. Also memories stored in the geometric past can be affected in quantum jumps and the fact that memories are highly unstable suggest that the time scale is measured in years.

It must be added that the notion of classical determinism in its standard form fails due to the special properties of Kähler action (vacuum degeneracy mathematically analogous to a gauge degeneracy but physically analogous to 4-D spin glass degeneracy). This failure provides a space-time correlate for the non-determinism of the quantum jump sequence.

3.4.2 The notion of self

The notion of self can be seen as a generalization of the notion of observer. The original definition of self was as a subsystem able to remain unentangled under state function reductions associated with subsequent quantum jumps. Everything is consciousness but consciousness can be lost if self develops bound state entanglement during U process so that state function reduction to smaller un-entangled pieces is impossible. A second aspect of self was assumed to be the integration of subsequent quantum jumps to coherent whole giving rise to the experienced flow of time.

What is the precise identification of self allowing to understand both of these aspects turned out to be difficult problem. I became aware the solution of the problem in terms of zero energy ontology (ZEO) only quite recently (2014). Self indeed corresponds to a sequence of quantum jumps integrating to single unit, but these quantum jumps correspond to state function reductions to a fixed boundary of causal diamond CD leaving the corresponding parts of zero energy states invariant. The parts of zero energy states at second boundary of CD change even the position of opposite boundary changes: one actually has wave function over positions of second boundary (CD sizes roughly) and this wave function changes. In positive energy ontology these repeated

state function reductions would have no effect on the state but in TGD framework there occurs a change for the second boundary and gives rise to the experienced flow of time and its arrow and gives rise to self. The first quantum jump to the opposite boundary corresponds to the act of free will or wake-up of self. Hence act of free will means change of the arrow of psychological time at some level of hierarchy of CDs.

This allows to understand the relationship between subject and geometric time and how the arrow of and flow of psychological time emerges. The average distance between the tips of CD increases on the average as along as state function functions occur repeatedly at the fixed boundary: situation is analogous to that in diffusion. The localization of contents of conscious experience to boundary of CD gives rise to the illusion that universe is 3-dimensional. The possibility of memories made possibly by hierarchy of CDs demonstrates that this is not the case. Self is simply the sequence of state function reductions at same boundary of CD remaining fixed and the lifetime of self is the total growth of the average temporal distance between the tips of CD.

There exists an infinite hierarchy of number theoretical entropies [K49] making sense for rational or even algebraic entanglement probabilities. In this case the entanglement negentropy can be negative so that Negentropy Maximization principle (NMP) favors generation of negentropic entanglement, which need not be bound state entanglement in standard sense.

In the case of negentropic entanglement (see fig. `http://www.tgdtheory.fi/appfigures/cat.jpg` or fig. 21 in the appendix of this book) a more natural interpretation is that expansion of consciousness rather than loss of it is experienced as self entangles with second system negentropically. Only entropic entanglement would lead to a loss of consciousness. Second condition would be that self is stable against splitting to unentangled subsystems. This criterion is satisfied if self corresponds to a system for which the entanglement between its subsystems is negentropic.

This leads to the vision that negentropic entanglement defines kind of Akashic records, kind of library storing potentially conscious information becoming conscious in interaction free measurement. Akashic records could define self model as opposed to self. Consistency with standard quantum measurement theory [K49] requires that density matrix for negentropic entanglement is proportional to unit matrix associated to unitary entanglement matrix associated with quantum computation. Potentially conscious "Akashic records" would define a model of self instead of self.

Self experiences its sub-selves as mental images and even we would represent mental images of some higher collective self. Everything would be conscious but consciousness could be lost. The flow of consciousness for a given self could be due to the quantum jump sequences performed by its sub-selves giving rise to mental images.

By quantum classical correspondence self has also space-time correlates. One can visualize sub-self as a space-time sheet "glued" by topological sum to the space-time sheet of self. Subsystem is not described as a tensor factor as in the standard description of subsystems. Also sub-selves of selves can entangle negentropically and this gives rise to a sharing of mental images about which stereo vision would be basic example. Quite generally, one could speak of stereo consciousness. Also the experiences of sensed presence [J135] could be understood as a sharing of mental images between brain hemispheres which are not themselves entangled. This is possible also between different brains. In the normal situation brain hemispheres are entangled.

At the level of 8-dimensional imbedding space the natural correlate of self would be CD (causal diamond). At the level of space-time the correlate would be space-time sheet or light-like 3-surface. The contents of consciousness of self would be determined by the space-time sheets in the interior of CD. Without further restrictions the experience of self would be essentially four-dimensional. Memories would be like sensory experiences except that they would be about the geometric past and for some reason are not usually colored by sensory qualia. As already noticed, .1 second time scale defining the duration of moment for sensory experience corresponds to that of electron's CD which suggests that Cooper pairs of electrons are essential for the sensory qualia.

3.4.3 How experienced time and the geometric time of physicist relate to each other?

The relationship between experienced time and time of physicist is one of the basic puzzles of modern physics. In the proposed framework they are certainly two different things and the challenge is to understand why the correlation between them is so strong that it has led to their identification.

One can imagine several alternative views explaining this correlation [K94, K95, K6] and it is better to keep mind open.

Basic questions

The flow of subjective time corresponds to quantum jump sequences for sub-selves of self having interpretation as mental images. If mind is completely empty of mental images subjectively experienced time ceases to exists. This leaves however several questions to be answered.

1. Why the contents of conscious of self comes from a finite space-time region looks like an easy question. If the contents of consciousness for sub-selves representing mental images is localized to the sub-CDs with indeed have defined temporal position inside CD assigned with the self the contents of consciousness is indeed from a finite space-time volume. This implies a new view about memory. There is no need to store again and again memories to the "brain now" since the communications with the geometric past by negative energy signals and also time-like negentropic quantum entanglement allow the sharing of the mental images of the geometric past.

2. There are also more difficult questions. Subjective time has arrow and has only the recent and possibly also past. The subjective past could in principle reduce to subjective now if conscious experience is about 4-D space-time region so that memories would be always geometric memories. How these properties of subjective time are transferred to apparent properties of geometric time? How the arrow of geometric time is induced? How it is possible that the locus for the contents of conscious experience shifts or at least seems to be shifted quantum jump by quantum jump to the direction of geometric future? Why the sensory mental images are located in a narrow time interval of about .1 seconds in the usual states of consciousness (not that sensory memories are possible: scent memories and phantom pain in leg could be seen as examples of vivid sensory memory)?

The recent view about arrow of time

The basic intuitive idea about the explanation for the arrow of psychological time has been the same from the beginning - diffusion inside light-cone - but its detailed realization has required understanding of what quantum TGD really is. The replacement of ordinary positive energy ontology with zero energy ontology (ZEO) has played a crucial role in this development. The TGD based vision about how the arrow of geometric time is by no means fully developed and final. It however seems that the most essential aspects have been understood now.

1. What seems clear now is the decisive role of ZEO and hierarchy of CDs, and the fact that the quantum arrow of geometric time is coded into the structure of zero energy states to a high extent. The still questionable but attractively simple hypothesis is that U matrix two basis with opposite quantum arrows of geometric time: is this assumption really consistent with what we know about the arrow of time? If this is the case, the question is how the relatively well-defined quantum arrow of geometric time implies the experienced arrow of geometric time. Should one assume the arrow of geometric time separately as a basic property of the state function reduction cascade or more economically- does it follow from the arrow of time for zero energy states or only correlate with it?

2. The state function reductions can occur both boundaries of CD. If the reduction occurs at given boundary is immediately followed by a reduction at the opposite boundary, the arrow of time alternates: this does not conform with intuitive expectations: for instance, this would imply that there are two selves assignable to the opposite boundaries!

   Zero energy states are however de-localized in the moduli space CDs (size of CD plus discrete subgroup of Lorentz group defining boosts of CD leaving second tip invariant). One has quantum superposition of CDs with difference scales but with fixed upper or lower boundary belonging to the same light-cone boundary after state function reduction. In standard quantum measurement theory the repetition of state function reduction does not change the state but now it would give rise to the experienced flow of time. Zeno effect indeed requires that

state function reductions can occur repeatedly at the same boundary. In these reductions the wave function in moduli degrees of freedom of CD changes. This implies "dispersion" in the moduli space of CDs experienced as flow of time with definite arrow. This view lead to a precise definition of self as sequence of quantum jumps to the reducing to the same boundary of CD.

3. This approach codes also the arrow of time at the space-time level: the average space-time sheet in quantum superposition increases in size as the average position of the "upper boundaries" of CDs drift towards future state function reduction by state function reduction.

4. In principle the arrow of time can temporarily change but it would seem that this can occur in very special circumstances and probably takes place in living matter routinely. Phase conjugate laser beam is a non-biological example about reversal of the arrow of time. The act of volition would correspond to the first state function reduction to the opposite boundary so that the reversal of time arrow at some level of the hierarchy of selves would take place in the act of volition.

3.4.4 Quantum correlates for various aspects of conscious experience

The identification of quantum correlates of cognition and intentionality, of sensory qualia, Boolean mind, and of emotions [K32] represents one challenge for Quantum Mind theories. As already explained, p-adic physics, the vision about life as something residing in the intersection of real and p-adic worlds, and the notion of number theoretic entropy provide a plausible starting point when one tries to say something about the geometric and quantum correlates of cognition and intentionality. Zero energy ontology makes possible the transitions transforming p-adic zero energy states to their real counterparts and having interpretation in terms of intentional action.

1. Quantum numbers characterize quantum states. Therefore the increments ΔQ of quantum numbers for a subsystem should characterize quantum jumps and it is attractive to assign classify fundamental qualia in terms of quantum number increments. "The increments of quantum numbers for a sub-system representing self" looks innocent but what it really means is surprisingly difficult to make precise. The following attempt relies on ZEO.

   (a) For the positive energy part of state located at "lower" boundary of CD self - subsystem S - and environment E are un-entangled. At the "upper" boundary there is entanglement between S and E, and it should be able to assign qualia as quantum number increments to this entanglement.

   (b) Consider increments of color quantum numbers identified in terms of visual colors as an example. In the positive energy state color quantum numbers for an unentangled subsystem S vanish by color confinement. In negative energy state they can be non-vanishing for S but vanish for $S \otimes E$. The experienced qualia for S are determined as quantum averages of color quantum numbers in the entangled state and expressible in terms of the sub-system density matrix. One can indeed assign to the zero energy state increments ΔQ_{ZEO} of color quantum numbers as difference of color quantum numbers for S at "upper" and "lower" boundaries of C. These increments characterize zero energy state rather than quantum jump.

   (c) In state function reduction the entanglement at upper boundary is reduced if the entanglement is entropic whereas negentropic entanglement can be stable. Quale is experienced sensorily as long as quantum jumps preserve negentropic entanglement. When entanglement is eventually reduced, thee experience can be only a memory about the experienced quale. The increments ΔQ of color quantum numbers in quantum jump can be identified as $\Delta Q = \Delta Q_{ZEO}$. Hence this notion is indeed well-defined.

   (d) This interpretation allows to assign to the quantum jump also space-time evolution changing the quantum numbers in the same manner as they change in quantum jump. This is what quantum-classical correspondence indeed requires.

One application is the identification of basic colors in terms of color quantum number increments of quantum states [K32]. This identification makes sense if one accepts the fractal hierarchy of QCD like dynamics allowed by p-adic length scale hierarchy and by the hierarchy of Planck constants. The original concrete model was provided by the capacitor model of sensory qualia in which a large number of particles which same quantum numbers flows to a subsystem during quantum jump inducing the analog of di-electric breakdown (note the analogy with nerve pulse). Bose-Einstein condensation provides one possible realization. In this case one can say that the quantum numbers of the particle in question represent the basic quale which is amplified.

The above picture forces to modify this view by replacing a color capacitor with a fixed size with that of a variable size corresponding to the size of system S and $S \otimes E$: the second plate of capacitor either in S or environment. The flow of charges associated with the transition generating quale still makes sense and generates strong color polarization in the scale $S \otimes E$. In the model the increase of the size of the color capacitor means a formation of flux tubes between the sensory receptor and environment such that net color is non-vanishing only for these flux tubes. In state function reduction reducing entanglement the flux tubes are split and S become color neutral but can represent a memory about the quale as negentropic color neutral entanglement in the scale of S: some sub-system of S can now experience the color quale. This suggests a holographic memory in which quale eventually is represented in very small scale in terms of negentropic entanglement.

The argument involves assumption about color confinement. In the case of qualia assignable to electromagnetic charges, spin, etc... similar assumption makes sense. Even in case of momentum and angular momentum this assumption makes sense and means that subsystem in the state of experiencing momentum or angular momentum increment as quale is in a real accelerated motion in the scale of CD. As a matter fact, the vanishing of quantum numbers of S in absence of entanglement might not be necessary for the interpretation.

2. One could also speak about Boolean qualia and fermions provide possible correlates for them. The 2^N many-fermion states of fermionic Fock space for N fermionic qubits define a basis of Boolean algebra. The entangled pairs of fermionic states associated with the positive and negative energy parts of zero energy states define quantal Boolean functions as sums over entangled pairs of many fermion states. Negentropic entanglement could define a representation of a rule with entangled pairs representing various instances of the rule. Time-like entanglement would define a representation for a "law of physics" and M-matrices would be fundamental representations of this kind. The increments of the fermionic quantum numbers could define Boolean qualia and one can imagine Boolean capacitor mechanism allowing to amplify a given Boolean statement.

One should be also able to say something about the quantum correlates of emotions. Here the notion of negentropic entanglement might be the key concept.

1. Emotions have a quale like character. For instance, psychological pleasure and pain resemble their physiological counterparts- and quite generally there is a tendency to assign to emotions the attributes of sensory experience. It would be attractive to assign this positive/negative dichotomy to the increase/reduction of entanglement negentropy. Emotion would represent Boolean bit as the sign of negentropy increment. The destruction of generation of negentropic entanglement would therefore be the core element of emotional quale. The character of entanglement involved would determine whether the emotion corresponds to pleasure or pain, joy or sorrow, pride or shame.

In the case of physiological pain or pleasure it is easy to imagine that the cause of pain destroys/creates negentropic entanglement. Pain and pleasure at this level relates directly to what happens to metabolism. This is easy to understand if the basic function of energy metabolism is to transfer negentropic entanglement. For higher level emotions the negentropy reduction or increase could be produced artificially to give an emotional content for something regarded as important.

2. Very often emotions are characterized by good-bad/right-wrong dichotomy characterizable by single binary digit. Perhaps emotions provide a representation of a high level summary

about large amounts information, a kind of Boolean function of very many qubits. The function of neural transmitters can be often interpreted in terms of reward or punishment. Information and emotions seem to be closely related: peptides are often regarded as both information molecules and molecules of emotion [J136]. This can be understood if the function of information molecule is to induce emotional response representing the information.

3. Comparison to a standard -be it moral rule, expected or desired behavior, or something else- is rather often an essential aspect of emotion. Comparison can in principle be represented as a quantal Boolean function involving the standard (say moral rule) represented in terms of negentropic entanglement. If the Boolean instance compared with the rule corresponds to an instance allowed by the rule, positive emotion results. Otherwise the emotion is negatively colored. One might also think that there is expectation for the result of comparison. If the outcome differs from expected- which corresponds to a flip of bit, positive or negative emotion results but could do so as a secondary representation. The above argument suggests that the outcome of comparison does not represent the emotion as such but there is a neural circuitry encoding the outcome to reward or punishment.

3.4.5   Self referentiality of conscious experience

Self referentiality of consciousness is one of its most mysterious looking aspects. In a loose formulation one could say that system is able to be conscious what it *is* conscious of. This formulation however leads to an infinite hierarchy of reflective levels and therefore to a paradox. One can however milden the formulation by saying that self-referential system is able to be conscious about what it *was* conscious of (with respect to subjective time of course!)

In this formulation quantum classical correspondence gives hopes about the understanding of self-referentiality. Quantum classical correspondence means in TGD framework that not only quantum states but also quantum jump sequences have space-time correlates. The failure of classical determinism for Kähler action in standard sense of the word is responsible for this and relates directly to the basic properties distinguishing TGD Universe from that of standard model. This allows to imagine that quantum jump leading from a superposition of space-time surfaces to a new one also gives rise to a representation of the conscious experiences which preceded the last quantum jump at the level of space-time geometry. Reductio ad absurdum would transform to evolution of consciousness able to add to the existing hierarchy a new reflective level in each quantum jump.

I have proposed several correlates for the self-referentiality of consciousness. Many-sheeted space-time would provide the physical representation (see fig. `http://www.tgdtheory.fi/appfigures/manysheeted.jpg` or fig. 9 in the appendix of this book).

Many-sheeted space-time and self-referentiality

The fractal hiearchy of magnetic flux tubes giving rise to braids, which in turn make possible topological quantum computation would be a rather realization of this representation, A possible concrete physical realization of self-referentiality is suggested by DNA as quantum computer model [K23]. One assumes that DNA nucleotides and lipids are connected by magnetic flux tubes. Since the lipid layer of the cell membrane is 2-dimensional liquid crystal, the lipids are in continual hydrodynamical motion and this means in time direction entanglement of the orbits. The events in nearby environment and also nerve pulses affect this flow. This braiding in time direction defines a topological quantum computation. This motion entangles also the flux tubes connecting the lipids to DNA nucleotides so that when the topological quantum computation halts it becomes stored into memory as space-like entanglement. In TGD framework also the time-like braiding provides a space-time representation of the quantum computation which also gives to a conscious experience at some level of the hierarchy.

Infinite primes and self-referentiality

The hierarchy of infinite primes (and of integers and rationals) [K84] was the first mathematical notion stimulated by TGD inspired theory of consciousness. The construction recipe is equivalent with a repeated second quantization of a super-symmetric arithmetic quantum field theory with

bosons and fermions labeled by primes such that the many-particle states of previous level become the elementary particles of new level. At a given level there are free many particles states plus counterparts of many particle states. There is strong structural analogy with polynomial primes. For polynomials with rational coefficients free many-particle states would correspond to products of first order polynomials and bound states to irreducible polynomials with non-rational roots.

The hierarchy of space-time sheets with many particle states of space-time sheet becoming elementary particles at the next level of hierarchy. For instance, the description of proton as an elementary fermion would be in a well defined sense exact in TGD Universe. Also the hierarchy of n:th order logics are possible correlates for this hierarchy.

This construction leads also to a number theoretic generalization of space-time point since a given real number has infinitely rich number theoretical structure not visible at the level of the real norm of the number a due to the existence of real units expressible in terms of ratios of infinite integers. This number theoretical anatomy suggest a kind of number theoretical Brahman=Atman identity stating that the set consisting of number theoretic variants of single point of the imbedding space (equivalent in real sense) is able to represent the points of WCW or maybe even quantum states assignable to causal diamond. One could also speak about algebraic holography.

The correspondence between the quantum states defined by WCW spinor fields and wave functions in the infinite-dimensional discrete space of hyper-octonionic units can be made more concrete [K84]. These wave functions must transforming irreducibly under discrete subgroup SU(3) of octonion automorpisms transforming ordinary hyper-octonionic prime to a new hyper-octonionic prime. SU(3) has interpretation as color group. One can assign standard model quantum numbers to these wave functions and prime property in principle fixes the spectrum of possible quantum states- in particular the spectrum of masses. Therefore the extremely esoteric looking notion of infinite prime might turn out to be very practical calculational tool.

Quantum Mathematics and self referentiality of consciousness

In Quantum Mathematics numbers are replaced with Hilbert spaces and the dimension of Hilbert space - in appropriately. generalized sense - characterizes the number.

1. This suggests a generalization of calculus for Hilbert spaces. Mathematical objects which are defined for numbers in various number fields become well defined when these numbers are replaced with Hilbert spaces. One can speak of the Hilbert space analogs of algebraic numbers, transcendentals, p-adic numbers and their extensions. Anything having as a building brick rationals, algebraic numbers, real or p-adic numbers or finite fields generalizes. Even the notions like matrix group, algebras, and ring generalize. Also the notion of manifold generalizes as well as the notion of calculus.

2. The Hilbert space in associated with the element of number field characterizes its number theoretic anatomy and therefore could be a correlate of cognition. The crucial step in the generalization of this process to the level of the Hibert space representing points. Points of Hilbert spaces can be replaced with Hilbert spaces and process can be repeated ad infinitum. This suggests that the self-referentiality at the deepest level corresponds to this fractal view about space-time based on assignment of quantum dynamics to numbers. Also a connection with the hierarchy of n:th order logics. A close relationship to infinite primes would not be surprising since in both cases one an infinite hierarchy of processes analogous to second quantization is involved. A natural question is whether many-sheeted space-time provides a dynamical representation in terms of space-time sheets for the number theoretic anatomy so that kind of Brahman=Atman identity or algebraic holography would hold true. This correspondence could be see as a cognitive representation of external world and one could also see the external world as symbolic representation of the world of cognition.

3. A connection with generalized Feynman diagrams and hierarchy of Planck constants is suggestive and the idea was originally inspired by the observation that the two vertices of generalized Feynman diagrams identifiable as generalizations of the basic stringy 3-vertex for closed strings and basic 3-vertex for Feynman diagrams correspond naturally to direct sum and tensor product in turn having natural correspondence with + and × of the usual arithmetics. This correspondence motivates the introduction of co-operations of direct sum and

tensor product meaning that quantum dynamics is brought into the game through these vertices. This suggests that Quantum Mathematics is actually Quantum dynamics in which generalized Feynman diagrams define sequences of arithmetic or even more general algebraic operations.

If so, the basic structures of Quantum Mechanics (QM) might reduce to fundamental mathematical and metamathematical structures, and that one even consider the possibility that Quantum Mechanics reduces to Quantum Mathematics with mathematician included or expressing it in a concise manner: QM=QM!

The fractal character of the Quantum Mathematics is what makes it a good candidate for understanding the self-referentiality of consciousness. The replacement of the Hilbert space with the direct sum of Hilbert spaces defined by its points would be the basic step and could be repeated endlessly corresponding to a hierarchy of statements about statements or hierarchy of nth order logics. The construction of infinite primes leads to a similar structure.

What about the step leading to a deeper level in hierarchy and involving the replacement of each point of Hilbert space with Hilbert space characterizing it number theoretically? What could it correspond at the level of states?

1. Suppose that state function reduction selects one point for each Hilbert space $x_n \times p^n$. The key step is to replace this direct sum of points of these Hilbert spaces with direct sum of Hilbert spaces defined by the points of these Hilbert spaces. After this one would select point from this very big Hilbert space. Could this point be in some sense the image of the Hilbert space state at previous level? Should one imbed Hilbert space $x_n \times p^n$ isometrically to the Hilbert space defined by the preferred state $x_n \times p^n$ so that one would have a realization of holography: part would represent the whole at the new level. It seems that there is a canonical manner to achieve this. The interpretation as the analog of second quantization suggest the identification of the imbedding map as the identification of the many particle states of previous level as single particle states of the new level.

2. Could topological condensation be the counterpart of this process in many-sheeted space-time of TGD? The states of previous level would be assigned to the space-time sheets topologically condensed to a larger space-time sheet representing the new level and the many-particle states of previous level would be the elementary particles of the new level.

3. If this vision is correct, second quantization performed by theoreticians would not be a mere theoretical operation but a fundamental physical process necessary for cognition! The above proposed unitary imbedding would imbed the states of the previous level as single particle states to the new level. It would seem that the process of second quantization, which is indeed very much like self-reference, is completely independent from state function reduction and unitary process. This picture would conform with the fact that in TGD Universe the theory about the Universe is the Universe and mathematician is in the quantum jumps between different solutions of this theory.

Chapter 4

Comparison of TGD Inspired Theory of Consciousness with Some Other Theories of Consciousness

4.1 Introduction

This work has been inspired by two books. The first book "On intelligence" is by Jeff Hawkins. The second book "Consciousness: the science of subjectivity" is by Antti Revonsuo.

4.1.1 On intelligence

Jeff Hawkins [J115] has developed a highly interesting and inspiring vision about neo-cortex, one of the few serious attempts to build a unified view about what brain does and how it does it. Since the key ideas of Hawkins have quantum analogs in TGD framework, there is high motivation for developing a quantum variant of this vision. The vision of Hawkins is very general in the sense that all parts of neo-cortex would run the same fundamental algorithm, which is essentially checking whether the sensory input can be interpreted in terms of standard mental images stored as memories. This process occurs at several abstraction levels and involve massive feedback. If it succeeds at all these levels the sensory input is fully understood.

TGD suggests a generalization of this process.

1. Quantum jump as a moment of consciousness and a sequence of quantum jumps inducing repeated state function reduction at the same boundary of causal diamond (CD) as self would be the basic identifications. These would define the fundamental algorithm realized in all scales defining an abstraction hierarchy. Negentropy Maximization Principle (NMP, [K49]) would be the variational principle driving this process and in optimal case lead to an experience of understanding at all levels of the scale hierarchy realized in terms of generation of negentropic entanglement. The analogy of NMP with second law suggests strongly thermodynamical analogy and p-adic thermodynamics used in particle mass calculations might be also seen as effective thermodynamics assignable to NMP.

   One can imagine the analogs of temperature and various other parameters as characteristics of "thermal equilibrium" under some constraints with respect to NMP instead of second law. These would be macroscopic parameters characterising the state of consciousness, and one can easily imagine psychological counterparts of thermodynamical notions. Psychological pressure would not be a mere metaphor!

2. The anatomy of quantum jump implies alternating arrow of geometric time at the level of imbedding space [K6]. This looks strange at first glance but allows to interpret the growth of syntropy introduced by Fantappie [J103] as a growth of entropy in reversed direction

of imbedding space time. As a matter fact, one has actually wave function in the moduli space of CDs and in state function reductions localisation of either boundary takes place and gradually leads to the increase of the imbedding space geometric time and implies the alternating arrow for this time. The state function reduction at positive energy boundary of CD has interpretation as a process leading to sensory representation accompanied by p-adic cognitive representation.

The time reversal of this process has interpretation as motor action in accordance with Libet's classical findings [J122]. This symmetry holds true in various length scales for CDs. In the same manner p-adic space-time sheets define cognitive representations and their time reversals as intentions. It seems that self model could be assigned to negentropically entangled collections of sub-CDs and negentropic entanglement would stabilize them.

A rather obvious inaccuracy in the earlier interpretation of negentropic entanglement has been corrected. The statement that negentropic entanglement corresponds to the experience of understanding (or any conscious experience) is in conflict with the basic postulate of TGD inspired theory of consciousness. The correct wording is that the *generation of negentropic entanglement* gives rise the experience of understanding and possibly some other emotionally positively colored experiences. Generation and loss of negentropic entanglement would be the key to the understanding of emotions.

3. One could understand the fundamental abstraction process as generation of negentropic entanglement serving as a correlate for the experience of understanding. This process creates new mental images (sub-CDs) and to longer sequences of mental images (accumulation of experience by formation of longer quantum association sequences). Abstraction process involves also reduction of measurement resolution characterizing cognitive representations defined in terms of of discrete chart maps mapping discrete set of rational points of real preferred extremals to their p-adic counterparts allowing completion to p-adic preferred extremal. The reversal of this abstraction process gives rise to improved resolution and adds details to the representation. The basic cognitive process has as its building bricks this abstraction process and its reversal.

4. The notion of self, which should be distinguished from a model for self, has been a continual source of worries in TGD inspired theory of consciousness [K75, K6]. Hierarchy of quantum jumps suggests that self can be identified as quantum jump and that the conscious information corresponds to the change of negentropy in quantum jump. The notion of negentropic entanglement however raises the temptation to identify self model (distinguished from self) as a property of quantum state, which consciousness certainly cannot be in TGD framework. Self representations would naturally correspond to negentropically entangled tensor products approximately invariant under quantum jump sequence. One can of course ask whether the notion of self reduced to quantum jump is needed at all.

4.1.2 Consciousness: the science of subjectivity

Antti Revonsuo has written a wonderful book about consciousness with title "Consciousness: the science of subjectivity" [J141].

1. Revonsuo discusses philosophical, historical, and conceptual foundations of consciousness science.

2. Various disorders of consciousness provide test benches for the theories of consciousness and Revonsuo discusses neuropsychological deficits of visual consciousness, neuropsychological dissociations of visual consciousness from behavior, and neuropsychological disorders of self-awareness.

3. If one believes (and even if one does not!) that the state of brain dictates completely the contents of consciousness, it is natural to search for the neural correlates of consciousness since brain state could indeed correlate in one-one manner with certain (say cognitive and representational) aspects of consciousness. Revonsuo analysizes methods and design of a typical NCC experiment, discusses neural basis of consciousness as a state and studies on the neural basis of visual consciousness.

4. A lot of theories of consciousness have been proposed and Revonsuo discusses both philosophical and empirical theories of consciousness critically pointing out the basic difficulties of various approaches. Revonsuo does not discuss quantum theories of consciousness.

5. The last chapters are devoted to altered states of consciousness (ASC) with a discussion of dreaming and sleep, hypnosis, and higher states of consciousness. The understanding of ASCs obviously define also tests for any theory of consciouesness.

In the following I will first discuss the ideas of Hawkins and then summarize some relevant aspects of quantum TGD and TGD inspired theory of consciousness briefly in the hope that this could make representation comprehensible for the reader having no background in TGD (I hope I have achieved this). The representation involves some new elements: reduction of the old idea about motor action as time reversal of sensory perception to the anatomy of quantum jump in zero energy ontology (ZEO); interaction free measurement for photons and photons as a nondestructive reading mechanism of memories and future plans (time reversed memories) represented 4-dimensionally as negentropically entangled states approximately invariant under quantum jumps (this resolves a basic objection against identifying quantum jump as moment of consciousness) leading to the identification of analogs of imagination and internal speech as fundamental elements of cognition; and a more detailed quantum model for association and abstraction processes.

After that I compare various theories and philosophies of consciousness with TGD approach following the beautifully organized representation of Revonsuo. Also anomalies of consciousness are briefly discussed. My hope is that this comparison would make explicit that TGD based ontology of consciousness indeed circumvents the difficulties against monistic and dualistic approaches and also survives the basic objections that I have been able to invent hitherto.

The appendix of the book gives a summary about basic concepts of TGD with illustrations. There are concept maps about topics related to the contents of the chapter prepared using CMAP realized as html files. Links to all CMAP files can be found at `http://www.tgdtheory.fi/cmaphtml.html` [L35]. Pdf representation of same files serving as a kind of glossary can be found at `http://www.tgdtheory.fi/tgdglossary.pdf` [L36]. The topics relevant to this chapter are given by the following list.

- TGD inspired theory of consciousness [L68]

- Quantum consciousness [L59]

4.2   The vision of Hawkins

Jeff Hawkins has written together with Sanda Blaskeslee a very inspiring book about conscious intelligence with title "On intelligence" [J115]. What makes the book so inspiring to me is that it tries to build a holistic strongly structured vision about the functioning of neo-cortex easily generalizable outside to its original context - in my case TGD inspired theory of consciousness based on rather different basic philosophy.

4.2.1   The philosophical attitudes of Hawkins

Before continuing I want to locate the vision of Hawkins to the map of theories.

1. Hawkins accepts functionalism stating that intelligence and maybe even consciousness are properties of organization and have nothing to with the stuff that the system is made of. This was the justification for AI people to regard brain as a primitive realization of something which can be realized much more elegantly using digital computers. Hawkins assumes that the functional structure at neuronal level determines the contents of consciousness and could therefore be seen as a materialist allowing emergence.

2. Hawkins does not discuss the possibility of quantum consciousness but his vision might allow also quantum formulation and in the following I will represent such a generalization.

Although Hawkins accepts functionalism, he represents excellent arguments against AI and connectionism, and computationalism in general stating brain is a computer.

1. The argument against computationalism according to AI goes as follows. The time scale of neural processing is 1 ms: this is million times longer than 1 ns: the time scale of processing in modern computers. Despite its slowness brain is able to recognize a face represented in various manners in a fraction of second. For recent day computers this is a mission impossible. Computationalistic brain should make this feat by using basic programs consisting of roughly 100 steps. Parallelism does not help as often claimed. As an analogy Hawkins mentions a task of carrying some amount of material to another side of a desert. Irrespective of how many camels are hired the task takes some minimum time determined by the maximal load carried by single camel over the desert and the distance to the other side.

2. Gradually the failure of AI was accepted, and the follower of AI was connectionism. Connectionism takes the notions of association and and standardized mental image (memory) seriously and is therefore nearer to what brain is thought to do. The possibility to complete full patterns from pieces by a non-linear algorithm seemed to give excellent hopes about progress. The dream was not fulfilled.

   Pattern recognition by computers differs from what brain does in one but overall important aspect: the ability to form invariant representations is lacking. When sensory input representing the same object but from a different perspective is used, computer based pattern recognition fails. A mere shift of the spatial pattern is enough to make recognition impossible. Brain can however easily recognize the pattern seen from different perspectives, the pattern can be even deformed in wide limits. Even patterns represented using pictures, sound, and touch are recognized as same object.

3. Hawkins criticizes also the behavioristic approach assuming that contents of consciousness can be deduced by looking only the behavior. Turing's test relies formulates mathematically this behavioristic dogma. It is probably relatively easy to cheat human subject to to believe that machine is conscious by using Turing test. This however does not demonstrate anything. The basic problem is that the more abstract the level of cognitive process is is, the less it shows itself in the behavior. The situation in which a person is fully conscious but completely paralyzed so that he is not able to express any thoughts via motor actions illustrates a failure of the naive behavioristic approach.

In TGD framework it is easy to agree with Hawkins. Turing machine is a model of computer in which one implicitly takes granted the identification of experienced and geometric time, which differ in many crucial aspects as even child knows. The starting point of TGD inspired consciousness theory as a generalization of quantum measurement theory is the paradox of quantum measurement theory caused by this identification. The discretization of geometric time is also an extremely heavy idealization and I find it surprising that it has raised so little criticism. In TGD framework the behavioristic approach and the materialistic identification of contents of consciousness with the state of brain must be given up since consciousness cannot be identified as a property of quantum state since it is assigned with the quantum jump between two quantum states.

4.2.2   Basic observations of Hawkins

Several observations and ideas of Hawking relate to the notion of time.

1. Instead of computation Hawkins sees memory, recognition of familiar objects in the sensory input, and their naming as fundamental processes in neo-cortex. Nerve pulse patterns are identified as names for objects. A cognitive representation is what sensory input gives rise to, and means a decomposition of the sensory input to objects with names, analogous to a linguistic essentially linear description of the percept.

2. It is not only spatial patterns but temporal sequences of them which matter. At higher level of abstraction one has a sequence of patterns instead of single patttern and the representation is less detailed. Sensory inputs are this kind of temporal sequences as are also plans for motor actions resulting as a reaction to the sensory input. Here "sensory input" and "motor action" could be understood very generally: even the nerve pulse patterns arriving neuron and leaving it can be seen as "sensory inputs" and "motor actions".

3. Hawkins emphasizes the similarities between sensory input and motor action and one can indeed claim that they one and same thing except that they seem to proceed in opposite directions of time: bottom-up and top-down. Libet's well-known findings that the neuronal activity begins a fraction of second earlier than conscious decision for motor action and later experiments suggesting even longer time scales might be understood in this framework. If one takes this idea seriously, one must however modify the existing beliefs about the relation between subjective time and the geometric time of physicists identified as fourth space-time dimension. Subjective time has constant arrow but this arrow might correspond to different arrow of geometric time for sensory input and motor action. This brings in mind TGD based view about time [K6] and suggests more detailed interpretation of the arrow of time as it emerges in TGD framework.

4. Hawkins sees as the basic function of neo-cortex construction of predictions based on the "understanding" of the sensory input and coded by cognitive representation. Prediction might seen also as an intention how to behave realized as a motor program defining the reaction to the sensory percept.

This general vision is very elegant. The challenge is to understand what various concepts such as memory, recognition of familiar objects, naming, and understanding do mean physically. This is far from trivial in the materialistic framework of standard physics, and one can hope that quantum TGD generalizing considerably also the quantum theory itself, could help in this challenge. In particular, p-adic physics and p-adic space-time sheets could serve as correlates for the "mind stuff", and one could see the formation of cognitive representations as a formation of p-adic charts about real physical systems. Sensory perception would be real, cognitive representation p-adic. In p-adic topology the decomposition to objects and discretization in a given resolution are natural so that it would be ideal to the description of cognition. Negentropic entanglement would be an excellent candidate for a correlate of understanding.

4.2.3 Invariant representations

Hawkins emphasizes the ability of brain to recognize objects represented in very different manners as a basic distinction between brain and computers.

1. Invariant representations distinguish brain from computer. Invariant representations are abstractions. Abstraction summarizes something common to a large class of objects and gives a name for this class of objects. For instance, "living room" as a name of this kind of class is extremely economical manner to represent information in terms of a concept instead of remembering every detail of every living room one has spent some time.

   So called idiot savants can have this kind of sensory memory, and are able to perform incredible memory feats, but this kind of memory is not useful unless one is an artist. An interesting question is whether animals could still possess sensory memories: this would be certainly useful gift in jungle. Another interesting question is whether cerebellum could have sensory memories not conscious-to-us and whether these could become conscious-to-us in some altered states of consciousness.

   Abstraction appears also in the music experience. Ordinary listener is not able to identify the key of the music piece but this does not affect the music experience much since only the ratios of the pitches of notes of the melody matter. People with "absolute ear" can however recognize the absolute key of the music piece and regard pieces in different keys as different ones. In the standard scale used for the piano, the ratios are not quite the same in different keys but this causes troubles for people with "absolute ear".

2. Hawkins sees the formation of associations as an important aspect of invariant representations allowing to recognize the same object using different sensory channels. Second aspect of abstraction is the elimination of un-necessary details: kind of reduction of sensory/cognitive resolution. Some kind of averaging could be involved.

3. Hawkins concludes that neo-cortex is specialized to the construction invariant representations and that there is a hierarchy of increasingly abstract invariant representations assignable to

sensory percepts and motor actions. All these representations are needed to achieve ideal perception but only the highest level abstractions are usually conscious-to-us. Note that in standard neuro-science framework "conscious-to-us" is synonymous to "conscious" but in quantum TGD approach entire hierarchy of conscious entities can be imaged so that "sub-conscious" translates to "conscious-but-not-to-us". This distinction allows to understand many brain disorders [J141] such as being not conscious of being able to see (and other agnosias) or believing that one sees although one is cortically blind or being cortically blind but believing that one is able to see. Note that if primary visual experience is at the level of retina, cortical blindness need not mean subjectively experienced blindness.

One of the hard challenges is to identify the mechanism giving rise to invariant representations. Neural firing patterns are though to transform synaptic connections and in this manner give rise to associations. Hebb's rules define an attempt to model what happens in the process. One can also understand what abstraction could mean.

In TGD framework one can consider the generation of negentropic entanglement as a mechanism of association: negentropically entangled state defines a rule represented as a superposition of state pairs (or n-plets) such that each pair (n-tuple) represents one particular instance of the rule. Abstraction means also getting rid of insignificant details. Here one can consider some kind of averaging (kind of ensemble of mental images at quantum level) or quantum superposition of states representing same object but with different details below cognitive resolution. I have also proposed that quantum states in general are superpositions of preferred extremals which have equivalent statistical geometries meaning that various geometric correlation functions are identical for them.

4.2.4 Observations about the structure and functioning of the neocortex

The proposal of Hawkins relies heavily on the observations about the structure and functioning of the neo-cortex.

1. Neocortex (see `http://en.wikipedia.org/wiki/Neocortex`) [J13] is a very thin grey layer at the top of cortex having thickness of about 3 mm and consisting of 6 layers, which according to Hawkins are functionally hierarchically ordered with layer 1 at the top representing the highest level of abstraction. Layer 4 is the layer to which inputs from distant regions of neocortex arrive and are transferred to the levels above and below it. There is a strong feedback and feedforwad between the layers.

2. Neo-cortex decomposes to various sensory and motor areas. In associative areas the inputs from sensory areas are combined and sent to motor areas. Sensory and motor areas in turn have hierarchical structure: for instance, visual areas consisting of sub-areas V1, ..., V5. Sensory input arrives to V1 and V1 is believed to identify from the sensory input various simple features. Higher areas identify more abstract features and sequences of them.

3. Hawkins emphasizes the fact that sensory perception and motor action are not simple bottom-up and top-down processes. Feedback is present and can be even 10 times more massive than input. The proposed interpretation is that input to from a given layer of neo-cortex to a higher layer (from say from 3 to 2) means formation of a more abstract and less detailed representation and vice versa. This representation consists also longer sequences of basic patterns and allows easier recognition. A good example is a situation in which music piece on CD changes: at the lower level this means unexpected input. At higher level music pieces on CD form a sequences and recognition as new piece is possible. The higher level can send this prediction back to the lower level.

4. Neo-cortex and also cortex look the same everywhere. This suggests that all basic units of the cortex perform essentially same basic function or algorithm. This idea is elegant and far reaching and would apply to the formation of cognitive representations which would be just the identification and naming of objects of sensory percept.

5. This picture applies also to motor action. If one accepts that motor action is time reversal of sensory perception and leads from abstract to less abstract and more detailed, one can ask

whether the feedback to less abstract levels could be interpreted as motor action at neuronal level. A fractal structure in which sensory perception and motor action takes place in various time and length scales would suggeset this kind of view.

There are many notions which require more detailed definition. The proposed detailed model for feedback need not of course be correct as such. What matters is the existence of hierarchical structure and communications between the levels of the hierarchy. In TGD framework this hierarchy would naturally correspond to self hierarchy and hierarchy of quantum jumps within quantum jups. In zero energy ontology it has as correlates the hierarchy of space-time sheets at space-time level and that of causal diamonds within causal diamonds at the level of imbedding space. Also the p-adic length scale hierarchy and hierarchy of effective Planck constants assigned with dark matter in TGD Universe relate to these hierarchies.

4.2.5 Universal algorithm

These observations inspire Hawkins to propose for the universal algorithm run by the units of neo-cortex.

1. The homogenuity of neocortex motivates the proposal that all units of the neo-cortex forming a hierarchy are performing the same universal algorithm, which is recognition of the virtual sensory input represented as nerve pulse pattern with some standard input stored in memory. If the recognition attempt fails, the input is sent to a higher more abstract level with less details and this level makes a similar trial. If the recognition attempt is successful, the input is sent to a lower level (this corresponds to a feedback) and same attempt is made.

2. This process continues until recognition is made at all levels or if this is not possible, the pattern is sent to hippocampus as a genuinely new pattern to be stored to memory. Some maximum time of unsuccessful processing is a natural criterion for the novelty. Percept is thus stored as a memory in hippocampal level only when it represents something new. The percepts which do not enter hippocampus are stored at lower cortical layers but do not represent memories conscious-to-us. This could explain why people at older age are not able to remember details of say movie unless they represent something genuinely new.

To me this picture looks rather attractive and inspires the question whether a generalization to quantum context - say in TGD framework - is possible.

4.2.6 The basic objection against the vision of Hawkins

The basic objection against Hawkins's vision applies to neuroscience view in general.

1. As Hawkins notices, the homogenuity of the neocortex and brain in general is in conflict with the idea that cortex is the seat of the sensory qualia. It is difficult to understand why the auditory and visual pathways could give rise to so different sensory qualia if only the organization of the sensory pathways matters.

2. A possibility not discussed by Hawkins nor by neuroscientists is that sensory qualia could be formed at the level of sensory organs.

   (a) TGD approach would suggest that qualia are realized at the level of sensory organs [K32] and quale mental images (sub-selves) entangle with the cortical mental images representing names of objects of the perceptive field represented at cortex and thus give rise to a coloring of the cognitive map. This would explain why the qualia associated with different sensory pathways are so different. Pure thought would correspond to cognition without this coloring and dreams would involve a feedback to the level of sensory organs (REM sleep) transforming thinking to vivid imagination. Note that also the feedback to the level of sensory organs and comparison of this virtual sensory input with the actual one is quite possible in TGD framework since there is no reason to restrict the feedback hierarchy to the 6 neo-cortical layers. Dark photons with large value of $\hbar_{eff}$ could make possible this feedback by generating sensory input by transforming to ordinary visible photons interpreted as bio-photons.

(b) The basic objection against this view is the phenomenon of phanton limb (see `http://en.wikipedia.org/wiki/Phantom_limb`) [J80], which in standard physics framework forces to locate the pain to the map of sensory field at cortex. One manner to solve the problem would be that that the pain is somewhere else than in phantom limb but mislocated in the construction of cognitive representation: this would be just wrong kind of association. The alternative approach would give up the standard view about the relationship between subjective and geometric time: the phantom pain is sensory memory of an actual pain in the limb which exists in the geometric past at a distance of maybe decades. The third option is that qualia are formed at the level of neurons and under some conditions correspond to those experienced by us. This requires new physics at the level of neurons and clear identification what the physical correlates of qualia are in this new physics.

4.3   Quantum TGD very briefly

Before discussing the TGD inspired identification of the universal algorithm as quantum jump in turn identified as a moment of consciousness, it is good to briefly summarize some basic aspects of quantum TGD.

4.3.1   Many-sheeted space-time, imbedding space, WCW

The basic geometric notions of TGD are many-sheeted space-time (see fig. `http://www.tgdtheory.fi/appfigures/manysheeted.jpg` or fig. 9 in the appendix of this book), imbedding space $M^4 \times CP_2$ (see fig. **??** in the appendix of this book) and "world of classical worlds" (WCW) identified as the infinite-dimensional space of space-time surfaces, which can be seen as analogs of Bohr orbits representing kind of archetypal field patterns in their geometry. The choice of the imbedding space is fixed by particle physics considerations uniquely and can be justified also by very general mathematical arguments. For instance, M^4 is the only space with Minkowskian signature allowing twistor structure, and CP_2 is one of the very few Euclidian compact manifolds allowing twistor structure and the only one for which twistor space is Kähler manifold. TGD leads to geometrization of the classical fields appearing in standard model and particle quantum numbers can be understood in terms of the symmetries of the imbedding space.

I will not go the detailed definitions of these notions here but refer to the articles and books at my homepage. What is essential is that TGD space-time is topologically non-trivial in all length scales and objects of various size scales that we see around us can be interpreted in terms of space-time sheets defining their own sub-Universes.

Second essential generalization and deviation from Maxwell's electrodynamics (and other field theories) is topological field quantization. For instance, magnetic field decomposes to flux quanta (flux tubes and sheets) represented as space-time time quanta. This quantization is in key role in the model of living matter and the dynamics of the "magnetic bodies" is crucial for understanding various aspects of bio-catalysis and also EEG. Magnetic body (hierarchy of them) brings to the usual picture of living system as biological body interacting with environment a completely new level.

4.3.2   Zero energy ontology (ZEO)

The failure of the strict determinism for the preferred extremals of Kähler action means that data in time=constant snapshot do not determine the future and past behavior. Several time=constant snapshots must be assumed and this led originally to the notion of association sequence. Later the notion of zero energy ontology (ZEO) emerged and was forced by number theoretical universality: the vanishing total quantum numbers indeed make sense in number theoretically universal manner. ZEO allows also to avoid the paradox suggested by the fact that Poincare invariance is exact in laboratory scales but not in cosmological scales: the solution relies on the observation that the notions of energy and momentum for the positive energy parts of zero energy states are scaled dependent in ZEO.

1. Zero energy states are superpositions over pairs of positive energy states and negative energy states and correspond to initial and final states of a physical event in positive energy ontology. Positive and negative energy states are localized at the opposite light-like boundaries of a causal diamond (CD) defined as intersection of future and past directed light-cones (CP_2 appears as a Cartesian factor but will not be mentioned separetely in the sequel). Space-time surfaces in the quantum superposition are identified as preferred extremals of Kähler action and are restricted inside CD for the simplest option.

2. CDs form a fractal hierarchy with size scales coming as integer multiples of fundamental size scale. Translates and Lorentz boosts of CDs are also possible. It is not quite clear whether one should allow CDs to intersect or should one require strict nesting. System has in general wave function in the moduli space of CDs and in quantum jump a localization to CDs for which either upper or lower boundary is fixed takes place.

3. CDs are the geometric correlates of selves at the level of imbedding space $M^4 \times CP_2$. The 4-D space-time surfaces define the correlate of selves at space-time level. One can consider two time coordinates: imbedding space time coordinate and that of 4-D surface.

4.3.3   p-Adic physics and cognition and intentionality

I ended up with p-adic physics from accidental observations related to the mass scale ratios of elementary particle spectrum. The construction of p-adic thermodynamics predicting particle masses with excellent accuracy inspired questions which led to the proposal that p-adic physics describes cognition present already at elementary particle level.

1. Imbedding space has also p-adic sectors corresponds to various p-adic number fields. These sectors are glued together along rational points common to real and p-adic number fields and also via common algebraic points in the case of algebraic extensions of p-adic number fields. The common rational points of real and p-adic space-time surface (or at least partonic 2-surface) define cognitive representation so that cognitive representations are always discrete.

   At the level of WCW the points of real and p-adic sectors identifiable with each other correspond to surfaces, whose algebraic representations make sense both in real and p-adic sense. The general vision is that life resides in this this intersection of real and p-adic worlds. For instance, this motivates the notion of number theoretic entanglement entropy which can be negative and is interpreted as a measure of information assignable to entanglement.

2. Mappings of real space-time surfaces to p-adic ones are fundamental and define cognitive representations [K119]. The mappings of p-adic space-time surfaces to real ones are interpreted as realizations of intentional actions. When motor action is identified as the time reversal for the formation of sensory representation, intentional action becomes time reversal for the formation of cognitive representation so that a very powerful and elegant symmetry emerges.

3. Finite measurement resolution is fundamental notion and actually forced by the notion of p-adic manifold. An attractive additional constraint is that the space-time surfaces in the superposition are perceptively equivalent in given measurement resolution characterized by p-adic prime assignable to the space-time surface and corresponding pinary cutoffs and also by the algebraic extension of p-adic numbers characterizing the angle resolution.

4.3.4   Length scale hierarchies and cognitive hierarchies

TGD involves several hierarchies.

1. One hierarchy is formed by the p-adic length scales assignable to p-adic primes coming as primes near powers of two.

2. Second hierarchy corresponds to size scales of CDs coming as integer multiples of CP_2 scale with secondary p-adic length scales being favored. One can assign to these length scales length scale resolution as p-adic length scale multiplied by a half-integer power of p, and angle resolution defined in terms of algebraic extenion of p-adic numbers used. These length

scales are now an essential part of the definition of the notion of p-adic manifold necessary for the construction of number theoretically universal calculus.

The resolution scales have also natural counterpart at quantum level and can be realized in terms of inclusions of hyper-finite factors of type II_1 [K100]. The included factor defines the degrees of freedom which cannot be seen in given resolution and the factor space obtained by dividing with the included factor defines quantum space with finite but fractional dimension.

3. The increase of resolution means getting rid of un-necessary details in the case of cognitive representations it would be un-necessary information allowing a formation of abstraction. The reduction of the resolution means addition of details and formation of lower level representation. In the realization of motor action this process indeed occurs. This process can be however as a formation of sensory representation in non-standard time direction. The findings of Libet conform with this view about motor action.

4. The hierarchy of (effective) Planck constants $\hbar_{eff}$ was conjectured for about 8 years ago [K24].

   (a) The values of $\hbar_{eff}$ would come as multiples of ordinary Planck constant: $\hbar_{eff} = n\hbar$. TGD provides two possible explanations for how $\hbar_{eff}$ emerges. The first one relies on multi-furcations of space-time surface implied by the failure of strict determinism of the basic variational principle: $\hbar_{eff} = n\hbar$ would correspond to n-furcation taking place at the boundary of causal diamond. Second explanation relies on the general structure of p-adic Lie-algebras predicting effective values of Planck constant coming in the proposed manner [K119]. These explanations should and could be equivalent.

   (b) For large values of $\hbar_{eff}$ the quantal scales (say Compton length of electron) become large and this makes possible macroscopic quantum coherence. The hypothesis is that dark matter corresponds to ordinary matter but with non-trivial value of $\hbar_{eff}$. What would make it dark is that particles with different values of $\hbar_{eff}$ cannot occur in the same vertex of a generalized Feynman diagram although particles with different value of $\hbar_{eff}$ can transform to each other.

   (c) The proposal is that magnetic flux quanta (sheets and tubes) can be carriers of dark matter. The phase transitions reducing $\hbar_{eff}$ reduce the length of the magnetic flux tube and if biomolecules form an "Indra's net" connected by flux tubes, these phase transitions could force two biomolecules connected by flux tube near to each other so that they could find each other in the dense molecular soup. The reconnection of closed magnetic flux tubes associated with two molecules in turn generates two flux tube pairs connecting the molecules and allowing the two systems to become effectively single quantum system in dark degrees of freedom with large value of Planck constant. Persinger's recent experiments give support for this vision [L32].

4.4 Quantum jump as the counterpart of fundamental algorithm in TGD?

In order to formulate the interpretation of quantum jump sequence as a fundamental algoritm of sensory perception, cognition, intentional action, and motor action, one must describe the basic ideas of TGD inspired theory of consciousness.

4.4.1 Basic ideas of TGD inspired theory of consciousness

Before discussing the TGD based analog for universal algorithm, it is good to begin by giving a list about basic ideas of TGD inspired theory of consciousness.

1. Identification of quantum jump between zero energy states as moment of consciousness. It is essential that the quantum states counterparts for entire time evolutions of Schrödinger equation rather than time=constant snapshots of single evolution. In this manner one can avoid the conflict between non-determinism of state function reduction and determinism of

Schrödinger equation. This however implies that subjective time whose chronon quantum jump is, cannot be identified with the geometric time of physicists. The correlation between these two times is of course possible in the sense that quantum jump sequences corresponds to an increase of geometric time defined in some natural manner. This correlation must be strong since these two times are usually identified.

2. Originally I distinguished between the notions of quantum jump and self proposed to emerge from some kind of gluing together of quantum jumps to larger structures in a manner analogous to the fusion of particles to bound states. The fractality of quantum jump in the sense that there are quantum jumps within quantum jumps led to the identification of quantum jump and self. This identification has however remained somewhat fuzzy.

   The recent considerations however suggests that negentropic entanglement in time direction is necessary for mental images (having sub-CDs as correlates) to mental images representing spatial patterns and for these patterns in turn to bind to a sequence of mental images representing abstract memories as sequences of mental images. Negentropically entangled sequence would be a quantal counterpart for the original association sequence introduced as purely geometric concept.

   Should these sequences define selves so that self would be something characterizing quantum state rather than something identified as quantum jump? Or could these sequences define a model of self to be distinguished from self identified as quantum jump? By definition negentropic entanglement (see fig. `http://www.tgdtheory.fi/appfigures/cat.jpg` or fig. 21 in the appendix of this book) tends to be preserved in quantum jumps so that it represents information as approximate invariant: this conforms with the idea of invariant representation and quite generally with the idea that invariants represent the useful information. This information would not be however conscious if the original view about conscious information as change of information is accepted. Could one imagine a reading mechanism in which this information is read without changing the negentropically entangled state at all? This reading process would be analogous to deducing the state of a two-state system in interaction free measurement to be discussed below.

3. Selves/quantum jumps form a hierarchy, which predicts higher level selves identifiable in terms of collective and transpersonal consciousness. Also lower levels of hierarchy should be present so that even neuron and even electron should possess primitive self-awareness.

4. The sub-selves of self are identified as mental images of self and sub-sub-selves are assumed to be experienced as ensemble averages- at least when the entanglement is not negentropic. This averaging could be seen as an alternative mechanism for the formation of abstractions. Another mechanism would be based on quantum superposition of perceptively equivalent space-time surfaces. Sharing of mental images by entanglement of sub-selves is proposed and the motivation comes from the space-time correlates of entanglement identified as magnetic flux tubes connecting the space-time sheets of sub-selves although space-time sheets of selves are disjoint. This picture requires a generalization of the usual tensor product description for the formation of many-particle states.

Negentropy Maximization Principle (NMP) defines the basic variational principle of TGD inspired theory of consciousness.

1. NMP states that the negentropy gain in the quantum jump is maximal. For the ordinary entanglement entropy NMP implies that state function reduction leads to a pure state, which is an eigenstate of the density matrix characterizing the interaction of subsystem with its environment. An interesting purely mathematical result is that the assumption that density matrix always reduces to a partial trace of pure state density matrix leads to the basic rules of quantum theory probabilities. TGD inspired theory of consciousness, which can be seen as a generalization of quantum measurement theory, allows only this kind of density matrices.

2. If one accepts the notion of negentropic entanglement making sense in the intersection of real and p-adic worlds, number theoretic entropy can become negative in state function reduction. This makes possible formation of negentropically entangled states wheras in the usual state

function reduction entanglement is always reduced. Negentropy is however associated with the entanglement rather that single particle states of either particle.

3. NMP and second law are very similar and one can consider the notion of the counterpart of thermodynamical equilibrium in which the average values of some conserved quantities are fixed so that one can assign to them temperature like parameters. At least in the ideal situation quantum jump could lead to the analog of thermal equilibrium prevailing in all scales with maximum amount of negentropic entanglement. This is probably too strong an idealization. The assignment of the experience of understanding with the generation of negentropic entanglement is a highly attractive idea. To assign it with negentropic entanglement itself does not conform with the basic postulate.

Both p-adic length scales and CDs form a hierarchy and this raises the question whether or not the quantum jumps inside CDs within CDs are related or not. One can consider three options.

1. For the first option the cascade of state function reductions can begin from any *unentangled* CD and after that proceeds to shorter length scales (smaller sub-CDs) until it stops when maximally negentropic entanglement is reached. This cascade would be analogous to motor action proceeding from long to short scales as detailes of the motor action are fixed. For sensory perception the cascade would be same but in opposite direction of imbedding space geometric time (state function reduction for the opposite boundary of CD). This would imply an effect analogous to quantum Zeno effect. If for given CD quantum jump cascade can begin only if CD is unentangled, negentropic entanglement stabilizes the CD, and it can spend long times in this negentropically entangled state but would not be conscious.

2. One can consider also the possibility that the CD from which the cascade begins is entangled with other CDs so that in quantum superposition of states the state function reduction cascades could occur separately for all summands. This would mean quantum parallelism for state function reductions. What is essential that state function reductions for components of the linear superposition in a given scale can occur only in shorter scales. For instance, in this picture hadrons could be seen as quantum coherent structures in hadronic length scales but dissipative quantum structures in quark length scales. It is is not clear to me whether the possible non-uniqueness of the state basis could exclude quantum parallellism for state function reductions.

3. For the third option quantum jumps inside various CDs would occur independently and top-down and bottom-up cascades are not predicted.

4.4.2   The anatomy of quantum jump in zero energy ontology (ZEO)

Concerning the notion of quantum jump ZEO encourages rather far reaching conclusions. In ZEO the only difference between motor action and sensory representations on one hand and intention and cognitive representation on the other hand is that the arrows of imbedding space time are opposite for them. Furthermore, sensory perception followed by motor actions corresponds to a basic structure in the sequence of state function reductions and it seems that these processes occur fractally for CDs of various size scales.

1. State function reduction can be performed to either boundary of CD but not both simultaneously. State function reduction at either boundary is equivalent to state preparation giving rise to a state with well defined quantum numbers (particle numbers, charges, four-momentum, etc...) at this boundary of CD. At the other boundary single particle quantum numbers are not well defined although total conserved quantum numbers at boundaries are opposite by the zero energy property for every pair of positive and negative energy states in the superposition. State pairs with different total energy, fermion number, etc.. for other boundary are possible: for instance, t coherent states of super-conductor for which fermion number is ill defined are possible in zero energy ontology and do not break the super-selection rules.

2. The basic objects coding for physics are U-matrix, M-matrices and S-matrix. M-matrices correspond to a orthogonal rows of unitary U-matrix between zero energy states, and are expressible as products of a hermitian square root of density matrix and of unitary S-matrix which more or less corresponds to ordinary S-matrix. One can say that quantum theory is formally a square root of thermodynamics. The thermodynamics in question would however relate more naturally to NMP rather than second law, which at ensemble level and for ordinary entanglement can be seen as a consequence of NMP.

   The non-triviality of M-matrix requires that for given state reduced at say the "lower" boundary of CD there is entire distribution of states at "upper boundary" (given initial state can lead to a continuum of final states). Even more, all size scales of CDs are possible since the position of only the "lower" boundary of CD is localized in quantum jump whereas the location of upper boundary of CD can vary so that one has distribution over CDs with different size scales and over their Lorentz boots and translates.

3. The quantum arrow of time follows from the asymmetry between positive and negative energy parts of the state: the other is prepared and the other corresponds to the superposition of the final states resulting when interactions are turned on. What is remarkable that the arrow of time at imbedding space level at least changes direction when quantum jump occurs to opposite boundary.

   This brings strongly in mind the old proposal of Fantappie [J103] that in living matter the arrow of time is not fixed and that entropy and its diametric opposite syntropy apply to the two arrows of the imbedding space time. The arrow of subjective time assignable to second law would hold true but the increase of syntropy would be basically a reflection of second law since only the arrow of the geometric time at imbedding space level has changed sign. The arrow of geometric at space-time level which conscious observer experiences directly could be always the same if quantum classical correspondence holds true in the sense that the arrow of time for zero energy states corresponds to arrow of time for preferred extremals. The failure of strict non-determinism making possible phenomena analogous to multi-furcations makes this possible.

4. This picture differs radically from the standard view and if quantum jump represents a fundamental algorithm, this variation of the arrow of geometric time from quantum jump to quantum jump should manifest itself in the functioning of brain and living organisms. The basic building brick in the functioning of brain is the formation of sensory representation followed by motor action. These processes look very much like temporal mirror images of each other such as the state function reductions to opposite boundaries of CD look like. The fundamental process could correspond to a sequences of these two kinds of state function reductions for opposite boundaries of CDs and maybe independently for CDs of different size scales in a "many-particle" state defined by a union of CDs.

   How the formation of cognitive and sensory representations could relate to quantum jump?

1. ZEO allows quantum jumps between different number fields so that p-adic cognitive representations can be formed and intentional actions realized. How these quantum jumps are realized at the level of generalized Feynman diagrams is non-trivial question: one possibility suggested by the notion of adele combining reals and various p-adic number fields to a larger structure is that the lines and vertices of generalized Feynman diagrams can correspond to different number fields [K105].

   The formation of cognitive representation could correspond to a quantum jump in which real space-time sheet identified as a preferred extremal is mapped to its p-adic counterpart or superposition of them with the property that the discretized versions of all p-adic counterparts are identical. In the latter case the chart map of real preferred extremal would be quantal and correspond to de-localized state in WCW. The p-adic chart mappings are not expected to take place but with some probabilities determined by the number theoretically universal U-matrix.

2. Similar consideration applies to intentional actions realized as real chart maps for p-adically realized intention. The natural interpretation of the process is as a time reversal of cognitive

map. Cognitive map would be generated from real sensory representation and intentional action would transform time reversed cognitive map to real "motor" action identifiable as time reversal of sensory perception. This would occur in various length scales in fractal manner.

3. The formation of superpositions of preferred extremals associated with discrete p-adic chart maps from real preferred extremals could be interpreted as an abstraction process. Similar abstraction could take place also in the mapping of p-adic space-time surface to a superposition of real preferred extremals representing intentional action. U-matrix should give also the probability amplitudes for these processes, and the intuitive idea is that the larger then number of common rational and algebraic points of real and p-adic surfaces is, the higher the probability for this is: the first guess is that the amplitude is proportional the number of common points. On the other hand, large number of common points means high measurement resolution so that the number of different surfaces in superposition tends to be smaller.

4. One should not make any un-necessary assumptions about the order of various kinds of quantum jumps. For the most general option real-to-padic and p-adic-to-real quantum jumps can follow any quantum jumps and state function reductions to opposite boundaries of CD can also occur any time in any length scale. Also the length scale of resolution scale assignable to the cognitive representation should be determined probabilistically. Quantal probabilities for quantum jumps should therefore apply to all aspect of quantum jump and now ad hoc assumptions should be made. Very probably internal consistency allows only very few alternative scenarios. The assumption that the cascade beginning from given CD continues downwards until stops due to the emergence of negentropic entanglement looks rather natural constraint.

4.4.3 How memories are represented and recalled?

Formation of memories and memory recall are key elements in the vision proposed by Hawkins. The question is what memories and memory recall are. If quantum jump is the fundamental process, it should automatically give rise to memories and memory recall.

1. Memories in given scale would naturally correspond to sequences of mental images defined by negentropically entangled sub-CDs of CD in given scale. According to earlier view the sequences of moments of consciousness bind to form higher level moments of consciousness, selves. Somewhat different view is that formation of selves means formation of sequence of negentropically entangled sub-CDs stable against NMP and preserved in quantum jump and even increasing in size. Thus self would correspond to a property of state and consciousness would be associated with the replacement of state with a new one.

2. The hierarchical structure of memories would emerge naturally. Conscious memory recall would correspond to a generation of negentropic entanglement between the new mental images emerging in the state function reduction (recall that the sizes of CDs increase and new sub-CDs emerge) and already existing negentropically entangled mental images. Generation of negentropic entanglement would give rise to the experience of recognition of the new mental images.

3. The natural guess is that negentropic entanglement is generated if the new sensory input is "consistent" with older mental images. The addition of new tensor factor would mean a more abstract representation so that the sequence of quantum jumps would mean accumulation of experience. Consistency with older mental images could mean that the mental images have same "name". The name could correspond to p-adic cognitive representation. The physical correlate could be a collection of resonance frequencies. The names would be same if the frequencies for older mental images and new one are same, so that resonant interactions becomes possible. The generation of negentropic entanglement would be like finding a radio station.

For this proposal memory recall and memory formation are actually more or less the same thing. Only the completely new memories claimed to be formed in hippocampus would not involve memory recall. The new memory would correspond to a new sub-CD or ensemble of sub-CDs representing the associated negentropically entangled mental images. Neuronal loop could make possible to build copies about the new memory and thinking about it would create copies of corresponding p-adic cognitive representations which in turn could be transformed via state function reduction to an opposite boundary of CD to actions. In TGD framework the 4-D hierarchy of memories could continue from hippocampus to the magnetic body: this would explain the correlation of EEG with memory and also with various other brain functions.

4.4.4 The roles of sensory perception and motor action in TGD framework

The attempts to define consciousness rely on two basic approaches. The first approach emphasizes direct sensory awareness and formation of cognitive representations from it (phenomenal consciousness and reflective consciousness). Second approach emphasizes volition, motor plans, and motor actions.

The analogs of sensory representations and motor actions emerge at the fundamental level in quantum TGD without mentioning anything about brain. In ZEO state function reduction is replaced with a cascade of state function reductions corresponding to various scales for CDs forming a fractal hierarchy. State function reduction can take place to either of the opposite boundaries of CD in a given length scale. The reduction at given boundary of CD would always force de-localization of the opposite boundary of CD creating quantum superposition of CDs with various sizes. Also new sub-CDs (correlates for sensory mental images) within the resulting bigger CDs are naturally generated. This would explain the arrow of geometric time at imbedding space level but the arrows are opposite at the opposite boundaries of CD.

The reduction to opposite boundaries of CD gives rise to zero energy states related by time reversal at the level of imbedding space. If "my" conscious experience corresponds to reductions to either "upper" or "lower" boundary of CD of wake-up cycle defining me, I will experience that the arrow of geometric at the level of imbedding space arrow is constant and would be basically due to the scaling up of the average size of "personal" CD. "Upper"/"lower" can be fixed by the arrow of time assignable to large enough CD defining environment.

Standard quantum measurement theory assumes that a state function reduction followed immediately by a new one does not affect the reduced state [this gives rise to so called quantum Zeno effect: quantum monitoring of unstable particle prevents its decay (watched kettle does not boil)]. That repeated state function reduction at given boundary of CD does not affect the zero energy state resulting in the reduction for given CD would generalize this hypothesis. If this assumption hold true, the subsequent reductions at the same boundary of CD would effectively correspond to single reduction and one would effectively have an alternating sequence of cascades of state function reductions beginning from opposite boundaries of CDs. Note however that there a fractal cascade of reductions beginning from sub-CDs the CD is assumed changing the state in smaller scales.

In TGD framework the counterpart of quantum Zeno effect would be achieved by closing an unstable particle inside small enough CD so that the unitary time evolution restricted to CD would not affect the particle appreciably and state function reductions at boundaries of this CD very rarely would give rise to a final state of decay. Watchdog in this case would be the self to which this CD corresponds to.

Motor action as time reversal of sensory perception

In TGD framework motor action could be seen as a time reversal of sensory perception so that sensory-motor pairing could be seen as fundamental element of all conscious existence. Just to fix conventions let us fix arrow of time as the arrow of the imbedding space time for a very large CD, maybe of cosmic size scale, so that there is unique time direction corresponding to future.

1. All scales for CDs are possible. For sub-CDs of given CD the experiences associated with sub-CD define mental images of CD and the experience can be assigned with either boundary

of sub-CD. Let us tentatively agree that for a given CD "lower" and "upper" boundaries are in future and past when seen from the center point of CD (past and future could be permuted in the convention).

This choice would conform with the interpretation that motor "me" I_m makes a fuzzy prediction of future as superposition of space-time sheets extending from the lower boundary of CD and sensory "me" I_s generates memories represented by superposition of space-time sheets extending downwards from the upper boundary of CD. I do not quite have the courage to completely exclude the second option in which the roles of motor me and sensory me are changed.

2. With this assumption one can assign to a sub-CD near upper *resp.* lower boundary of sub-CD sensory mental images *resp.* their time reversals. In the interior they would represent memories *resp.* predictions. The larger CD would experience these sub-selves as mental images and interpret them in terms of ordinary sensory percepts *resp.* volitions, decisions, and plans. The primary sensory experience, phenomenal experience, involves generation of negentropic entanglement as the sensory mental image combines as a tensor factor with the existing sequence of mental images forming a sensory representation defining memory. The reading of this sequence of mental images using interaction free quantum measurement gives rise to a conscious memory about the mental image sequence.

3. A prediction, which looks rather strange at first glance, follows. "My" CD would be seat for two selves having their own phenomenal experiences seated at the opposite boundaries of my CD. They would be sensory me I_s assignable to sensory perception and motor me I_m assignable to motor action as time reversed sensory perception and assignable to the opposite boundaries of CD when they are localized in state function reduction. The time reversed sensory percept is interpreted in terms of predictions, volitions, and plans at least by larger CD having the CD as sub-CD. Sensory and motor "mes" would appear in all scales in the hierarchy of sub-CDs.

4. Since the scale of CDs increases quantum jump by quantum jump on the average and new sub-CDs emerge, the size scale of the largest CD in hierarchy increases and the perceptual fields of the two "me"s associated with it shift towards geometric future *resp.* past of the imbedding space. The sub-CDs near the boundaries of largest CD give rise to sensory percepts of the two "me"s involved with the largest CD in the hierarchy. Those in the interior define memories. The flow of time would correspond to the gradual shifting of the upper/lower boundary of largest CD to future/past and generation of sensory mental images (sub-CDs) near the boundary. Same would of course occur for the smaller CDs. The time interval about which memories are about and also the time scale for predictions of future increases since the size of the personal CD is gradually scaled up.

Quantitative considerations

One can make also quantitative questions.

1. What is the average increase of the temporal distance between the tips of CD in a pair of state function reductions to opposite boundaries defining the chronon of subjective experience? The duration of this chronon can depend on the level of the self hierarchy.

   For human sensory consciousness this chronon would naturally correspond to the time scale of about .1 seconds having interpretation as a duration of sensory mental image. Each pair of state function reductions would generate a layer of the sensory mental images at the lower and upper boundary of "our" CD.

   This leaves open the size scale of "our" CD and lifetime would represent only the size scale for the increase of "our" CD during life cycle. This would mean that the durations of consciousness for the two "me"s assignable to "our" CD would be measured using .1 second as a natural unit.

2. What can one say about the size scales of CDs themselves? Since the memories are about the time interval, which is roughly the duration of life cycle at most, the first guess is that the

size of personal CD is of the order of duration of life cycle. By the previous argument however only the increase of the distance between the tips of "personal" CD naturally corresponds to the duration of life cycle so that the size scale of personal CD could be much larger. Note that the conscious experiences of I_s and I_m assignable to sensory percepts and motor actions should correspond to sub-CD:s with size scale not much larger than .1 seconds. This is consistent with the interpretation of sensory percepts of I_m as plans, decisions, predictions, and volitions. The sub-CDs with time scale of say years are however possible and would correspond to memories and plans in time scales of years.

3. One can imagine also a fractal hierarchy for the increments ΔT_i of the temporal distance T_i between tips of CDs assignable to single pair of quantum jumps to opposite boundaries of CD in given length scale. $\Delta T = .1$ seconds would not be the only possible duration of chronon. This time scale is however very special since it corresponds to the Mersenne prime M_{127} assignable to electron which corresponds to largest Mersenne prime which does not correspond to completely super-astrophysical p-adic length scale. The smaller Mersenne primes - such as M_{107} and M_{89} could correspond to shorter time scales perhaps assignable to nerve pulse in the case of lightest quarks. All primes characterizing elementary particles could define chronons of this kind serving as clocks. The hierarchy of chronons could mean sensory percepts and motor actions have a fractal hierarchy of resolutions identifiable as kind of abstraction hierarchy.

   The clocks defined by these chronons of duration T_i should be synchronized in the sense that there would $N_{ij} = \Delta T_i / \Delta T_j$ quantum jumps with time increment T_j per single quantum jump with time increment T_i.

   Could various periodic phenomena such as diurnal period of 24 hours defining sleep-awake cycle, annual cycle, and various bio-rhythms such as EEG rhythms, define also chronons? Could cyclity which seems to appear at the level of sensory and cognitive mental images relate to this kind of chronons: for instance, after images are a good example about mental images having analog of wake-up-sleep cycle.

Questions

There are also questions about the relation to the functioning of brain.

1. How sleep-awake cycle relates to this picture? The above argument suggest that .1 second time scale rather than 24 hour time scale defines the increase of CD scale assignable to single pair of state function reduction assignable to "me". Therefore the period assignable to single moment of human sensory conscious of the two "me"s would be of order .1 seconds.

   This strongly suggests that due to the lack of sensory input and absence of motor actions we are conscious during sleep but do not have memories from this period. Dreams generated by virtual sensory input to retina would produce memories during sleep state. Revonsuo indeed mentions that according to the reports of subject persons after awakenings sleeping period seems to involve either dreams or sleep mentation. Sleep mentation is very simple during nREM sleep: for instance, repetition of some word of internal speech. Sleep mentation would involve motor actions generating internal speech and in some cases also genuine speech. Also genuine motor actions such as sleep walking are possible.

2. Could the sensory-motor dichotomy have some relation to the right-left dichotomy at the level of brain? Right and left brain hemisphere could naturally correspond to parallel CDs of same size scale. Could right and left brain (or parts of them) organize their wake-up periods as in shift work: if left brain hemisphere is awake right hemisphere sleeps (sensorily perceives the opposite end of its CD) and vice versa, an alternating dominance by either hemisphere results, and one could understand sensory rivalry. The time scale of CDs possibly involved would be much shorter than that of sleep-awake cycle in this case. Interestingly, the duration of hemisphere dominance period in some disorders like schizophrenia is anomalously long.

   The CD containing both these CDs - "entire brain CD" - would be also present. The view of "brain CD" about world represented by entangled right and left negentropic mental images would be analogous to initial and final state and thus contain much more information than

given by either right or left hemisphere. In the case of visual mental images this would give rise to stereo vision.

Could this shift work between parts of right and left hemisphere be realized in several time scales of CDs? Even in the scale corresponding to sleep-awake rhythm? It is known that in case of some birds and mammals, which must be motorially and sensorily active all the time, the brain hemispheres have this kind of shift work in long time scale.

4.4.5 Self or only a model of self?

Negentropic entanglement provides a model for associations as rules in which superposition of tensor product states defines rule with entanglement pairs defining its various instances. This generalizes to N-fold tensor products. Associations would be realized as N-neuron negentropic entanglement stable against NMP. One could also think of realizing associative areas in terms of neurons whose inputs form entangled tensor product and when sensory inputs are received they form analogous tensor product in representative degrees of freedom.

Thus negentropic entanglement is necessary for mental images (having sub-CDs as correlates) to mental images representing spatial patterns. Negentropic entanglement in time direction for these patterns (zero energy states) is in turn necessary to bind them to sequences of mental images representing abstract memories as sequences of mental images. Negentropically entangled sequence would be a quantal counterpart for the original association sequence introduced as purely geometric concept.

This picture however challenges the identification of self as quantum jump. Should the negentropically entangled sequences of mental images define selves so that self would be something characterizing zero energy state rather than something identified as quantum jump? Could they define a model of self to be distinguished from self identified as quantum jump? Or could one give up the notion of self altogether and be satisfied with model of self? At this moment it seems that nothing is lost by assuming only the model of self.

By definition negentropic entanglement tends to be preserved in quantum jumps so that it represents information as approximate invariant: this conforms with the idea of invariant representation and quite generally with the idea that invariants represent the useful information. There is however a problem involved. This information would not be conscious if the original view about conscious information as a change of information is accepted. Could one imagine a reading mechanism in which this information is read without changing the negentropically entangled state at all? This reading process would be analogous to deducing the state of a two-state system in interaction free measurement to be discussed below in more detail.

4.4.6 Could interaction free measurement be used to deduce information about self model?

The assumption that self model is a negentropically entangled system which does not change in state function reduction, leads to a problem. If the conscious information about this kind of sub-self corresponds to change of negentropy in quantum jump, it seems impossible to get this information. Quite generally, if moment of consciousness corresponds to quantum jump and thus change, how it is possible to carry conscious information about quantum state? The following proposal for non-destructive reading of memories and future plans allows to resolve this problem.

Bomb testing problem as a model for interaction free measurement

One can consider a generalization of so called interaction free measurement as a manner to deduced information about self model. This information would be obtained as sequences of bits and might be correspond to declarative, verbal memories rather than direct sensory experiences.

1. The bomb testing problem of Elitzur and Vaidman gives a nice concrete description of what happens in interaction free measurement, see `http://en.wikipedia.org/wiki/ElitzurVaidman_bomb-testing_problem` [B2] for an illustration of the system considered.

   The challenge is to find whether the bomb is dud or not. Bomb explodes if it receives photon with given energy. The simplest test would explode all bombs. Interaction free measurement

allows to make test by destroying only small number of bombs and at idealized limit no bombs are destroyed.

The system involves four lenses arranged in square and two detectors C and D at the upper right corner of the square. In the first lens at the lower left corner the incoming photon beam splits to reflected and transmitted beams: the path travelled by transmitted beam contains the bomb.

(a) The bomb absorbs photon with a probability which tells the fraction of photon beam going to the path at which bomb is (is transmitted through the lens). The other possibility is that this measurement process creates a state in which photon travels along the other path (is reflected). This photon goes through a lens and ends up to detector C or D through lens.

(b) If the bomb is dud, the photon travels through both paths and interference at the lens leads the photon to detector D. If C detects photon we know that the bomb was not a dud without exploding it. If D detects the photon, it was either dud or not and we can repeat the experiment as long as bomb explodes, or C detects photon and stop if the detector continues to be D (dud). This arrangement can be refined so that at the ideal limit no explosions take place and all.

2. The measurement of bomb property is interaction free experiment in the sense that state function reduction performed by absorber/bomb can eliminate the interaction in the sense that photon travels along the path not containing the bomb. One might say that state function reduction is an interaction which can eliminates the usual interaction with photon beam. State function reduction performed by bomb can change the history of photon so it travels along the path not containing the bomb.

This picture is only metaphorical representation of something much more general.

1. Bomb could be of course replaced with any two-state system absorbing photons in one state but not in the other state, say atom. Now one would test in which state the atom is gaining one bit of information in the optimal situation. Two-state atom could thus represent bit and one could in principle read the bit sequence formed by atoms (say in row) by this method without any photon absorption so that the row of atoms would remain in the original state.

2. Two-state system could be replaced with N-state system. In this case the testing selects at first step one state as analogs of bomb intact and the remaining states as analogs of dud. If the answer was "dud" in the first step, the next step selects one preferred state from $N-1$ states and regards the remaining states as "dud". The process continues until the state of the system is measured.

3. In TGD framework the photon paths branching at lenses correspond to branching 3-surfaces analogous to branching strings in string model and photon wave splits to sum of waves travelling along the two paths.

Memory recall as an interaction free measurement

One can imagine several applications if the information to be read in interaction free manner can be interpreted as bit sequences represented as states of two-state system. Lasers in ground states and its excited state would be analogous many particle quantum system. In TGD framework the analog of laser consisting of two space-time sheets with different sizes and different zero point kinetic energies would be the analogous system.

For instance, a model of memory recall with memories realized as negentropically entangled states such that each state represents a qubit can be considered. The model applies also to the reading of future plans (memories on reversed time direction).

1. Reading of a particular qubit of memory means sending of negative energy photon signal to the past, which can be absorbed in the reading process. The problem is however that the

memory representation is changed in this process since two state system returns to the ground state. This could be seen as analog of no-cloning theorem (the read thoughts define the clone). Interaction free measurement could help to overcome the problem partially. Memory would not be affected at all at the limit so that no-cloning theorem would be circumvented at this limit.

2. A possible problem is that the analogs of detectors C and D for a given qubit are in geometric past and one must be able to decide whether it was C or D that absorbed the negative energy photon! Direct conscious experience should tell whether the detector C or D fired: could this experience correspond to visual quale black/white and more generally to a pair of complementary colors?

3. ZEO means that zero energy states appear have both imbedding space arrows of time and these arrows appear alternately. This dichotomy would correspond to sensory representation-motor action dichotomy and would suggest that there is no fundamental difference between memory recall and future prediction by self model and they different only the direction of the signal.

4. Since photon absorption is the basic process, the conscious experience about the qubit pattern could be visual sensation or even some other kind of sensory qualia induced by the absoroption of photons. The model for the lipids of cell membrane as pixels of a sensory screen suggests that neuronal/cell membranes could serve defined digital self model at the length scale of neurons.

 Some comments are in order.

1. To avoid misunderstandings it should be emphasized that TGD based view about memory is not the same as the standard view. In ZEO brain is four-dimensional and in principle memories can be negentropically entanglement memories in geometric past. It is possible to build copies of memories by memory recall, and learning would correspond to a generation of large enough number of copies of the memory mental image. Memory recall could be seen as a negative energy signal inducing the interaction free measurement of memory qubits. Dark photons with EEG frequencies (say in theta band characterizing hippocompus) but having energies of visible photons could be involved with the memory recall. Correlation between EEG and bio-photons supports this view.

2. If the systems taking the role of the detectors C and D in interaction free measurement are analogous to population reversed lasers, their return to the ground state could automatically generate virtual sensory input propagating to the sensory organs and allowing to check whether it is consistent with the actual sensory input. The generation of the feeback signal takes some time expected however to be much shorter than that for a typical neuronal activity.

   Since the signals would propagate with light velocity, the virtual sensory input could travel practically instantaneously from the brain to sensory organs and possibly also vice versa. Libet's experiments on passive aspects of consciousness [J71] in fact demonstrate a time delay which is fraction of second having interpretation in terms of time to propagate to a layer of magnetic body of size scale of Earth and back: these delays are consistent with the fact that the chronon of sensory experience is about .1 seconds. The propagation of photon signals in both directions would make possible construction of sensory representation in time scale much shorter than that of neural activity. This mechanism could also explain generation of after images.

3. Photons can be replaced with phonons or quanta of any other wave motion with constant propagation velocity (no dispersion of signal) in a given reference frame. This suggests that imagination and internal speech correspond to the two reading mechanisms of memories.

Some critical questions

There are two basic objections against quantum theories of consciousness. How it is possible to have conscious information about invariant under quantum jumps if only change is experienced continuously? The outcome of state function reduction in standard quantum theory is random: how can one understand freedom of choice and intentional behaviour in terms of state function reduction? NMP and the possibility of negentropic entanglement imply that TGD based quantum theory is not equivalent with the standard one, and this allows to circumvent the objections.

There are however two further questions, which I cannot answer yet. Can one really assume that the notion of interaction free measurement continues to make sense in TGD framework? Could NMP allow to make this notion exact or make it impossible? Could the invariants or at least their existence be experienced directly without interaction free measurement?

The experiments carried out to test whether 40 Hz thalamocortical resonance is correlate for conscious experience suggests that the resonance is present only when a new pattern is discovered, not when it has become a memory. The TGD inspired interpretation would be that the resonances accompanies negentropy gain and quantum jump is necessary for conscious experience. However, the reports about higher states of consciousness (and also my own experiences) suggest that the invariants can be experienced directly when all thoughts (interaction free measurements) are eliminated. This experience cannot be however communicated: one understands does not know what one understands. Therefore also the original vision that negentropic entanglement corresponds to conscious experience - experience of pure understanding, which is not communicable - and in apparent contradiction with the basic hypothesis about quantum jump, would be correct after all!

Why vision and hearing are so fundamental for cognition?

The interaction free measurement is formulated in terms of photons. It can be however formulated also for sound waves using phonon detectors and acoustic waves traversing through two different paths. Quantum coherence is required but the hierarchy of Planck constants makes sense also for phonons by the basic equation $E = hf$.

In TGD framework there are good reasons to believe that sound waves are not only something emerging at the level of condensed matter but correspond to oscillations of string like objects at 4-D space-time surface. These strings connect the wormhole contacts assignable to the light-like orbits of partonic 2-surfaces. Partonic 2-surfaces can be assigned with elementary particles but also to 2-surfaces with arbitrarily large size scale. The outer boundary of any physical object would correspond to a partonic 2-surface. String world sheets carry fermion fields localized at them (right-handed neutrino is an exception in that it is de-localized at entire space-time surface). The fact that strings always connect two partonic 2-surfaces corresponds to the fundamental two-particle character of sound waves. Sound would be as fundamental phenomenon as photons and other massless bosons.

This encourages to ask whether photon (more generally gauge boson: TGD suggests that scaled up copies of gluons and weak bosons behaving like massless particles even in cell length scale are possible) and photon absorption could define fundamental conscious representations of information realized in terms of interaction free measurements for negentropically entangled states remaining unchanged under state function reduction in good approximation.

Photons would correspond to "seeing" but at neuronal level rather than at the level of retina - and imagination. Phonons would correspond to hearing at neuronal level and internal speech which is also essential for cognition. Both internal speech and imagination could be understood at fundamental aspects of cognition. Dark photons with energies of visible photons (decaying to what is interpreted as bio-photons) and dark phonons would be behind imagination and internal speech. I have already earlier proposed that the lipid layers of neuronal membranes (and maybe also ordinary cell membranes) can be regarded as pixels of a sensory map representing neuronal qualia [K32]. These pixels could serve as the counterparts of the detectors C and D appearing in interaction free measurement. The evidence for the importance of bio-photons (in TGD framework dark photons decay to bio-photons in energy conserving manner) in biology and neuroscience is emerging, see for instance the experiments of Persinger's group [J85, J86, J87]. I have discussed these findings from TGD point of view in [L32].

One can speculate about direct translation between the words of language and visual pre-

images. In general I try to avoid reference to anything personal since but at this time I cannot resists the temptation to mention that during my first "great experience", which served as a powerful inspiration for TGD inspired theory of consciousness, I was able to see my thoughts and discovered that this kind of correspondence seems to exists: I did experimentation with internal speech by uttering words and immediately getting visual image to my visual field as a response!

Biophotons seem to be associated only with the right hemisphere [J85]. This suggests that right hemisphere or some parts of it prefer dark photons being thus specialized to visual imagination in accordance with the fact that spatial relationships are the speciality of the right hemisphere. Could this mean that left hemisphere or some parts of it prefer dark phonons (or dark photons in IR range transforming [L32] to ordinary photons at ear and generating virtual auditory input? Left hemisphere indeed is the verbal hemisphere specialized to linear linguistic cognition and produces also internal speech.

Realization of memory representations in terms of braided flux tubes

While reading a marvellous book "The Field" by Lynn McTaggart [I81] about evolution of ideas about the role of electromagnetic fields in biology and neuroscience, I became aware of two questions which I had not yet answered. The first question is following: How various representations (sensory - , memory -,...) - "Akashic records" - are realized as negentropically entangled states?

Magnetic body should be the seat of memories in some sense.

1. I have already earlier proposed this kind of realization based on the observation that braiding in time direction generates space-like braiding [K23]. Dancers on the parquette with their feet connected to the wall by threads illustrates the idea. When dancers move at the parquette their world lines define a time-like braiding in 3-dimensional space-time assignable to the floor. Also the threads connecting the dancers to the wall get braided - or entangled - as one might also say. There is clearly a duality between time-like and space-like braidings: the running topological quantum computer program coded by braiding in time direction is stored as space-like braiding defining memory representation of what happened. Note that same mechanism realizes also predictions and future plans as time reversed topological quantum computer programs in ZEO. CDs in various scales contain this kind of programs and their memory representations.

2. I have also proposed that the geometric entanglement - braiding - of flux tubes defines a space-time correlate for quantum entanglement. In the case of topological quantum computation it would be naturally described by probabilities, which are rational numbers (or perhaps even algebraic numbers in some algebraic extension of p-adic numbers characterizing together value of the p-adic prime the evolutionary level of the system). Hence the notion of number theoretic negentropy makes sense and one obtains a connection with topological quantum computation.

3. The representation of memories in terms of space-like braiding of magnetic flux tubes connecting various systems would be universal, and not restricted to DNA-cell membrane system in which the flux tubes would connect DNA nucleotides [K23, K93] or codons (this seems to be the more plausible option [L32]) with the lipids. One could indeed speak about Akashic records (see http://en.wikipedia.org/wiki/Akashic_records).

4. The time reversals or these representations defined by the zero energy states of opposite arrow of the imbedding space time would define a representation for future predictions/ plans in ZEO. For instance, the development of a seed to a full-grown organism could be coded in this manner in time scale where CD has time scale of order of the lifetime of the organism. Already Burr found evidence that the radiation field assignable to the seed has the same shape as the plant [I30, I81] or animal (salamander in his experiments). This energy field would naturally correspond to the magnetic body containing dark photon Bose-Einstein condensates. The Akashic records and their time reversal would naturally correspond to the morphic fields of Sheldrake [I96, I97]: memories and future plans in time scales longer than than duration of life cycle for an individual member of species would be possibles. Every scientist of course agrees that the societies are busily predicting and planning their futures

but find very difficult to accept the idea that this could have some concrete quantum physical correlate.

How to construct and read conscious hologram?

The above discussion raises the question about how the vision about brain as a conscious hologram is realized in the proposed conceptual framework.

The idea about living system as a hologram has strong empirical basis. One of the most dramatic demonstrations of the hologram like character of brain was the discovery of Pietch [J137] that salamander's brain can be sliced to pieces and shuffled like a deck of cards and put together. When the resulting stuff is returned to the head of the salamander, it recovers! This extreme robustness is very strong support for the non-local hologram like storage of biological information. Ironically, Pietch tried to demonstrate that the theory of Karl Pribram [J138, J139] about brain as a hologram is wrong! In TGD framework one can go even further and ask whether this robustness actually demonstrates that various representations (sensory - , cognitive - , memory - ...) are realized at the long magnetic flux loops and sheets of the magnetic body rather than brain.

The notion of conscious hologram [K10] is one of the key ideas of TGD inspired theory of consciousness. Hitherto I have not been however able to find a really convincing concrete proposal for how brain could be a hologram in TGD Universe. The reading of memory - and other representations by interaction free measurement however leads to a natural proposal for what the hologram might be.

1. Certainly the formation of the hologram must closely relate to the vision about universal Akashic records realized in terms of braided flux tubes and their non-destructive reading by interaction free measurement. Oversimplifying, tor a given bit of the representation the photons scattered without interaction would kick either of the two detectors C and D associated with it to an excited state (see `http://en.wikipedia.org/wiki/ElitzurVaidman_bomb_tester`). This process is very much like absorption of photons by a photosensitive plate defining an ordinary hologram.

2. The lipids of the cell membrane are good candidates as something in 1-1 correspondence with the basic units of this hologram (note the analogy with computer screen - also a liquid crystal!). If one irradiates the laser like system formed by the detectors not only by the radiation scattered from the quantum Akashic records but by its superposition with the reference wave of same frequency, one obtains a good candidate for a hologram. It would be defined by the excited quantum state consisting of laser systems analogous to the detectors C and D. Any piece of the system should give and approximate representation of the memory and robustness of the representation is achieved.

3. In semiclassical treatment the probability that a given laser like detector is excited must be proportional to the modulus squared of the net field amplitude, which is a superposition of reference wave and scattered wave Also just. as in the case of ordinary holograms, the irradiation of the laser like system by the negative energy counterpart of the reference wave (its phase conjugate emitted in a state resulting in state function reduction to the opposite boundary of CD) effectively generates the conjugate of the scattered wave since only those parts of the system can return to the ground state with considerable probability for which the probability to go to excited state is high enough. Note that this implies that magnetic body contains geometric representations of the perceptive field as indeed assumed [K41, K42]. This is however not quite the classical hologram. Rather, the total number of absorbed negative energy phase conjugate photons for given pixel defines the "real" picture. A given point of the hologram corresponds to an ensemble of laser like detectors so that a statistically deterministic response is obtained as an ensemble average.

How to realize this concretely?

1. I have proposed that the lipids of cell membrane could serve as pixels of sensory representations [K32]. They could indeed serve as the pixels of conscious hologram. Each pixel should contain large number of laser like "detectors" so that statistical determinism would be achieved.

2. There should be pair C and D of detectors such that either of them absorbs photon in an interaction free measurement so that a value of bit is defined. Universality serves as a strong constraint as one tries to guess what C and D could be.

    (a) The lipids at the two lipid layers of cell membrane could be in 1-1 correspondence with C and D. This option is not however universal.

    (b) It is however quite possible that the magnetic fields involved are what I have called wormhole magnetic fields [K101], which carry monopole flux and and involve two space-time sheets carrying opposite net fluxes. As a matter of fact, all elementary particles correspond to flux quanta of wormhole magnetic fields. In this case the two sheets would naturally correspond to detectors C and D and in the simplest situation they would have same Minkowski space projection. Universality of both detectors and holograms is achieved.

3. The cyclotron Bose-Einstein condensates for charged particles at magnetic flux tubes assignable to lipids are good candidates for the laser like systems if they contain cyclotron Bose-Einstein condensates. There are however several options since the magnetic flux tubes are closed and there are several manners to realize this.

    (a) DNA as topological quantum computer vision and the view about cell membrane as a sensory receptor communicating data to the magnetic body in turn sending control signals via DNA suggest the following. Magnetic flux loops have a part connecting DNA with nuclear or cell membrane (this would be the analog for the dipole of the dipole magnetic field) and part which is long - even with size scale of Earth and corresponds to the magnetic field created by the DNA-cell membrane system. This picture applies both to the flux tubes of ordinary magnetic field and to the flux tubes of the wormhole magnetic field.

    (b) An assumption in accordance with the general role of magnetic body is that Akashic records reside at the short portions of flux tubes connecting lipids with DNA codons: their braiding would define basic example about universal representations in living matter. The laser like detectors would reside at the long portions of the flux tubes connecting cell membrane and DNA. If wormhole magnetic fields are in question, the detectors C and D could correspond to the two parallel flux tubes carrying opposite monopole fluxes.

    (c) Universality suggest that this picture allows many alternative realizations. In principle, the relative motion of any system (partonic 2-surfaces with light-like orbits) connected by flux tubes could give rise to Akashic records. The lipids of axonal membrane are excellent candidates for the pixels and the flux tubes connecting the lipids to micro-tubuli [J12] would also define Akashic records with long parts of the flux tubes serving as the laser like system. The maximization of the memory capacity would also explain why the neural pathways to brain tend to maximize their lengths by connecting right side of the body to left hemisphere and vice versa.

4. What remains still open is how to integrate the Josephson junctions defined by the lipid layers of the cell membrane to this picture.

4.4.7 Could quantum jump represent the basic aspects of abstraction process automatically?

Could quantum jump automatically represent the basic aspects of abstraction process and its reversal as it manifests itself at the level of brain?

1. The sizes of CDs in the quantum superposition defining zero energy state tend to increase. This means that the time scale of sensory and cognitive representations increases. Also new sub-CDs are generated as the size scales of CDs increase and this means generation of new mental images identifiable as memories.

2. NMP favors the formation of negentropic entanglement between sub-CDs so that sequences of mental images with both space-like entanglement (spatial patterns) and time-like entanglement (sequences of spatial patterns) are formed. NMP guarantees their stability. Zeno effect could make possible the analog of thermodynamical equilibrium to prevail for several quantum jumps on same boundary of CD having no effect in a given length scale. If quantum jumps occur independently for several scales, they can occur simultaneously in other scales.

3. Map from real to p-adic sector occurs defines a cognitive representation, a prediction for the future (or past when intention is realize as action). In the ideal situation "thermal equilibrium" with respect to NMP is achieved for a given CD. Next state function reduction having observable effects occurs at the opposite boundary of CD and gives rise to motor action or intention about motor action defined by this sensory representation. The transformation to real sector realizes intention.

4.4.8 Quantum jump as the counterpart of fundamental algorithm?

In TGD framework the materialistic identification of consciousness as a property of the physical state of brain is not made. Consciousness is assigned with quantum jump and is therefore something between two quantum worlds.

In quantum TGD context functionalism does not look like an attractive idea. However, the idea that cognitive processing as identification and naming of objects of the perceptive field could be totally universal and taking place already at the elementary particle level, does so. The additional feature would be coloring of this cognitive map. Sensory qualia would do this and could be assigned to the quantum jump and identifiable basically in terms of increments of various quantum numbers in quantum jump.

The TGD counterpart of the functionalistic dream could be dream about the reduction of basic aspects of brain function - formation of sensory and motor representations and their realization, to the basic the basic anatomy of quantum jump and properties of negentropically entangled states approximately invariant under quantum jumps. All systems, even electron would do this, but brain would be highly specialized to this fundamental process.

4.4.9 Could quantum computationalism make sense?

There are strong objections against classical computationalism but what about its quantum variant? The first question is about what one means with quantum computationalism. The usual quantum computation algorithm is modelled by classical computation and might not catch all aspects of activity that one might want to call quantum computation or more generally, conscious cognitive processing.

The vision about DNA as topological quantum computer is one of the key ideas of TGD inspired quantum biology and might actually apply to much wider class of biomolecules biological structures. The notion of magnetic body which distinguishes TGD from ordinary biology and neuroscience is central here. The braiding of magnetic flux represents topological quantum computation programs. One can actually see the braid strands connecting DNA nucleotides or triplets with lipids of nuclear or cell membrane as a representation for quantum software whereas DNA represents the hardware. The reconnections of flux tubes would generate quantum coherence between distant objects and the phase transitions changing their lengths could make possible the miracles of bio-catalysis. The so called cultural evolution could correspond to the evolution of the magnetic bodies.

Could brain - or perhaps even entire Universe - perform quantum computation in some generalized sense and whether sensory processing could be seen as quantum computation in this more general sense? In TGD framework one can consider a generalization of the notion of quantum computation so that quantum jump identified as moment of consciousness defines quantum computation in generalized sense and can be seen also as the counterpart of fundamental algorithm giving rise to sensory and cognitive representations and realizations of motor actions as their time reversals.

1. Generalized Feynman diagrams [K33] involve propagator lines for fermions to which one can assign topological quantum computation with basic gate identified as the basic braiding

operation. These braid strands can be assigned with fermions at the ends of the light-like orbits of partonic 2-surfaces. Also the magnetic flux tubes can take the role of braid strands.

2. The vertices, which come in two varieties, do not have counterpart in ordinary quantum computation and seem to represent something totally new. The first vertex is the analog of string vertex and represents fusion or decay of 3-surface (or associated partonic 2-surface).

   (a) To this vertex one can naturally assign direct sum of state spaces associated with the braid strands carrying fermions. This $\oplus$ vertex has also time reversal and identifiable as co-vertex so that algebra and co-algebra structures are present simultaneously.

   (b) Second vertex is not encountered in string model and generalizes the ordinary 3-vertex of ordinary Feynman diagrams. At this vertex the orbits of 3 partonic 2-surfaces meet at their common end (partonic 2-surface). Now tensor product $\otimes$ is the natural operations and again one has algebra and co-algebra structure. These vertices are algebraically completely analogous with the ordinary sum and product.

   This led to the crazy proposal that arithmetics, the notions of real and p-adics numbers, and even more general mathematical notions generalize by replacing numbers with Hilbert spaces and that calculus for Hilbert spaces could make sense [K105]. This brings in infinite abstraction hierarchy and means a huge generalization of the structure of mathematics but might be needed if one wants to understand reflective consciousness.

3. The replacement of points of Hilbert space with Hilbert space to get a new structure means an abstraction. Single state is replaced with a set of states defined by state basis. Could this process correspond to the formation of abstractions is at the fundamental level? If so $\oplus$ could mean formation of quantum superposition of perceptively equivalent zero energy states representing the percept. $\otimes$ would represent association of different percepts (say through different sensory channels) which represent same object. The superposition of tensor product states would define rule and abstraction and could be the basic cognitive process assignable to generalized Feynman diagrams.

4. This process would be far reaching generalization of the ordinary arithmetics with $+$ and $\times$ to that for $\oplus$ and $\otimes$ and their co-operations. The basic fact about practical arithmetics is that the same computation as a sequence of operations can be performed with very many manners but there is the shortest manner to do it. At the level of generalized Feynman diagrams this would mean huge symmetries. The physical equivalence classes of generalized Feynman diagrams would be huge and in twistor approach to generalized Feyman diagrams these symmetries have an identification as counterparts for the symmetries of twistor diagrams. Whether the representatives inside these equivalence classes are also cognitively equivalent is not clear. These observations suggest that generalized Feynman diagrams might be much nearer to what happens when human brain computes and that quantum computation in the ordinary sense corresponds only to a single line of generalized Feynman diagram, and has same relation to what really happens in brain as single particle quantum mechanics to full quantum field theory.

4.5 Philosophical and conceptual foundations of consciousness science

Revonsuo Revonsuobook discusses both philosophical, historical, and conceptual foundations of consciousness science. In the following I will restrict the attention to philosophical and conceptual foundations. In the following discussion the book of Revonsuo serves as excellent reference providing also references to various articles relating to the topics discussed so that I have not included them.

4.5.1   Philosophical foundations

Revonsuo distinguishes between dualism and monism as basic approaches and discusses in detail both kind of approaches and in section "Why the mind-body problem will not go away?" considers the basic problems (explanatory gap/hard problem) shared by both approaches. In materialism the understanding of qualia, phenomenal experience, is the problem. In dualism the assumption of material and mental as separate "substances" leads to problems with the laws of physics. If one assumes that the mental causation to reduces to that of laws of classical physics, consciousness loses its causal role and becomes a mere epiphenomenon.

Quantum consciousness allows a third philosophical approach giving hopes of avoiding the problems of monism and dualism. This view is not discussed by Revonsuo. If quantum jump is identified as a moment of consciousness, the attempts to reduce the phenomenal aspects of consciousness to the properties of quantum states do not make sense. Consciousness would be in the change, in the re-creation of quantum world.

The challenge is to understand that the contents of consciousness represents also properties of the internal and external world at least approximately invariant under quantum jumps (mental images must represent useful information: rules, memory mental images, self model, model for the external world, etc...). Here quantum theory provides a solution: interaction free measurement [B2] allows in arbitrarily good approximation to obtain conscious knowledge about subsystem (defining memory representation now) without changing its state.

4.5.2   Conceptual foundations

Revonsuo also discusses conceptual foundations of consciousness.

Phenomenal consciousness and qualia

1. Phenomenal consciousness and qualia should certainly be the central concepts of consciousness science. Ironically, in many theories of consciousness (eliminative materialism and some forms of functionalism and representationalism) qualia and phenomenal consciousness are not accepted at all so that not much remains to be explained as Dennett's "Consciousness Explained" (title of this book) expresses it.

   In TGD framework quantum jumps is naturally the source of phenomenal consciousness and qualia cannot be properties of the state since they are assigned with the re-creation of the Universe in quantum jump. This means that the "-ness" in "consciousness" is not appropriate. In finnish language the word "tajunta" would be much more appropriate word.

   One must of course considerably generalize the notion of quantum jump from the state function reduction of wave mechanics in order to understand basic aspects of conscious experience. In ZEO the positive energy parts of zero energy states are characterized by quantum numbers. In complete analogy, fundamental qualia can be labeled by the increments of various quantum numbers in quantum jump for positive/negative energy part of zero energy state.

2. Phenomenal consciousness seems to consists of centre and periphery. Attention seems to distinguish between centre and periphery. Whether a genuine background is present in phenomenal conscious experience is however difficult to test, say by introspection.

   Change blindess and inattentional blindness are general phenomena involving no brain disorder and in strong conflict with the intuitive belief that sensory experience represents all that is present in the perceptive field. In experiments demonstrating change blindess subject person sees a complex visual scenery. A little bit later the subject person is shown second picture and told that some big change distinguishes it from the first picture. As a rule subject persons are unable to identify this change unless they have directed their attention to just the particular feature that changes. Change blindedness obviously relates to the memory representations about the earlier sensory percepts. It seems that without attention they do not become parts of the memory representation.

   Inattentional blindness means that subject person concentrated on some cognitive task, does not notice unexpected stimuli in the perceptive field. A classic example is a situation in which person focuses attention to basket ball and fails to notice a person walking over the

playground in gorilla mask. These findings have inspired the hypothesis that attention can be equated with consciousness and that only the target of attention is in the spotlight of consciousness. The mental image representing person in gorilla mask would not be negentropically entangled with the memory representation.

Attention

What attention could then mean in TGD framework?

1. Both change blindness and inattentional blindness that the mental images representing object of perceptive field becomes part of memory representation when it is attended. This suggests that attention corresponds to the generation of negentropic entanglement binding the new mental images to the negentropically entanglement sequence of earlier mental images. Generation of negentropic entanglement (see fig. `http://www.tgdtheory.fi/appfigures/cat.jpg` or fig. 21 in the appendix of this book) would characterize attention. Clearly, attention cannot be equated with consciousness.

   We do not usually remember our dreams unless we wake-up immediately: could this be due to the fact that the dream mental images are not attended unless person wakes up during the dream? Could the objects of dream percept attended during lucid dreaming?

2. The target of attention should become a part of self + world model of the perceiver at the level of cognitive and memory representations at least. To direct attention is to store as a memory. If this does not happen, there is no potentially conscious memory about the object (memory recall would correspond to interaction free measurement) although it t could contribute to phenomenal consciousness even when it is not attended. Illusions in which subject person is deluded to identify some inanimate system as his body part are consistent with the proposed definition of attention.

3. I have proposed the formation of magnetic flux tubes connecting target of attention and perceiver as a space-time correlate of attention. "Perceiver" would correspond to a space-time sheet to which one can assign a negentropically entangled collection of sub-CDs representing a model for self + external world. Obviously the systems connection by a bridge of attention would form a single macroscopic quantum system. The negentropic entanglement of zero energy states associated with corresponding sub-CDs would be the quantum correlate of attention. At imbedding space level the correlate could be overlap of the M^4 projections of the CDs involved.

   Various meditation practices suggests that the attention can be generated also when the target is inanimate object and means the experiencer becomes one with the target of attention. The recent experiments of Persinger [J85, J86, J87] provide support for the role of magnetic flux tubes as correlates for the formation of macroscopic quantum coherence binding the two systems to single quantum system.

4. Selective attention would also mean a state function reduction for a particular sub-CD representing sensory mental image negentropically entangling it with the collection of sub-CD:s representing self model of perceiver but eliminating its entanglement with sub-CDs representing other objects of the perceptive field.

5. Attention would have metabolism as a physiological correlate. I have proposed that ATP either carries negentropic entanglement and transfers it to the target or that the energy liberated in the process ATP→ ADP generates negentropic entanglement. I have also proposed that ATP → ADP process means standardized manner to build reconnection in the network of magnetic flux tubes changing the connectedness of the magnetic Indra's net between biomolecules. In the case of two objects with disjoint magnetic bodies, reconnection of the flux tubes means that they become connected by a pair of magnetic flux tubes making possible negentropic entanglement. This is just what should happen when the new mental images is connected to the negentropically entangled connection of old mental images. Therefore a rather direct connection with metabolism, attention, and building of sensory representations seems to emerge.

Reflective consciousness

Reflective consciousness is second key aspect of consciousness besides phenomenal consciousness. Some consciousness theorists accept only reflective consciousness since it makes consciousness theorizing easy by allowing the reduction of brain to classical computer.

1. Reflective level of consciousness is typically about conscious experience itself and is often equated with the formation of representations. Becoming conscious about what one was conscious suggests however strongly that the representations are extended in this step. The binding of new mental images by negentropic entangled to a negentropically entangled collection of older mental images is what would happen in this process and the dynamics of quantum jump in ZEO would automatically induce this process.

2. The mathematical description of abstraction involves two elements: tensor product and direct sum. Tensor product identified as a correlate for association is the first element. The higher the abstraction level, the larger the number of factors in the tensor product. For instance, various sensory qualia are tensor produced in associative areas so that large number of different views about object a generated simultaneously.

   Direct sum by superposing perceptively equivalent zero energy states represents the averaging aspect of abstraction allowing to get rid of un-necessary details and to see the wood from trees. The measure for the abstraction level for direct sum can be identified as perceptive/cognitive resolution. The notion of resolution emerges unavoidably from the notion of p-adic manifold based on cognitive maps mapping real preferred extremals of Kähler action to their p-adic counterparts and their inverses (see the appendix of the book). This map is defined only for a discrete set of rational points (also algebraic for algebraic extensions of p-adic numbers). A reasonable working hypothesis is that the preferred extremals in the quantum superpositions have same discretizations characterized by the resolution. An alternative working hypothesis is that they have same geometric correlation functions in the resolution used.

3. In particular, quantum jump typically implies the increase of the size scale of CD involved and the addition of tensor factors to the negentropically entangled structure representing self model and model for self + external world.

About the definition of consciousness

The notion of consciousness is rather fuzzy and there is large number of definitions of consciousness which emphasize some aspect of consciousness and neglect others. Revonsuo lists some definitions and discusses their failures.

1. Consciousness as the ability to respond to stimulation emphasizes the visible behavioral aspects of consciousness state (ability to respond to them). The problem is that pure reflex responses are not conscious-to-us and person can be fully paralyzed and still be fully conscious. Responsiveness would be better term than consciousness in this case.

2. Consciousness as the ability to represent information from the external world. This definition applies only to the representative part of conscious experience and one can imagine a person having phenomenal conscious but without ability to build cognitive representations. Living matter and also computers and even camera form representations about external world so that this ability obviously not complete characterization of consciousness.

3. Consciousness defined as wakefulness requires both awareness about self and environment and ability to respond to changes in the environment. Dream experiences represent the obvious objection now.

4. Consciousness as access to output systems, control of behavior or behavioral interactions with the world. Functionalists want to reduce consciousness to the existence of some input-output function and define consciousness as "access consciousness". Conscious information is information which can be represented verbally or realized as a motor response. This definition neglects completely the phenomenal aspects of consciousess and according to it computers are conscious.

All the definitions discussed by Revonsuo regard consciousness as a property of system. If this property is physical then consciousness becomes epiphenomenon without causal role. In TGD framework the identification of quantum jump as consciousness means that consciousness is not a property of physical world but something between two physical worlds.

4.6 Philosophical and empirical theories of consciousness

Revonsuo [J141] analyzes in detail selected philosophical and empirical theories of theories of consciousness demonstrating their problems.

4.6.1 Some philosophical theories of consciousness

Revonsuo discusses as examples of philosophical theories of consciousness.

- Multiple drafts theory [J63] (Dennett, see `http://en.wikipedia.org/wiki/Multiple_drafts_theory`),

- Sensorimotor theory [J132] (O'Regan and Noe, see `http://nivea.psycho.univ-paris5.fr/Synthese/MyinFinal.html`).

- Biological naturalism [J144] (Searle, see `http://en.wikipedia.org/wiki/Biological_naturalism`).

- Naturalistic dualism [J55] (Chalmers, see `http://en.wikipedia.org/wiki/David_Chalmers#Philosophy_of_mind`)

- Higher order theories of consciousness (HOTs) [J54] (entire industry).

- External representationalism [J157, J64] (Tye, Dretshke, see `http://en.wikipedia.org/wiki/Fred_Dretske`)).

- Neurophenomenology [J14, J159] (Varela, Lutz, Thompson, Noe, see `http://en.wikipedia.org/wiki/Neurophenomenology`).

- Reflexive monism [J160] (Velmans, see `http://en.wikipedia.org/wiki/Reflexive_monism`)).

- Virtual reality theory [J121, J126] (Metsinger, Lehar)). The book of Revonsuo gives a lot of references to these theories.

In the following some comments about these theories from TGD vantage point.

1. Dennett can be seen as eliminative materialist and functionalist. Dennett's theory denies qualia, phenomenal consciousness, and subjectivity - all that is usually counted as core elements of consciousness - and accepts only representational, narrative consciousness. Consciousness accompanies complex, parallel information processing system in this framework and complex enough computer is conscious in Dennett's Universe. "Multiple drafts" means that different streams of information are competing with each other to get access to output systems - or to gain fame in brain - as Dennett puts it. The compettiion for metabolic resources between sub-selves could correspond to this competition in TGD framework.

2. Sensorimotor theory of O'Regan and Noe defines consciousness as ways of acting or as something we do, rather as phenomenal experiences or internal representations. The relation to the external world becomes decisive. The conclusion is that consciousness does not involve brain activity at all so that the search for neural correlates of consciousness would be waste of time. Also the notion of phenomenal consciousness is rejected. There are obvious killer objections against sensorymotor theory. People who are totally paralyzed can still be conscious. Dreams - whose reality even very few philosophers are ready to deny - serve as a second killer objection against the theory.

3. Biological naturalism of Searle identifies consciousness as a biological phenomenon, a higher level emergent feature of brain activity. In accordance with the materialistic dogma conscious phenomena would be caused by the neurobiological properties of neuronal systems and consciousness has no causal powers. Subjectivity - first person ontology as philosopher would put it - is however accepted and not assumed to reduce to any objective neurophysiological phenomenon so that consciousness becomes more or less a miracle. The theory therefore assumes strong emergence as opposed to weak emergence meaning that consciousness can be explained using physics. The problem is that there is no ideas about the systems for which phenomenal consciousness should emerge.

   In TGD framework quantum jump would bring in subjectivity. Miracle like emergence is not needed and subjectivity is assigned with a basic process of quantum physics.

4. Chalmers is known for introducing the hard problem: How any physical system can product any experiential, qualitative states at all? Chalmers's naturalistic dualism is a dualistic theory which does not regard phenomenal experience as a part of the physical world but accepts it as an internal representation of information. Chalmers does not however postulate "eternal soul" as Descartes did. The consistency with the laws of physics forces to conclude that consciousness has no causal powers. Chalmers approach implies panpsychism: all physical systems have some kind of phenomenal consciousness.

   The solution of hard problem in TGD approch relies of the identification of quantum jump as moment of consciousness. Consciousness is not assigned with the state but with its change. Panpsychism is unavoidable and self hierarchy expresses this concretely. In TGD consistency with the laws of quantum physics is achieved and the more refined view about quantum jump allows to understand the basic sensory input-motor action sequence at various levels of self hierarchy.

5. In higher order theories (HOTs) consciousness is always reflective consciousness. Phenomenal consciousness is denied and all conscious experiences are representational (intentionality, aboutness, directedness). HOTs deny consciousness from all creatures no able to formulate higher order thoughts. Therefore infants and animals are doomed to be unconscious zombies in HOT universe.

   In TGD framework the negentropically entangled states defining abstractions and rules at various levels of hierarchy would define almost invariants about which interaction free measurements provide information. This conscious information would be the only kind of conscious information accepted in HOTs as conscious information.

6. Externalistic representationalism (Tye, Dretske) assumes that brain constructs only representations of inputs coming from the external world. Therefore also phenomenal aspects, qualia, are something in the external world and only represented in brain. Redness of rose is thus a property of rose, not something generated by the absorption of photons of certain wavelength in retina. The idea that the visual perception of distant galaxy would mean direct experiencing of its visual qualia seems rather strange - at least in the universe of standard physics. The question how the qualia of external world are represented in brain represents a difficult problem for externalistic representationalism.

   The idea that sensory qualia are in the external world looks rather weird in standard physics framework. In TGD framework qualia are assigned with sensory organs defining the boundary between internal and external world for a given CD. In TGD Universe consciousness is however not restricted to brain. The hierarchy of dark matter realized as phases with effective value of Planck constant coming as integer multiple of the ordinary Planck constant and residing at magnetic flux quanta makes macroscopic quantum coherence possible in arbitrarily long length and time scales so that it is quite possible to imagine that the contents of our conscious experience can contain contributions from quite long length and time scales.

   p-Adic space-time sheets have literally infinite size in real sense (this statement makes sense for common rationals and some common algebraic points) so that cognition is in TGD framework a cosmic phenomenon and only cognitive representations defined by the discrete intersections of real and p-adic space-time sheets are located inside CDs.

4.6.2   Some empirical theories of consciousness

Revonsuo discusses also current empirical theories of consciousness taking as examples the following theories.

- Global workspace theory [J38] (Baars, see `http://en.wikipedia.org/wiki/Global_workspace_theory`).

- Neurobiological theory [J60] (Crick and Koch, see `http://en.wikipedia.org/wiki/The_Astonishing_Hypothesis`).

- The dynamic core theory [J68] (Tononi and Edelman, see `http://en.wikipedia.org/wiki/A_Universe_of_Consciousness`).

- The integrated information theory [J156] (Tononi, see `http://en.wikipedia.org/wiki/Integrated_Information_Theory_(IIT)`).

- Thalamocortical binding theory [J123] (Llinas, see `http://en.wikipedia.org/wiki/Rodolfo_Llins`).

- Recurrent processing theory [J120] (Lamme, see `http://www.ini.unizh.ch/~peterk/Lectures/AttentionSeminar/Lamme.Tins.00.pdf`).

- Microconsciousness theory [J168] (Zeki, see `http://en.wikipedia.org/wiki/Semir_Zeki`).

- Consciousness as the feeling of what happens [J62] (Damasio, see `http://en.wikipedia.org/wiki/Damasio`).

In the following some TGD inspired comments about these theories.

1. The neurobiological theory introduced the hypothesis that 40 Hz frequency assignable to thalamocortical resonance (see `http://en.wikipedia.org/wiki/Recurrent_thalamo-cortical_resonance`) is fundamental for binding the conscious experiences. The motivation is that thalamus has dense net of bi-directional loops to cortex. It turned out later that this resonance is strong only when the objects of perceptive field are recognized.

   (a) A possible TGD inspired interpretation is based on the observation that negentropic entanglement is generated during the sensory perception as the sensory mental image or its representation at cortex negentropically entangles with the earlier sensory mental image or its cortical representation to form an updated memory representation. This stage could involve 40 Hz resonant interaction with the earlier stored sequence of sensory memories giving rise to the negentropic entanglement (the process is driven by NMP).

   (b) The experience of understanding that I earlier erratically assigned with negentropic entanglement (in conflict with NMP!) would be assigned with the *generation* of negentropic entanglement (in accordance with NMP!) and with the defining postulate of TGD inspired theory of consciousness. Revonsuo has performed an experiment which demonstrates that 40 Hz resonance appears when a random looking visual pattern consting of dots and short line segments is recognized to represent 3-D object but fades out after the recognition [J140]. The finding conforms with TGD based interpretation.

   (c) In TGD framework thalamus would suggest itself as a central self representing "me" having as sub-selves the negentropically entangled mental images assignable to cortex (reflective consciousness) and the sensory mental images assignable to various sensory organs (phenomenal consciousness).

2. Damasio's theory emphasizes the importance of emotions as a basic building brick of conscious experience. In TGD framework emotions are associated with negentropy: positive emotions correspond to negentropy gain and negative emotions to negentropy loss. NMP states that the information gain in state function reduction is maximal and is therefore analogous to second law and indeed implies for ordinary entanglement second law at the ensemble level [K49].

NMP suggests the analog of thermodynamics and even non-equilibrium thermodynamics for negentropic entanglement. In the presence of constraints on zero energy states (fixed average energy, particle number, etc..) this would imply existence of parameters analogous to temperature, pressure, etc..) so that the use of thermodynamical quantities as metaphors for the macro aspects of consciousness would have justification. In this picture emotions define a central element of experience.

4.6.3 Major issues of disagreement between theories

Revonsuo summarizes the two chapters by discussing the major issues of disagreement between theories of consciousness. These issues concern the location of consciousness (externalism vs. internalism), the fundamental nature of consciousness (phenomenology vs. cognition), and fundamental form of phenomenal consciousness (atomism vs. holism).

Internalism vs. externalism

Internalism and externalism are basic views about the location of phenomenal conscious experience.

1. Internalism assumes that the neurophysiological and functional state of the brain determines the contents of consciousness. It seems possible to understand the representational aspects of consciousness: brain decomposes sensory field to objects and gives them names represented as patterns of neuronal activity. The understanding of how phenomenal consciousness, qualia, is not so easy. The neurons look the same everywhere and it has not been possible to point out or even imagine how the the organizational structure of the neurons could give distinguish between say hearing, vision, and touch although they all carry geometric and dynamical information.

2. Externalism locates qualia in the external world and that brain only represents them. This option has been already discussed.

What happens in TGD Universe?

1. The first thing to observe is that in TGD framework it is not possible to locate consciousness anywhere: consciousness is in the quantum jump, between two zero energy states of the Universe. The contents of consciousness can be however localized and one could ask whether the seat for the contents of conscious experience is located inside or outside brain. Actually this is too limited formulation if one takes seriously the self hierarchy and the notion of magnetic body implying that brain alone is not the seat for the contents of consciousness in TGD Universe.

2. In TGD framework both internalism and externalism are both right and wrong: qualia are in the intersection of external and internal worlds defined appropriately. Sensory organs define examples about this kind of intersection but there is fractality involved. Also cell membranes can be seen as sensory organs. This picture follows from the basic assumptions of quantum TGD.

   (a) Strong form of general coordinate invariance implies strong form of holography. Already holography implies that space-time surfaces as carriers of geometric information provide classical space-time correlates associated with the light-like 3-surfaces representing the orbits of partonic 2-surfaces representing boundaries between space-time regions with Euclidian and Minkowskians signatures of the induced metric. By strong form of holography these partonic 2-surfaces and the 4-D tangent space data of space-time surface at them are enough to fix zero energy states: I call this effective 2-dimensionality.

   The partonic 2-surfaces have interpretation as boundaries of physical objects in all scales and they carry the quantum numbers and therefore also the quantum number increments are associated with them and therefore also phenomenal consciousness and qualia. The space-time regions of Minkowskian and Euclidian signature of induced

metric define the space-time correlates of "internal" and "external". The partonic 2-surfaces are therefore identifiable as seats of conscious experience. It is important to notice that there is entire fractal hierarchy of partonic 2-surfaces. Partonic 2-surfaces can be also connected by strings carrying fermion number and these string world sheets connect different partonic 2-surfaces: string oscillations define sound as a fundamental phenomenon and are behind hearing and internal speech as already proposed.

(b) Strong form of holography implies that partonic 2-surfaces and their 3-D orbits are very much like sensory organs which indeed define boundary between internal and external worlds. This motivates the assignment of qualia to sensory organs. The fractal generalization suggests that even elementary particles enjoy primitive phenomenal consciousness. p-Adic physics as physics of cognition suggests that even primitive cognition is associated with elementary particles.

This would elegantly solve the basic objection against internalism since qualia would indeed strongly correlate with their physical cause (oscillations of string like objects in 4-D space-time possibly underlying sound waves, photons and possibly also other masless bosonic quanta at various wave lengths underlying vision, physical touch having topological correlate in TGD Universe).

Phantom limb and dreams define the basic objections against this picture but it is possible to circumvent these objections if one accepts feedback from brain to sensory organs as virtual sensory input realized as dark photons travelling along magnetic flux tubes, and TGD based view about time allowing to interpret pain in non-existing limb as a sensory memory. Also erratic assignment of position to the actual pain somewhere else than non-existing limb can explain phantom pain. This kind of mis-assignments can be produced as illusions at the level of sensory representations.

(c) There is however a question to be answered. Space-time regions can have Euclidian or Minkowskian signature of the induced metric. Does holography hold for both and do the light-like 3-surfaces between them represent holographically both. For instance, can one assign the two representations two the two sides of this 3-surface and for strong form of holography to partonic 2-surfaces and the tangent space data at the two sides of space-like 3-surface at the boundary of CD?

Do these two representations define representations of internal qualia (virtual input from sensory representations) and external qualia (real input from external world)? Is the comparison of the virtual input generated by sensory representation with external input crucial in the construction of sensory representations: sensory representation is faithful only when these qualia are opposites of each other (when defined in terms of quantum number increments). One can get convinced about the reality of virtual qualia by swimming for some time in windy sea. At the beach the wave motion continues in the body and can make walking difficult.

Representational aspects of consciousness are usually identified as internal aspect localizable inside brain. In TGD framework the notion of magnetic body forces to challenge this assumption.

1. The representational states identified as negentropically entangled subsystems represent association patterns and also temporal sequences of association patterns. These tend to remain unchanged under the dynamics dictated by NMP and therefore represent information as quantum rules as superpositions of their instances. Interaction free measurement allows to get information about these representation without changing them since photon/phonon absorption represents the necessary change making this information conscious: these secondary qualia have representative role (black/white as value of bit). The representations for declarative memories, a model for external world, self model, predictions of future, plans for motor action and future,... : all this can be represented in terms of negentropically entangled states.

2. There is no reason to localize the representational states to sub-CDs inside brain although cognitive representations and naming of objects of perceptive field might be carried out by brain. The memories and plans of future (related by time reflection) could correspond to

something in their real time scale and at the level of magnetic bodies this would mean size scale of Earth (EEG as communication tool to magnetic body) and even light years! Also scaled variants of these representation are expected by fractality and these zoom-ups and zoom-downs defining "stories" might be one of the key features of intelligence.

3. In the case of cognition having p-adic space-time sheets as space-time correlates, it is impossible to locate even contents of consciousness to a finite space-time region in real sense. Cognitive representations consisting of common rational and possibly also some algebraic points of real and p-adic preferred extremals of Kähler action, can be however said to be located to a finite volume of space-time defined by causal diamond.

Phenomenology vs. cognition

As already noticed, in TGD Universe even representational consciousness reduces always to phenomenal consciousness. Imagination and internal speech represent our experiences about phenomenal consciousness at neuronal level and the representation - as we experience it - does not carry sensory qualia. Interaction free measurements make it possible to represent the aspects of quantum states which are invariant in the dynamics dictated by NMP as secondary qualia, say those assignable to photon absorptions. The interaction free measurement can be realized also in terms of sound waves with absorption of phonon replacing the absorption of photon. This could give rise to internal speech and eventually to written language. This suggests that neuronal vision *resp.* hearing is fundamental for imagination *resp.* internal speech. One can also wonder whether there exists a translation of the worlds of language to visual images.

Atomism vs. holism

Atomism postulates that conscious experience can be decomposed to fundamental building bricks defining "micro-consciousness" in the same sense as matter consists of elementary particles. Holism in turn assumes that the experience is holistic and does not have this kind of decomposition.

In TGD framework the presence of self hierarchy changes the situation. One has fractal hierarchy of levels of consciousness having length scale hierarchy of CDs as imbedding space correlate and p-adic length scale hierarchy as space-time sheets as space-time correlate. One can identify fundamental qualia as increments of quantum numbers dictated by the symmetries of TGD Universe. On the other hand, the geometric aspects of experience related to the patterns defined by subsystems of negentropically entanglement subsystems defining representative aspects of consciousness do not reduce to fundamental qualia.

4.6.4 Common beliefs consciousness theories from TGD point of view

It seems that most theories of consciousness agree in some key aspects.

1. Brain serves as a seat of consciousness including phenomenal experience in the case that qualia and phenomenal experience are accepted at all as something real. The causal powers of consciousness are denied since in the ontology inspired by classical physics this would lead to difficulties.

   In TGD framework the situation is different. Brain is the seat of sensory and cognitive representations whereas phenomenal consciousness can be assigned with sensory organs. Qualia can be assigned to quantum number increments associated with quantum jump and sensory representations become conscious via secondary qualia realized as internal speech and imagination.

2. The privacy of consciousness seems to be accepted as something totally obvious. This has been formulated as question "What it feels to be a bat" claimed to have no answer.

   In TGD framework self hierarchy and the notion of magnetic body (field body) encourages to give up the belief on privacy of consciousness. Magnetic flux tubes are identified as space-time correlates for attention binding some parts of the systems connected in this manner to single quantum system so that sharing of mental images becomes possible: therefore the claim that it is not possible to feel what it is to be a bat might be wrong in TGD Universe.

For a scientists it is of course very difficult to take seriously the claim that shaman could directly experience what it is to be a bear: maybe scientist should be ready to reconsider their belief system in this respect.

4.7   Disorders of consciousness

Revonsuo [J141] discusses also various disorders of consciousness typically associated with representative and reflective aspects of consciousness. These disorders pose strong constraints on the theories of consciousness.

In TGD framework the generation of negentropic engtanglement (directed attention) is the basic mechanism making possible the updating of memory representations. If this mechanism fails, the outcome is a disorder explaining various neuropsychological deficits of consciousness and neurophysiological dissociation of consciousness from behavior. Failure to generate negentropic entanglement at all or generation of the negentropic entanglement with wrong memory representation would be the basic reasons for disorders. At physiological level ATP$\rightarrow$ ADP transition generates flux tube connections giving rise to negentropic entanglement so that the problem could reduce to dysfunction at this level.

4.7.1   Neuropsychological deficits of visual consciousness

The first kind of anomalies discussed by Revonsuo are neuropsychological deficits of visual consciousness. Examples of this kind of deficits are visual agnosia: loss of coherent visual objets, semantic dementia: loss of the meaning of objects, asimultangnosia: loss of the phenomenal background, neglect: loss of phenomenal space, and akinetopsia: loss of visual animation.

These anomalies clearly demonstrate the modular character of the information processing in brain. In TGD framework this corresponds to negentropic entanglement for systems representing various components of experience and represenging abstract rules. Neurophysiological deficit could imply that some component is missing (say emotional component giving meaning to the objects in semantic dementia or component represring phenomenal background). Second possibility is that the components are not at all organized to form a negentropically entangled tensor product (visual agnosia).

Loss of visual animation could mean that the sequence of negentropically entangled sub-CDs (time-like entanglement) representing the posittion of object in space has too low temporal resolution. In other words visual mental images are updated with too low frequency. The resolution needed to experience discrete sequence of imagines as a continuous motion corresponds to at least 50 Hz frequency for visual mental images.

4.7.2   Neuropsychological dissociations of visual consciousness from behavior

Second kind of anomalies correspond to neuropsychological dissociations of visual consciousness from behavior. Examples are blind sight, implicitly visually guided action, implicit face recognition in prosopagnosia, implicit recognition of words and objects in neglect. In most theories of consciousness self hierarchy has only one-level so that the only interpretation is that there is an appropriate zombie represent making possible these dissociations but carrying the information needed for the action in question. In TGD framework also this information would be conscious albeit not conscious-to-us.

1. Consider first the dissociation from of sensory consciousness from motor action. As described above, ZEO more or less forces to conclude that for given CD there are two "mes" corresponding to lower and upper boundary of CD and they correspond to sensory me and motor me for which motor action is time reversed sensory perception. Thus the motor me, I_m, could enjoy time reversed sensory consciousness.

2. The minimal option is that the dissociated sub-self is present but does not entangle negentropically to the sub-self system of "me" representing memory mental images. Sensory "me" I_s would have sensory qualia but since it does not attend to the target of perceptive field

would not remember anything about it. I_m would have not only the time reversed sensory qualia and they would also negentropically entangle with time reversed memory representations defining plans and volitions. This would mean that motor actions using sensory information would be possible.

A person suffering from blind vision (cortical blindness is not in question) reports that she is unable to see consciously but her visual areas are intact and she demonstrates the access to visual information via successful motor activities. It could be that person has still retinal vision but this phenomenal visual images do not negentropically entangle with cortical representations so that there are no conscious visual qualia or remembered visual qualia.

The proposed picture suggests that both the sensory I_s and motor "me" I_m assignable to sub-CDs in a time scale of say .1 seconds could have phenomenal vision. Only I_m could however build sensory representations consistent with incoming information (containing also the retina level representation in the tensor product). As mental images of CD these representations would correspond to volitions, decisions, and plans: this information would be enough for coherent motor activities.

The unability to recognize faces could be due to the fact that the name of person represented as sub-CD is not negentropically entangled with the collection of visual mental images representing the face. Same applies to inability to recognize words and objects. Implicit recognition however occurs and manifests itself in measured changes of skin conductance. This would suggest that emotional response is still present and realized as negentropic entanglement of the visual sub-CD with emotional sub-CD and expressing itself motorially as change a in skin conductance. The change of skin conductance would therefore be neurophysical correlate for time reversed sensory input.

4.7.3 Neuropsychological disorders of self-awareness

Neuropsychological disorders of self-awareness represent third kind of anomalies of consciousenss discussed by Revonsuo and include amnesia, split-brain state, anosognosia, asomatognosia, and deficits of belief systems (delusions). An interesting observation is that left-hemisphere acts as a rationalizing interpreter capable of amazing self deceptions and right hemisphere takes the role devil's advocate.

1. In the case of amnesia the patient lives in eternal now but can remember the events before he became amnesic. Hippocampus seems to be at least partially responsible for constructing memories so that either memory construction or memory recall fails for these memories. One possibility is that for some reason the sensory mental images representing personal history are not anymore negentropically entangled in time direction so that self model is not updated. An alternative, but perhaps not so plausible, explanation is that the interaction free measurement reading these mental images fails for some reason.

2. Split-brain state is artificially induced by splitting the corpus callosum. In this state patient behaves as had possessed two separate selves, which can have conflicting future plans, desires, and actions. This seems to be in strong conflict with standard views about consciousness but if one accepts self-hierarchy this is just what is expected. Corpus callosum would entangle the different brain hemispheres to single unit.

   The non-trivial topology of TGD space-time makes also sharing of mental images possible since two unentangled selves can have entangled sub-selves. This corresponds to a situation in which one has two space-time sheets which are disjoint but there are smaller space-time sheets (sub-selves) topologically condensed on them and connected by flux tubes. In the appropriate resolution the larger space-time sheets are un-entangled whereas smaller space-time sheets in their own and better resolution are entangled.

3. In the case of asognonosia thr patient has some deficit but is not conscious about it, and fabulates all kinds of explanations for why the deficit manifests itself in this behavior. The deficit could be paralysis, cortical blindness, neglect of second half of perceptive field, or something else. The simplest explanation is that the self-model is not updated so that basically a failure of negentropic tensor producting would be in question.

A cortically blind person suffering Anton's syndrome claims that he sees. If qualia are seated at sensory organs, person could have genuine visual qualia if the retina is intact. Flawless sensory representations are necessary for a successful motor action since the zero energy state resulting in motor action is obtained by state function reduction from the zero energy state defining sensory and memory representations. Therefore the loss of appropriate cortical visual representations would make person effectively blind even if phenomenal vision is intact.

Patient can also suffer from paralysis and refuse to admit that something is wrong. Besides the general explanation one could also consider the possibility that motor representations still contain the lowest level as time reversed sensory representation. This explanation would be analogous to that for Anton's syndrome.

4. In asomatognosis person denies the possession of part of his own body. Also this disorder could be understood if the representation of that part of body is not negentropically entangled with representations of other parts of the body.

4.8   Altered states of consciousness

Revonsuo [J141] devotes three chapters to altered states of consciousness (ASC) discussing dreaming and sleep as ASCs, hypnosis as a candidate for ASC and higher states of consciousness as ASCs.

4.8.1   Dreaming and sleep as ASC

The first chapter about ASCs is devoted to dreaming and sleep as altered states of consciousness. Hypnagogic and hypnopompic hallucinations, sleep paralysis, sleep mentation vs. dreaming, the contents of dreaming, lucid dreaming, bad dreams and nightmares, night terrors, sleepwalking and nocturnal wander, and sleep behavior disorder and dreamwalking are the titles of the sections and give a good overall view about topics discussed.

In preceding sections I have already discussed TGD view about dreams as virtual sensory experiences generated by the input from brain or even magnetic body to the sensory organs, which in TGD Universe serve naturally as seats for the contents of phenomenal experiences. This interpretation distinguishes TGD from the competing theories of consciousness.

4.8.2   Hypnosis

Second chapter about ASCs is devoted to hypnosis as a possible candidate for ASC and discussed hypnotic induction and hypnotic suggestivity.

Hypnosis can be seen as a challenge to the cherished belief about the privacy of consciousness. Hypnotist and subject person indeed seem to form a larger coherent unit in which the motor system of the subject person becomes effectively part of the motor system of hypnotist. Hypnotist can also induce suggestions giving rise to sensory experiences what could be regarded as hallucinations, perhaps by inducing virtual sensory inputs, which also can be seen as motor actions in very general sense. The formation of negentropic entanglement by the generation of magnetic flux tubes connecting the subject person and hypnotist would be part of the TGD based model. This would allow the hypnotist to negentropically entangle with the self model of the subject at highest level and realize his volitions using the motor system of the subject person [?].

4.8.3   Higher states of consciousness

The third chapter devoted to ASCs is about higher states of consciousness: meditation, optimal experience and flow, runner's high, OBEs, NDEs, and mystical experiences. In several experiences of this kind sensory input and motor activity contribute minimally to the conscious experience. Typical for OBEs is that person sees his own body from third person perspective.

Remark: Besides genuine OBE like experiences I have personally had also OBE like experiences in which I see my body in somewhat surreal perspective and find myself floating in the roof and thinking hardly for possible tests whether I am really levitating.

OBEs and in particular NDEs obviously challenge the belief that brain alone is the seat of consciousness. Therefore it is not surprising that both OBEs and NDEs are labelled as pathological in materialistic approach to consciousness (or what is left from it after application of the basic dogmas). It is of course possible that this kind of conscious experiences become possible under some brain disorders such as epilepsy.

The explanation of NDE as a kind of final activity of a dying brain looks rather artificial: especially so because these experiences are highly structured and coherent and rather universal rather than being chaotic as one might expect if the state of consciousness corresponds directly to the state of brain as materialistic dogma states.

OBEs and NDEs

TGD suggests the following approach to OBEs [K87] and NDEs.

1. The notion of magnetic body (bringing in mind the "aether body" of the esoteric teachings) could have central role in TGD inspired quantum biology and neuroscience, and especially so in the explanation of OBEs and NDEs. EEG and its scaled variants would provide control and communication tool for the magnetic body and also lower frequencies than those appearing in EEG could be involved so that the flat EEG during NDEs would reflect only the absence of sensorimotor activities.

2. The highest level sensory representations would be naturally realized at magnetic body and give rise to sensory representations about biological body and even its environment and in this manner give rise to the third person aspect of consciousness. If this is the case, one could understand how it is possible to see own biological body as an outsider during OBEs and NDEs.

   The representations at the magnetic body could in turn generate virtual sensory input as a feedback down to the level of sensory organs also in the ordinary wake-up consciousness as a check that these representations are consistent with the sensory input. The mechanism for generating the sensory input as dark photons and perhaps also dark phonons has been already suggested in the discussion of interaction free measurement as a manner to read memory representations.

3. This model is consistent with the correlation of these experiences with the epileptic seizures. Epileptic seizure could lead to a failure to communicate sensory data to the magnetic body by EEG and also to a failure to receive signals from the magnetic body reflecting itself as chaotic motor activities. Therefore the contribution of magnetic body and third person perspective would dominates the experience.

4. One can argue that in absence of sensory input and motor activity, and perhaps even neural activity (EEG in many NDEs is flat) the contribution of the magnetic body to the conscious experience dominates. Magnetic body could provide the virtual sensory input even during ordinary dreams and dreams might be seen as a kind of simulation of the external world by virtual input from the magnetic body and as brain level interpretation for what possibly happens at the level of the magnetic body. Also motor actions could be simulated as motor actions of the magnetic body. Maybe purely mental image exercises known to have genuine effect on motor skills could be interpreted as motor exercises performed by magnetic body!

5. Also some illusions such as moving train illusion (the sensation that the stationary train in which person is sitting moves induced by a train passign by) could be understood as resulting from the motion of personal magnetic body relative to the biological body. The moving train catching the attention of the subject person (recall the proposal that attention has magnetic flux tubes as a correlate) would anchor the magnetic body of the subject person to its rest system.

6. The unpleasant sensation of falling down near a precipice could be due to the imagined falling down. It would be magnetic body which represents the falling down and its acceleration with respect to the biological body generates the sensation. Magnetic body quite generally simulate the motion of biological body and the discrepancy between the simulation and real

motion of biological body would generate a conscious experience. If the simulation is ideal, no conscious experience would be generated. This would allow to understand why the learned skill becomes unconscious routine. Similar simulations would take place already in the case of sensory input as already proposed. If time reversal relates motor activity and sensory perception, this kind of symmetry is very natural.

Mystical states

The third chapter about ASCs is about mystical states. Mystical experiences have often long-lasting effects on the life of the experiencer as increased spontaneity and courage to choose one's own way to live. Typically it is difficult to express verbally the contents of experience: for instance, the writings of Krishnamurti emphasize this. I have had some spontaneous mystical experiences of my own, and in the following I will take the liberty to insert remarks about them to the nice summary of Revonsuo about emotional, cognitive and perceptive aspects of mystical stats.

- Emotionally mystical states are highly positive: peace, calmness, harmony, love, joy, awe, bliss are the words used to characterize the emotional state. The realization that everything in the Universe has a deep hidden meaning makes these experiences so special. Universe is experienced a a holy place, not at all that dirty world of everyday experience.

- Mystical states involve the experience of deep understanding of underlying principles of existence and direct answers to deep questions about life and existence. Dramatic expansion of consciousness to even cosmic consciousness is also reported. There is also a direct experience about hierarchical structure of conscious existence and about communication with higher levels of the hierarchy. In religious experiences God represents one (in monoteistic religions often the only accepted) higher level in the hierarchy.

  Remark: In my own mystical experiences I had deep experience of understanding but without knowing what it was that I understood. In the light of afterwisdom the ideas that I became conscious of during these experiences for almost three decades ago could be interpreted as precognitions about some basic ideas of TGD and TGD inspired theory of consciousness.

- Mystical states are also accompanied by a heightened sensory consciousness. The world looks extremely bright, clear, brilliant, colorful, and pure.

  Remark: My own experiences began with the increase of the experienced intensity of the sounds from environment.

- *Remark*: The experience about own body can change dramatically. The usual unpleasant sensory noise suddenly disappears and the entire body ends up to what might be called fluid like state: experience is akin to the sensation localizable to spine that music sometimes creates. In my own case this was actually the beginning of the experience.

- Enlightment experiences are regarded as the highest form of mystic experience and involves the experience timelessness, emptiness, liberation from all attachments, and the realization that even self is an illusion.

Could one say something interesting about these experiences in TGD framework?

1. The experience about hierarchical structure of consciousness is certainly consistent with TGD view which however derives from the mathematical structure of the theory (fractal hierarchy of quantum jumps) rather than being assumed on basis of my personal mystical experiences.

2. The generation of negentropic entanglement should be accompanied by the experience of understanding and the large increase in the size of personal CD could generate large amount of negentropic entanglement. This could also explain the strongly positive emotional coloring of the experiences in general. The experience of understanding would mean genuine understanding but perhaps at levels remaining unconscious or indescribable using the existing tools of language.

3. The generation of negentropic entanglement (see fig. `http://www.tgdtheory.fi/appfigures/cat.jpg` or fig. 21 in the appendix of this book) at the scales of biological body leading to enhanced quantum coherence could create the dramatic change in the experience about own body.

4. The personal magnetic body could be significant in mystic experiences. A phase transition increasing $\hbar_{eff}$ could scale up the size of some parts of the magnetic body. Reconnection mechanism could make possible fusion of the magnetic body with other magnetic bodies: this could relate to the sensation of becoming one with the external world and disappearance of separations. Krishnamurti has beautifully described the experience of becoming the people around him. Also t this experience challenges the belief on absolute privacy of consciousness.

5. The hierarchy of quantum jumps assignable to the hierarchy of CDs with various scales is basic prediction of TGD inspired theory of consciousness. The characteristic time scale of long term memories and planned action and size scale of the perceptive field are natural characteristics for the level of self in self hierarchy. Mystic experiences could correspond to a state function reduction leading to an especially large average size scale of CDs involved in quantum superposition of zero energy state representing "me". This would mean higher abstraction level and large. A phase transition leading to an exceptionally large increase of the effective Planck constant $\hbar_{eff}$ scaling up the size of CD is a good guess for what might happen.

6. Could one find quantum correlate for the experience of understanding without any mental images and without knowing what it is that one understands? This seems to be the case on both reported and my personal experiences. Hence I am forced to ask whether the invariants defined by various representations could be experienced directly in absence of the memories generated by interaction free measurements and giving rise to cognition. The "Akashic records" defined by the negentropically entangled representations would be the counterpart for this wisdom, which can be only felt but not expressed using language or pictures. Accepting this would force to give up the hypothesis that the change in quantum jump alone contributes to conscious experience: also what remains invariant in quantum jump would do so.

Part II

QUANTUM BIOLOGY IN TGD UNIVERSE

Chapter 5

Quantum Mind, Magnetic Body, and Biological Body

5.1 Introduction

Quantum biology-rather than only quantum brain- is an essential element of Quantum Mind in TGD Universe. Cells, biomolecules, and even elementary particles are conscious entities and the biological evolution is evolution of consciousness so that it would be very artificial to restrict the discussion to brain, neurons, or microtubules. The basic new physics inspired ideas behind TGD inspired quantum biology have been discussed already in the first article but deserve to be listed.

The article is devoted to some applications of TGD inspired view about Quantum Mind to biology. Magnetic body carrying dark matter and forming an onion-like structure with layers characterized by large values of Planck constant is the key concept. Magnetic body is identified as intentional agent using biological body as sensory receptor and motor instrument. EEG and its fractal variants are identified as a communication and control tool of the magnetic body and a fractal hierarchy of analogs of EEG is predicted. Living system is identified as a kind of Indra's net with biomolecules representing the nodes of the net and magnetic flux tubes connections between then. The reconnection of magnetic flux tubes and phase transitions changing Planck constant and therefore the lengths of the magnetic flux tubes are identified as basic mechanisms behind DNA replication and analogous processes and also behind the phase transitions associated with the gel phase in cell interior. The braiding of magnetic flux makes possible universal memory representation recording the motions of the basic units connected by flux tubes. Braiding also defines topological quantum computer programs updated continually by the flows of the basic units. The model of DNA as topological quantum computer is discussed as an application.

In the following I briefly summarize some applications to quantum biology. I am of course forced to leave details to the books about TGD inspired theory of consciousness and quantum biology at my homepage [K88, K11, K62, K35, K10, K42, K46, K81].

1. A vision about relationship between information processing and metabolism in TGD Universe is represented.

   (a) The already existing ideas include the notion of time mirror mechanism as a manner to realized intentional action, memory recall, and remote metabolism by sending negative energy photons to geometric past where some system able to absorb them exists. The proposal is that the utilization of ATP is also possible in this manner: this quantum credit card would make living matter extremely flexible since instantaneous reaction to changing circumstances would become possible. Many-sheeted space-time inspires the idea that the dropping of particles, in particular electrons and protons, to larger space-time sheets liberates metabolic energy. This mechanism would provide universal metabolic currencies and also ATP-ADP might be based on it.

   (b) The new idea is that the presence of ATP at magnetic flux tube is a necessary prerequisite for negentropic entanglement between its ends. ATP could be seen as a molecule of

consciousness in this picture and high energy phosphate bond would be replaced with a state involving negentropic entanglement. There is also a connection with the model of living matter as quantum computer.

(c) A possible modification of second law to take into account negentropic entanglement is discussed. The pessimistic modification states that genuine islands of negentropy can be generated rather than islands in which entropy is very small. The generation of negentropy is however always accompanied by compensating generation of entropy. A possible interpretation is that the eventual reduction of negentropic entanglement in state function reduction generates this entropy at ensemble level.

2. TGD approach to living matter was strongly motivated by the findings about strange behavior of cell membrane and of cellular water, and gel behavior of cytoplasm. These findings are briefly discussed in TGD framework by bringing in magnetic flux tubes as a new element.

3. Water is in key role in living matter and TGD inspired view about water and various anomalies related to the physics of water are also discussed.

The appendix of the book gives a summary about basic concepts of TGD with illustrations. There are concept maps about topics related to the contents of the chapter prepared using CMAP realized as html files. Links to all CMAP files can be found at `http://www.tgdtheory.fi/cmaphtml.html` [L35]. Pdf representation of same files serving as a kind of glossary can be found at `http://www.tgdtheory.fi/tgdglossary.pdf` [L36]. The topics relevant to this chapter are given by the following list.

- Magnetic body [L52]

- Basic Mechanisms associated with magnetic body [L39]

- Hierarchy of Planck constants [L50]

- Negentropy Maximization Principle [L54]

- Bio-anomalies [L41]

- Biophotons [L42]

- Cell membrane anomalies [L44]

- DC currents of Becker [L46]

- ELF effects on brain [L47]

- Microtubules [L53]

- Pollack's observations [L56]

5.2 Quantum mind and magnetic body

The notion of magnetic/field body (see fig. `http://www.tgdtheory.fi/appfigures/fluxquant.jpg` or fig. 17 in the appendix of this book) is probably the feature of TGD inspired theory of quantum biology which probably creates strongest irritation in standard model physicist. A ridicule as some kind of Mesmerism might be the probable reaction. The notion of magnetic/field body has however gradually gained more and more support and it is now an essential element of TGD based view about living matter. In the following I discuss the basic applications in the hope that the overall coherency of the picture might force some readers to take this notion seriously. The notion of magnetic body leads to a dramatic modification of the views about functions of brain and biological systems in general. I will talk mostly about magnetic body although it is clear that field body has also electric parts (electric flux quanta with cell membrane and various electrets populating living matter) as well as radiative parts realized in terms of "massless extremals" or topological light rays [K56] providing correlates for EEG and its fractal analogs.

5.2.1 Living matter as ordinary matter controlled by dark matter at magnetic bodies

The notions of many-sheeted space-time, topological field quantization, and magnetic body were in a key role in the model of living matter as a macroscopic quantum system. It was assumed that space-time sheets are not at thermal equilibrium and that the space-time sheets responsible for the macroscopic quantum coherence are at very low temperature. See the articleBiosystems as macroscopic quantum systems [L1] and figs. **??,??, ??, ??**, `http://www.tgdtheory.fi/appfigures/reconnect2.jpg` or fig. 19, fluxtubedynamics in the appendix of this book.

1. Libet's findings and the model of memory based on time mirror hypothesis suggests that magnetic body is indeed needed. What is the real function of magnetic body? Is it just a sensory canvas? The previous considerations suggest that it is also the seat of geometric qualia, in particular the pitch of sound should be coded by it. It would be relatively easy to understand magnetic body as a relatively passive sensory perceiver defining sensory map. If one assumes that motor action is like time reversed sensory perception then sensory and motor pathways would be just sensory pathways proceeding in opposite time directions from receptors to the various layers of the magnetic body. Brain would perform the information processing.

   Certainly there must exist a region in which the motor and sensory parts of the magnetic body interact. What comes in mind is that these space-time sheets (or actually pairs of space-time sheets) are parallel and generate wormhole contacts between them. This interaction would be assignable to the region of the magnetic body could receive positive energy signals from associative sensory areas and send negative energy signals to motor motor neurons at the ends of motor pathways wherefrom they would propagate to premotor cortex, supplementary motor cortex and to frontal lobes where the abstract plans about motor actions are generated.

2. The hierarchy of Planck constants and identification of dark matter as phases with non-standard value of Planck constant makes it possible to give up the assumption about low temperatures at flux quanta. Dark matter becomes the key notion in the quantum controller of ordinary matter in living matter. The large value of Planck constant - integer multiple of standard value- scales up quantum lengths since typically they are proportional to $\hbar$ and scales the quantum coherence lengths and times. This also scales the energy $E = hf$ associated with a photon with given frequency. This allows to understand the quantal effects of ELF em fields to vertebrate brain.

3. Large Planck constant means that quantum length scales such as Compton length are scaled up. This makes possible macroscopic quantum coherence and non-locality. Magnetic flux tubes are identified as carriers of dark matter with non-standard value of Planck constant.

4. The ideas about the role of magnetic flux quanta have evolved considerably. It is natural to assume that magnetic flux tubes carry macroscopic quantum phases of dark matter. The phase transitions changing Planck constant reduce or increase the length of the flux tube and could be responsible for the dramatic volume changes of cytoplasm. The reconnections of magnetic flux tubes make possible dynamics for the topology of the web formed by magnetic flux tubes. ATP-ADP process can be associated with this kind of reconnection process. The braiding of magnetic flux tubes makes possible topological quantum computations and DNA and lipid layers of cell membrane form an ideal hardware for topological quantum computer with braiding of flux tubes connecting lipid layers with DNA nucleotides defining the TQC programs. Braiding provides also a universal memory storage mechanism since liquid flow induces braiding of the particle in the flow. Lipid layers of cell membrane are indeed liquid crystals so that their flows update quantum computer programs coded by space-like braiding.

5. Living matter would be ordinary matter controlled by the dark manner at the "magnetic body" of the system and. magnetic flux tubes and sheets act as carriers of dark matter. Phase transitions changing the value of Planck constant induce contractions or lengthenings of the flux tubes and would be key mechanism in the volume changing phase transitions in living matter. Reconnection process for the flux tubes is second mechanism and ATP-ADP mechanism would involve basically the reconnection which would in quantum computer

inspired picture mean formation of a link to and address in memory. Braiding of flux tubes makes possible topological quantum computation. For details see the chapters Macroscopic quantum coherence and metabolism as different sides of the same coin [K39]. DNA as topological quantum computer [K23].

Dark Matter Hierarchy and Hierarchy of EEGs. [K20]. TGD Based View about Classical Fields in Relation to Consciousness Theory and Quantum Biology. Quantum model for bio-superconductivity. [**?**] [K66].

5.2.2 Magnetic body as intentional agent and experiencer

In TGD Universe brain would be basically a builder of symbolic representations assigning a meaning to the sensory input by decomposing sensory field to objects and making possible effective motor control by magnetic body containing dark matter. A concrete model for how magnetic controls biological body and receives information from it is discussed in the model for the nerve pulse [K66] and for the hierarchy of EEGs [K20, K69].

Also magnetic body could have sensory qualia, which should be in a well-defined sense more refined than ordinary sensory qualia [K32]. The quantum number increments associated with cyclotron phase transitions of dark ion cyclotron condensates at magnetic body could relate to the cognitive and possibly also emotional content of sensory input and would indeed have interpretation as higher level sensory qualia. On the other hand, the positive/negative emotional coloring itself might be the core of what it is to be emotion and most naturally relates to the sign of negentropy increment in quantum jump so that it would not be a quale in the sense that visual colors are.

Right brain sings – left brain talks metaphor could characterize this emotional-cognitive (holistic-reductionistic) distinction for higher level qualia and would correspond to coding of sensory input from brain by frequency patterns *resp.* temporal patterns (analogs of phonemes). Fourier analysis indeed transforms local data into holistic data.

These qualia could be seen as somatosensory qualia at the level of magnetic body. One must be however cautious with interpretations. It is not all obvious whether the qualia should be assigned with body alone or magnetic body alone or both. Out of body experiences and various illusions such as train illusion and the disgusting sensation about falling when one is near the edge of cliff could be virtual world experiences resulting from the relative motion of the magnetic body with respect to the biological body: the sensory sensation would correspond to to the interference effects for dark photon radiation between the biological body and magnetic body [K87].

TGD framework fundamental qualia are associated with sensory receptors although also neuronal qualia are possible. The new view about time allows to overcome the arguments suggesting that qualia must be solely at the level of brain (say the pain in phantom limb).

Remote mental interactions between magnetic body and biological body are a key element of this picture. Remote mental interactions in the usual sense of the world would occur between magnetic body and some other, not necessary biological, body. This would include receival of sensory input from and motor control of other than own body. Also inanimate matter (no negentropic entanglement) possesses magnetic bodies (so that also psychokinesis could be based on the same mechanism). Magnetic body for which dissipation is much smaller than for ordinary matter (proportional to $1/\hbar$), could continue its conscious existence after biological death and find another biological body and use it as a tool of sensory perception and intentional action.

5.2.3 Time mirror mechanism can be seen as the basic mechanism of memory, intentional action, and metabolism

It means sending negative energy signal propagating backwards in time and ZEO gives precise meaning for this notion.

1. Memory recall in the case of symbolic memories would correspond to sending of negative energy signal to geometric past. The signal would be reflected as positive energy signal. An alternative possibility is that time-like entanglement is generated. This mechanism would make it un-necessary to store memories again and again. The proposed model for the recent finding that memory code with six bits might make sense suggests that metabolism is necessarily involved. The negative energy quantum absorbed in geometric past transforms ATP

to ADP and deletes the conscious memory item but creates it again in the geometric now. This would conform with no-cloning theorem.

2. Sending of negative energy signals to a system serving as energy storage to generate metabolic energy as a recoil makes possible an extremely flexible quantum credit card in living matter. This kind of flexibility is extremely useful in circumstances requiring very rapid reactions.

3. Motor actions could be regarded as realizations of intentions using negative energy signals propagating to the direction of geometric past. This hypothesis would explain the strange finding of Libet that conscious decision in volitional action seems to occur later than the neural activity initiating the motor action. One could argue that the free will aspect of motor actions does not conform with the interpretation as sensory perception in reversed direction of time. On the other hand, also percepts are selected -say in binocular rivalry [J69] . Only single alternative percept need to be realized in a given branch of the multiverse. This makes possible metabolic economy: for instance, the synchronous firing at kHz frequency serving as a correlate for the conscious percept requires a lot of energy since dark photons at kHz frequency have energies above thermal threshold. Similar selection of percepts could occur also at the level of sensory receptors but quantum statistical determinism would guarantee reliable perception. The passivity of sensory perception and activity of motor activity would reflect the breaking of the arrow of time if this interpretation is correct.

5.2.4 Biosystems as conscious holograms

The notion of conscious hologram is TGD based generalization of the idea about brain as a hologram. In nutshell, the notion of conscious hologram follows from the topological field quantization. Classical fields and matter form a Feynman diagram like structure consisting of lines representing matter (say charged particles) and bosons (say photons). The matter lines are replaced by space-time sheets representing matter (elementary particles, atoms, molecules,...), and virtual bosons are replaced by topological light rays ("mass-less extremals", MEs). Also magnetic flux tubes appear and together with MEs they serve as correlates for bound state quantum entanglement.

The internal lines of the Feynman diagram are analogous to wave guides and the classical fields and coherent light propagating along these wave guides interfere at the space-time sheets representing the vertices of the Feynman diagram and the "points" of the conscious hologram. The formation of the hologram corresponds to the self-organization induced by the leakage of supra currents to smaller (say atomic) space-time sheets. This leakage is induced by the high frequency MEs propagating along low frequency MEs serving as correlates for quantum entanglement. The 3-D stereovision associated with ordinary hologram is generalized to stereo consciousness resulting, when the mental images associated with different 'points' of conscious hologram fuse to single mental image. Central nervous system can be regarded as a conscious hologram of this kind.

Time mirror mechanism (see fig. `http://www.tgdtheory.fi/appfigures/timemirror.jpg` or fig. 24 in the appendix of this book) is a key element of intentional action. The notion of four-wave interaction generalizes: the interference pattern of oppositely moving reference waves forming an archetypal standing wave (possibly moving as in case of nerve pulse) can be replaced by any synchronously oscillating periodic spatial pattern. Plasma waves for which the frequency does not depend on wave vector are ideal candidates for holograms in the generalized sense. Living matter is full of this kid of holograms: besides plasma oscillations associated with biologically important ions, also Z^0 plasma oscillations associated with atoms and molecules can define holograms. p-Adic length scale hypothesis predicts a hierarchy of plasma frequencies related by powers $2^{3k/4}$ so that even so called "non-living matter" could build this kind of sensory representations based on plasma oscillations.

p-Adic length scale hypothesis and dark matter hierarchy allow to quantify the notion of conscious hologram. The hierarchy of generalized EEGs associated with the dark matter hierarchy allows to propose concrete mechanism of remote mental interactions playing a key role also in the interaction of magnetic bodies with the biological body. Experimental findings related to anomalous pre-cognition support the view that even galactic magnetosphere acts as a conscious entity receiving sensory input from bio-sphere and controlling it.

Bio-photons provide an application of the general theory. Simple mathematical facts about the delayed luminescence induced by an external perturbation combined with the model for a hierarchy

of dark EEGs assignable to that of Josephson junctions, lead to a model in which positive and negative energy MEs transversal to DNA strand and representing dark photons generate coherent bio-photons via de-coherence. Rather detailed quantitative models for how MEs and supra current circuits interact and how bio-photons are generated during the gene expression emerge.

Peter Gariaev and his group have discovered a radio wave emission from DNA induced by laser light. The model explaining delayed luminescence covers also this phenomenon: now the decay of dark photons with energies above thermal threshold to radio-wave photons rather than de-coherence would be the mechanism. The findings allow an explanation in terms of a many-sheeted laser action, and a rather detailed view about how bio–system acts as a many-sheeted laser at a wide wave-length range emerges.

William Tiller in Stanford University has carried out impressive experimental work with what he calls intention imprinted electronic devices (IIED), and his results challenge that standard assumption that the intentions of experimenter do not affect the experimental apparatus. The analysis of the work of Tiller in the conceptual framework of TGD leads to the conclusion that four-wave interaction, which is a basic mechanism to produce phase conjugate waves (negative energy topological light rays), serves also as a basic mechanism of intentional action. This leads to a unified view allowing to see EEG and nerve pulse as a particular realization of four-wave interaction.

5.2.5 High T_c superconductivity in living matter

The TGD inspired model for high T_c super-conductivity as quantum critical phenomenon is developed. The relies on the notions of quantum criticality, dynamical quantized Planck constant requiring a generalization of the 8-D imbedding space to a book like structure, and many-sheeted space-time. In particular, the notion of magnetic flux tube as a carrier of supra current of central concept.

The model of super-conductivity

The model for generalized EEG relates very closely to the general model of high T_c superconductivity. This motivates a separate discussion of the vision about bio-super-conductivity in TGD Universe.

1. General mechanisms of bio-superconductivity

The many-sheeted space-time concept provides a very general mechanism of superconductivity based on the 'dropping' of charged particles from atomic space-time sheets to larger space-time sheets. The first guess was that larger space-time sheets are very dry, cool and silent so that the necessary conditions for the formation of high T_c macroscopic quantum phases are met.

The possibility of large $\hbar$ quantum coherent phases makes however the assumption about thermal isolation between space-time sheets un-necessary. At larger space-time sheet the interactions of the charged particles with classical em fields generated by various wormhole contacts feeding gauge fluxes to and from the space-time sheet in question give rise to the necessary gap energy. The simplest model for Cooper pair is space-time sheet containing charged particles having attractive Coulombic interaction with the quarks and antiquarks associated with the throats of the wormhole contacts.

Wormhole contacts can be interpreted as Higgs type fields and photon massivation could be understood in terms of a coherent state of charged wormhole contacts. The coherent states of charged wormhole contacts and of Cooper pairs do not imply non-conservation of energy, charge, and fermion number in zero energy ontology.

A crucial element is quantum criticality predicting a new kind of superconductivity explaining the strange features of high T_c super-conductivity. There are two kinds of Cooper pairs, exotic Cooper pairs and counterparts of ordinary BCS type Cooper pairs. Both correspond to a large value of Planck constant. Exotic Cooper pairs are quantum critical meaning that they can decay to ordinary electrons. Below temperature $T_{c_1} > T_c$ only exotic Cooper pairs with spin are present and their finite lifetime implies that super-conductivity is broken to ordinary conductivity satisfying scaling laws characteristic for criticality. At T_c spinless BCS type Cooper pairs become stable and

exotic Cooper pairs can decay to them and vice versa. An open question is whether the BCS type Cooper pairs can be present also in the interior of cell.

These two superconducting phases compete in certain narrow interval around critical temperature for which body temperature of endotherms is a good candidate in the case of living matter. Also high T_c superfluidity of bosonic atoms dropped to space-time sheets of electronic Cooper pairs becomes possible besides ionic super conductivity. Even dark neutrino superconductivity can be considered below the weak length scale of scaled down weak bosons.

Magnetic magnetic flux tubes and sheets are especially interesting candidates for supra current carries. In this case the Cooper pairs must have spin one and this is indeed possible for exotic Cooper pairs. The fact that the critical magnetic fields can be very weak or large values of $\hbar$ is in accordance with the idea that various almost topological quantum numbers characterizing induced magnetic fields provide a storage mechanism of bio-information.

This mechanism is extremely general and in principle works for electrons, protons, ions, charged molecules and even exotic neutrinos and an entire zoo of high T_c bio-superconductors, super-fluids and Bose-Einstein condensates is predicted. Of course, there are restrictions due to the thermal stability it room temperature and it seems that only electron, neutrino, and proton Cooper pairs are possible at room temperature besides Bose-Einstein condensates of all bosonic ions and their exotic counterparts resulting when some nuclear color bonds become charged.

2. Hierarchies of preferred p-adic length scales and values of Planck constant

TGD inspired quantum biology and number theoretical considerations suggest preferred values for $r = \hbar/\hbar_0$. For the most general option the values of $\hbar$ are products and ratios of two integers n_a and n_b. Ruler and compass integers defined by the products of distinct Fermat primes and power of two are number theoretically favored values for these integers because the phases $exp(i2\pi/n_i)$, $i \in \{a, b\}$, in this case are number theoretically very simple and should have emerged first in the number theoretical evolution via algebraic extensions of p-adics and of rationals. p-Adic length scale hypothesis favors powers of two as values of r.

The hypothesis that Mersenne primes $M_k = 2^k - 1$, $k \in \{89, 107, 127\}$, and Gaussian Mersennes $M_{G,k} = (1+i)k - 1$, $k \in \{113, 151, 157, 163, 167, 239, 241..\}$ (the number theoretical miracle is that all the four p-adic length scales sith $k \in \{151, 157, 163, 167\}$ are in the biologically highly interesting range 10 nm-2.5 μm) define scaled up copies of electro-weak and QCD type physics with ordinary value of $\hbar$ and that these physics are induced by dark variants of corresponding lower level physics leads to a prediction for the preferred values of $r = 2^{k_d}$, $k_d = k_i - k_j$, and the resulting picture finds support from the ensuing models for biological evolution and for EEG [**?**] This hypothesis - to be referred to as Mersenne hypothesis - replaces the earlier rather ad hoc proposal $r = \hbar/\hbar_0 = 2^{11k}$ for the preferred values of Planck constant.

The role of Josephson currents

The general vision is that Josephson currents of various ions generate Josephson photons having dual interpretations as bio-photons and EEG photons. Josephson photons can in principle regenerate the quale in the neurons of the sensory pathway. In the case of motor pathways the function would be different and the transfer of metabolic energy by quantum credit card mechanism using phase conjugate photons is suggested by the observation that basic metabolic quanta 2 eV *resp.* 4 eV are associated with smooth muscle cells *resp.* skeletal muscle cells.

As already found in the previous section, the energies of Josephson photons associated with the biologically important ions are in general in visible or UV range except when resting potential has the value of -40 mV which it has for photoreceptors. In this case also IR photons are present. Also the turning point value of membrane potential is +40 mV so that one expects the emission of IR photons.

Josephson photons could be used to communicate the qualia to the magnetic body.

1. If Josephson currents are present during the entire action potential, the entire range of Josephson photons down to frequencies of order 2 kHz range is emitted for the standard value of $\hbar$. The reason is that lower frequencies corresponds to cycles longer than the duration of the action potential. The continuum of Josephson frequencies during nerve pulse makes it possible to induce cyclotron transitions at the magnetic body of neuron or large structure.

This would make possible to communicate information about spatial and temporal behavior of the nerve pulse pattern to the magnetic body and build by quantum entanglement a sensory map.

2. The frequencies below 2 kHz could be communicated as nerve pulse patterns. When the pulse rate is above $f = 28.57$ Hz the sequence of pulses is experienced as a continuous sound with pitch f. f defines the minimum frequency for which nerve pulses could represent the pitch and there remains a 9 Hz long range to be covered by some other communication method.

3. The cyclotron frequencies of quarks and possibly also of electron would make possible a selective reception of the frequencies emitted during nerve pulse. Same applies also to the Josephson frequencies of hair cell (, which does not fire). If the value of Planck constant is large this makes possible to communicate the entire range of audible frequencies to the magnetic body. Frequency would be coded by the magnetic field strength of the flux tube. Two options are available corresponding to the standard ground state for which Z^0 field is very weak and to almost vacuum extremals. For the first option one as ordinary cyclotron frequencies. The cyclotron frequency scales for them differ by a factor

$$r(q) = \frac{Q_{eff}(q)}{Q_{em}(q)} = \frac{\epsilon(q)}{2pQ_{em}(q)} + 1 \; per, \;\; \epsilon(u) = -1 \;\;, \epsilon(d) = 1$$

from the standard one. For $p = .0295$ one obtains $(r(u), r(d), r(e)) = (24.42, 49.85, 15.95)$. The cyclotron frequencies for quarks and electron with masses m(u)=2 MeV, m(d)=5 MeV, and m(e)=.5 MeV are given the table below for the two options. If one assumes that B_{end} defines the upper bound for field strength then he standard option would require both d quark and electron. Gor $d$quark with kHz CD the upper bound for cyclotron frequencies would be 20 kHz which corresponds to the upper limit of audible frequencies.

fermion	$f_c(e)/MHz$	$f_c(u)/MHz$	$f_c(d)/MHz$
standard	.564	.094	.019
nearly vacuum extremal	8.996	2.275	.947

Table 4. Cyclotron frequencies of quarks and electron in magnetic field $B_{end} = .2$ Gauss for standard vacuum with very small Z^0 field and nearly vacuum extremal.

4. Besides cyclotron frequencies also the harmonics of the fundamental frequencies assignable to quark and electron CDs could be used and in case of musical sounds this looks a highly attractive option. In this case it is now however possible to select single harmonics as in the case of cyclotron transitions so that only the rate of nerve pulses can communicate single frequency. Lorentz transform sub-CD scales up the frequency scale from the secondary p-adic time scale coming as octave of 10 Hz frequency. Also the scaling of $\hbar$ scales this frequency scale.

4. What are the roles of Josephson and cyclotron photons?

The dual interpretation of Josephson radiation in terms of bio-photons and EEG photons seems to be very natural and also the role of Josephson radiation seems now relatively clear. The role of cyclotron radiation and its interaction with Josephson radiation are not so well understood.

1. At least cell membrane defines a Josephson junction (actually a collection of them idealizable as single junctions). DNA double strand could define a series of Josephson junctions possibly assignable with hydrogen bonds. This however requires that the strands carry some non-standard charge densities and currents- I do not know whether this possibility is excluded experimentally. Quarks and antiquarks assignable to the nucleotide and its conjugate have opposite charges at the two sheets of the wormhole flux tube connective nucleotide to a lipid. Hence one could consider the possibility that a connection generated between them by reconnection mechanism could create Josephson junction.

2. The model for the photoreceptors leads to the identification of bio-photons as Josephson radiation and suggests that Josephson radiation propagates along flux tubes assignable to the cell membranes along sensory pathways up to sensory cortex and from there to motor cortex and back to the muscles and regenerates induced neuronal sensory experiences.

3. Josephson radiation could be used quite generally to communicate sensory data to/along the magnetic body: this would occur in the case of cell membrane magnetic body at least. The different resting voltages for various kinds of cells would select specific Josephson frequencies as communication channels.

4. If motor action indeed involves negative energy signals backwards in geometric time as Libet's findings suggest, then motor action would be very much like sensory perception in time reversed direction. The membrane resting potentials are different for various types of neurons and cells so that one could speak about pathways characterized by Josephson frequencies determined by the membrane potential. Each ion would have its own Josephson frequency characteristizing the sensory or motor pathway.

The basic questions concern the function of cyclotron radiation and whether Josephson radiation induces resonantly cyclotron radiation or vice versa.

1. Cyclotron radiation would be naturally associated with the flux sheets and flux tubes. The simplest hypothesis is that at least the magnetic field $B_{end} = .2$ Gauss can be assigned with the some magnetic flux quanta at least. The model for hearing suggests that B_{end} is in this case quantized so that cyclotron frequencies provide a magnetic representation for audible frequencies. Flux quantization does not pose any conditions on the magnetic field strength if the above discussed general flux quantization condition involving charged currents at the boundary of the flux quantum are assumed. If these currents are not present, $1/\hbar$ scaling of B_{end} for flux tubes follows.

2. The assumption that cyclotron radiation is associated with the motor control via genome is not consistent with the vision that motor action is time reversed sensory perception. It would also create the unpleasant question about information processing of the magnetic body performed between the receival of sensory data and motor action.

3. The notion of magnetic sensory canvas suggests a different picture. Josephson radiation induces resonant cyclotron transitions at the magnetic body and induces entanglement of the mental images in brain with the points of the magnetic body and in this manner creates sensory maps giving a third person perspective about the biological body. There would be two kind of sensory maps. Those assignable to the external world and those assignable to the body itself. The Josephson radiation would propagate along the flux tubes to the magnetic body.

4. There could be also flux tube connections to the outer magnetosphere of Earth. It would seem that the reconnections could be flux tubes traversing through inner magnetosphere to poles and from there to the outer magnetosphere. These could correspond to rather low cyclotron frequencies. Especially interesting structure in this respect is the magnetic flux sheet at the Equator.

5.2.6 Possible roles of the magnetic body in living matter

An attractive working hypothesis is that dark matter and negentropic entanglement can be assigned to the magnetic bodies. For instance, the dark elementary particles at the ends of the magnetic flux tubes connecting (say) biomolecules could be entangled negentropically. Negentropic entanglement, which is not identifiable as ordinary bound state entanglement, can be applied to explain the stability of high energy phosphate bond in ADP and ATP and of DNA polymers, which are highly charged and thus expected to be unstable [K27]. This also allows to interpret metabolic energy transfer as a transfer of negentropic entanglement at the deeper level.

The anatomy of magnetic body

Consider first the anatomy of the magnetic body.

1. Magnetic body has a fractal onion like structure with decreasing magnetic field strengths and the highest layers can have astrophysical sizes. Cyclotron wave length gives an estimate for the size of particular layer of magnetic body. $B = .2$ Gauss is the field strength associated with a particular layer of the magnetic body assignable to vertebrates and EEG. This value is not the same as the nominal value of the Earth's magnetic field equal to .5 Gauss and follows from the TGD based explanation of the quantal effects of ELF em fields on vertebrate brain known for decades [J46]. It is quite possible that the flux quanta of the magnetic body correspond to those of wormhole magnetic field and thus consist of two parallel flux quanta which have opposite time orientation. This is true for flux tubes assigned to DNA in the model of DNA as a topological quantum computer [K23, K93].

2. The layers of the magnetic body are characterized by the values of Planck constant and the matter at the flux quanta can be interpreted as macroscopically quantum coherent dark matter. This picture makes sense only if one accepts the generalization of the notion of imbedding space [K19].

3. In the case of wormhole magnetic fields it is natural to assign a definite temporal duration to the flux quanta and the time scales defined by EEG frequencies are natural. Encouragingly, the inherent time scale .1 seconds assignable to electron as a duration of zero energy space-time sheet in zero energy ontology having positive and negative energy electron at its ends would correspond to 10 Hz cyclotron frequency for ordinary value of Planck constant. For larger values of Planck constants the time scale scales as $\hbar$. Quite generally, a connection between p-adic time scales of EEG and those of electron and lightest quarks is highly suggestive since light quarks play key role in the model of DNA as topological quantum computer.

4. TGD predicts also a fractal hierarchy of scaled variants of electro-weak and color physics so that ZXG, QXG, and GXG corresponding to Z^0 boson, W boson, and gluons appearing effectively as massless dark particles below some biologically relevant length scale suggest themselves. In this phase quarks and gluons are unconfined and electroweak symmetries are unbroken so that gluons, weak bosons, quarks and even neutrinos might be relevant to the understanding of living matter. In particular, long ranged entanglement in charge and color degrees of freedom becomes possible. For instance, TGD based model of atomic nucleus as nuclear string suggests that biologically important fermionic could be actually chemically equivalent bosons and form cyclotron Bose-Einstein condensates.

This picture would mean that dark matter -usually believed to interact extremely weakly with the ordinary matter- would become a key player in biology. The failure to observe dark matter would be the completely wrong view about its nature. In TGD framework dark matter would make itself visible both via classical em fields and via the phase transitions transforming dark photons to ordinary ones. For instance, bunches of EEG photons and bio-photons could be interpreted as decay products dark photons [K20].

What magnetic body looks like?

What magnetic body looks like has been a question that I have intentionally avoided as a question making sense only when more general questions have been answered. This question seems how unavoidable now. Some of the related questions are following. The magnetic flux lines along various parts of magnetic body must close: how does this happen? Magnetic body must have parts of size at least that defined by EEG wavelengths: how do these parts form closed structures? How the magnetic bodies assignable to biomolecules relate to the Earth sized parts of the magnetic body? How the personal magnetic body relates to the magnetic body of Earth?

1. The vision about genome as the brain of cell would suggest that active and passive DNA strands are analogous to motor and sensor areas of brain. This would suggests that sensory data should be communicated from the cell membrane along the passive DNA strand. The

simplest hypotesis is that there is a pair of flux sheet going through the DNA strands. The flux sheet through the passive strand would be specialized to communicate sensory information to the magnetic body and the flux sheet through the active strand would generate motor action as DNA expression with transcription of RNA defining only one particular aspect of gene expression. Topological quantum computation assignable to introns and also electromagnetic gene expression would be possible.

2. The model for sensory receptor in terms of Josephson radiation suggests however that flux tubes assignable to axonal membranes carry Josephson radiation. Maybe the flux tube structures assigned to DNA define the magnetic analog of motor areas and flux tubes assigned with the axons that of sensory areas.

3. A complex structure of flux tubes and sheets is suggestive at the cellular level. The flux tubes assignable to the axons would be parallel to the sensory and motor pathways. Also microtubules would be accompanied by magnetic flux tubes. DNA as topological quantum computer model assumes and the proposed model of sensory perception and cell membrane level suggests transversal flux tubes between lipids and nucleotides. The general vision about DNA as brain of cell suggest flux sheets through DNA strands.

   During sensory perception of cell and nerve pulse the wormhole flux tube connecting the passive DNA strand of the first cell to the inner lipid layer would recombine with the flux tube connecting outer lipid layer to some other cell to form single flux tube connecting two cells. In the case of sensory organs these other cells would be naturally other sensory receptors. This would give rise to a dynamical network of flux tubes and sheets and axonal sequences of genomes would be like lines of text at the page of book. This structure could have a fractal generalization and would give rise to an integration of genome to super-genome at the level of organelles, organs and organism and even hypergenome at the level of population. This would make possible a coherent gene expression.

4. This vision gives some idea about magnetic body in the scale of cell but does not say much about it in longer scales. The CDs of electrons and quarks could provide insights about the size scale for the most relevant parts of the magnetic body. Certainly the flux tubes should close even when they have the length scale defined by the size of Earth.

Additional ideas about the structure follow follow if one assumes that magnetic body acts a sensory canvas and that motor action can be regarded as time reversed sensory perception.

1. If the external world is represented at part of the magnetic body which is stationary, the rotation of head or body would not affect the sensory representation. This part of the magnetic body would be obviously analogous to the outer magnetosphere, which does not rotate with Earth.

2. The part of the magnetic body at which the sensory data about body (posture, head orientations and position, positions of body parts) is represented, should be fixed to body and change its orientation with it so that bodily motions would be represented as motions of the magnetic , which would be therefore analogous to the inner magnetosphere of rotating Earth.

3. The outer part of the personal magnetic body is fixed to the inner magnetosphere, which defines the reference frame. The outer part might be even identifiable as the inner magnetosphere receiving sensory input from the biosphere. This magnetic super-organism would have various life forms as its sensory receptors and muscle neurons. This would give quantitative ideas about cyclotron frequencies involved. The wavelengths assignable to the frequencies above 10 Hz would correspond to the size scale of the inner magnetosphere and those below to the outer magnetosphere. During sleep only the EEG communications with outer magnetic body would remain intact.

4. Flux quantization for large value of $\hbar$ poses an additional constraint on the model.

   (a) If Josephson photons are transformed to a bunch of ordinary small $\hbar$ photons magnetic flux tubes can correspond to the ordinary value of Planck constant. If one assumes the quantization of the magnetic flux in the form

$$\int B dA = n\hbar$$

used in super-conductivity, the radius of the flux tube must increase as $\sqrt{\hbar}$ and if the Josephson frequency is reduced to the sound frequency, the value of $\hbar$ codes for the sound frequency. This leads to problems since the transversal thickness of flux tubes becomes too large. This does not however mean that the condition might not make sense: for instance, in the case of flux sheets going through DNA strands the condition might apply.

(b) The quantization of magnetic flux could be replaced by a more general condition

$$\oint (p - ZeA) dl = n\hbar \ , \tag{5.2.1}$$

where p represents momentum of particle of super-conducting phase at the boundary of flux tube. In this case also $n = 0$ is possible and poses no conditions on the thickness of the flux tube as a function of $\hbar$. This option looks reasonable since the charged particles at the boundary of flux tube would act as sources of the magnetic field.

(c) Together with the Maxwell's equation giving $B = ZeNv$ in the case that there is only one kind of charge carrier this gives the expression

$$N \quad = \quad \frac{2m}{RZ^2e^2} \tag{5.2.2}$$

for the surface density N of charge carrier with charge Z. R denotes the radius of the flux tube. If several charge carriers are present one has $B = \sum_k N_k Z_k e v_k$, and the condition generalizes to

$$N_i \quad = \quad \frac{2m_i v_i}{RZ_i \sum_k Z_k v_k e^2} \ . \tag{5.2.3}$$

It seems that this condition is the most realistic one for the large $\hbar$ flux sheets at which Josephson radiation induces cyclotron transitions.

Some functions of the magnetic body

The list of possible functions of the magnetic body is already now rather impressive.

1. Magnetic body controls biological body and receives sensory data from it. Together with zero energy ontology and new view about time explains Libet's strange findings about time lapses of consciousness [J71] in terms of time taken for the sensory signals from biological body to propagate to the appropriate layer of the magnetic body [K20]. EEG, or actually fractal hierarchy of EXGs assignable to various body parts makes possible communications to and control by the various layers of the magnetic body. WXG could induce charge density gradients by the exchange of W boson. Also the gluonic counterparts of EXG:s -QXG- are possible.

2. The flux sheets of the magnetic body traverse through DNA strands. The hierarchy of Planck constants and quantization of magnetic flux predicts that the flux sheets can have arbitrarily large width [K36]. This leads to the idea that there is hierarchy of genomes corresponding to ordinary genome, supergenome consisting of genomes of several cell nuclei arranged along flux sheet like lines of text, and hypergenomes involving genomes of several organisms arranged in a similar manner. The prediction is coherent gene expression at the level of organ, and even of population.

For instance, one could see the observed correlations between EEGs of two improvising musicians [J101], the findings of Germine [J107] and also those of Persinger and colleagues about macro-entanglement [J135] as an experimental support for both macroscopic entanglement between brain and for the crucial role of magnetic body as a space-time correlate for this entanglement. In this picture the great leaps in evolution, in particular, the emergence of EEG, could be seen as the emergence of a new larger layer of magnetic body characterized by a larger value of Planck constant. For instance, this would allow to understand why the quantal effects of ELF em fields [J46] requiring so large a value of Planck constant that cyclotron energies are above thermal energy at body temperature are observed for vertebrates only.

3. Magnetic body makes possible information processing in a manner highly analogous to topological quantum computation [K23]. The model of DNA as topological quantum computer [K23] assumes that flux tubes of wormhole magnetic field connect DNA nucleotides with the lipids of the lipid layer of nuclear or cell membrane. The flux tubes would continue through the membrane and split during topological quantum computation. The time-like braiding of flux tubes makes possible topological quantum computation via time-like braiding and the induced space-like braiding makes possible the representation of memories. The model allows general vision about the deeper meaning of the structure of cell and makes testable predictions about DNA. A good metaphor is dancers with feet connected to the walls of the dancing hall by threads. The dance representing quantum computation is coded to the braiding of the threads.

   One prediction is the coloring of braid strands realized by an association of quark or antiquark to nucleotide so that scaled up dark copy of QCD in cellular length scale would be involved. Color and spin of quarks and antiquarks would thus correspond to the quantum numbers assignable to braid ends. Color isospin could replace ordinary spin as a representation of qubit and quarks would naturally give rise to qutrit, with third quark would have interpretation as unspecified truth value. Fractionization of these quantum numbers takes place which increases the number of degrees of freedom.

   This prediction would relate closely to the discovery of topologist Barbara Shipman [A27] that the model for the honeybee dance suggests that quarks are in some manner involved with cognition -something totally unimaginable unless one accepts the possibility of fractal hierarchies of electroweak and hadronic physics. Also microtubules associated with axons connected to a space-time sheet outside axonal membrane via lipids could be involved with topological quantum computation and actually define an analog of a higher level programming language.

4. The strange findings about the behavior of cell membrane are summarized in [I86] and discussed in TGD framework in [K66]. Mention only the finding that metabolic deprivation does not lead to the death of cell, the discovery that ionic currents through the cell membrane are quantal, and that these currents are essentially similar than those through an artificial membrane, suggest that the ionic currents are dark ionic Josephson currents along magnetic flux tubes. A high percent of biological ions would be dark and ionic channels and pumps would be responsible only for the control of the flow of ordinary ions through cell membrane.

   A further important finding is that the water in the cell interior in gel phase is ordered and nearer to ice that liquid [I86]. This explains nicely the stability of DNA and various biopolymers as being due to the fact that depolymetrization by hydration is not possible in this phase. One could envisage the resting state of cell as a cellular winter during which proteins are folded or frozen to unfolded configurations by strong hydrogen bonds. External perturbation feeds energy to the system and induces periods during which the ice is frozen and proteins wake up and begin to unfold or fold and form aggretates as a response to the perturbation and return to the ground state after the energy of the signal is dissipated.

5. These findings together with the discovery that also nerve pulse seems to involve only low dissipation lead to a model of nerve pulse in which dark ionic currents automatically return back as Josephson currents without any need for pumping. This does not exclude the possibility that ionic channels might be involved with the generation of nerve pulse. In TGD

inspired model [K66] nerve pulse would result as a perturbation of $f \simeq 1$ kHz frequency soliton sequence mathematically equivalent to a situation in which a sequence of gravitational penduli rotates with constant phase difference between neighbors except for one pendulum which oscillates and oscillation moves along the sequence with the same velocity as the kHz wave. The oscillation would be induced by a "kick" for which one can imagine several mechanisms. Nerve pulse would be like dissonance in background harmony. This view conforms with the general vision that any equilibium in living matter is homeostasis rather than analog of equilibrium in mechanical system.

The model explains some features of nerve pulse not explained by Hodkin-Huxley model. These include the mechanical changes associated with axon during nerve pulse, the outwards force generated by nerve pulse with a correct prediction for its order of magnitude, the adiabatic character of nerve pulse, and the small rise of temperature of membrane during pulse followed by a reduction slightly below the original temperature.

The model predicts that the time taken to travel along any axon is a multiple of time dictated by the resting potential so that synchronization is an automatic prediction and would have nothing to do with transmitters. Not only kHz waves but also a fractal hierarchy of EEG (and EXG) waves are induced as Josephson radiation by voltage waves along axons and microtubules and by standing waves assignable to neuronal (cell) soma. The value of Planck constant involved with flux tubes determines the frequency scale of EXG so that a fractal hierarchy results.

The model forces to challenge the existing interpretation of nerve pulse patterns and the function of neural transmitters. Neural transmitters need not represent actual/only) signal but could be more analogous to links in quantum web. The transmitter would code the address of the receiver, which could be a gene inside neuronal nucleus. Nerve pulses would build a connection line between sender and receiver of nerve pulse along which actual signals would propagate. Also quantum entanglement between receiver and sender can be considered.

6. Acupuncture points, meridians, and Chi are key notions of Eastern medicine and find a natural identification in terms of magnetic body lacking from the western medicine. Also a connection with well established notions of DC currents and potentials discovered by Becker and with TGD based view about universal metabolic currencies as differences of zero point energies for pairs of space-time sheets with different p-adic length scale emerges [K39]. The spectrum for increments of zero point kinetic energies represents lines which cannot be explained in terms of molecule physics and the empirical evidence for them is discussed in [K7]

   Chi would correspond to these fundamental metabolic energy quanta to which ordinary chemically stored metabolic energy would be transformed. The identification nearest in spirit to the the original intuition would be in terms of negentropic entanglement. Meridians would most naturally correspond to flux tubes with large $\hbar$ along which dark supra currents flow without dissipation and transfer the metabolic energy between distant cells. Acupuncture points would correspond to points between which metabolic energy is transferred and their high conductivity and semiconductor like behavior would conform with the interpretation in terms of metabolic energy storages.

   The energy gained in the potential difference between the points would help to kick the charge carrier to a smaller space-time sheet. It is possible that the main contribution to the of charge at magnetic flux tube is magnetic energy and slightly below the metabolic energy quantum and that the voltage difference gives only the lacking small energy increment making the transfer possible. Also direct kicking of charge carriers to smaller space-time sheets by photons is possible and the observed action spectrum for IR and red photons corresponds to the predicted increments of zero point kinetic energies.

7. The notion of magnetic body implicates the notion of magnetic motor actions. Magnetic flux tubes and their motor actions could play key role in bio-catalysis and explain the magic ability of biomolecules to find each other. The model of DNA as topological quantum computer [K23] suggest that not only DNA and its conjugate but also some amino-acid sequences acting as catalysts could be connected to DNA and other amino-acids sequences or more general biomolecules by flux tubes acting as colored braid strands. The shortening of the flux tubes

in a phase transition reducing the value of Planck constant would make possible extremely selective mechanisms of catalysis allowing precisely defined locations of reacting molecules to attach to each other. With recently discovered mechanism for programming sequences of biochemical reactions (based on idea that each step in the reaction sequence means key allowing to open the door to the room containing the next key) [I93] this would make possible to understand the miraculous looking feats of bio-catalysis. Second key mechanism would be the re-connection of the magnetic flux tubes changing the topology of the Indra's net formed by magnetic flux tubes having biomolecules at their nodes.

8. Water memory is one of the highly disputed notions and motivated by the claimed effects of homeopathy. Water memory for which the work of the group led by HIV Nobelist L. Montagnier [I44] gives support would be naturally based on the coding of the biologically relevant properties of molecules to the cyclotron frequencies of its magnetic body. Water memory could rely on the copies of this magnetic body.

   Quite surprisingly, the finding of the group suggest also that genetic code might have higherto unknown realization. TGD indeed predicts several realizations, for instance those based on electromagnetic field patterns [K36]. The model of watermemory [K37] in turn led to a theoretical surprise [K93]. One could understand DNA, RNA, tRNA, and amino-acids in terms of states of dark nucleons constructed from three quarks and that vertebrate genetic code follows as a prediction in the sense that the numbers of counterparts of DNA codons coding for given amino-adic are predicted correctly [L10]. Prebiotic evolution as a process leading to a chemical realization of fundamental codes and counterparts of biomolecules existing already at the level of elementary particle physics together with the reduction of metabolic currencies to increments of zero point energies would solve two egg or hen problems of theoretical biology.

   There is no reason to assume that dark genes would not be still there and in close interaction with ordinary genes and in principle they could make possible controlled evolution analogous to industrial R&D process based on the construction of new genetic variants at the virtual world level of dark genes and the transcriptions to ordinary genes so that the new options could be tested under real life situations.

9. Although not directly related to the notion of magnetic body, the ability to construct "stories", temporally scaled down or possible also scaled up representations about the dynamical processes of external world, deserves to be mentioned. This ability might be actually one of the key aspects of intelligence [K23]. There is direct empirical evidence for this activity in hippocampus [J166]. The phase transitions reducing or increasing the value of Planck constant would indeed allow to achieve this by scaling the time duration of the zero energy space-time sheets providing cognitive representations.

Dark water and water memory: genetic code realized at elementary particle level?

The assumption was that water -possibly in liquid crystal like state- provides representations of molecules and in this manner makes possible water memory, frequency imprinting.

The hierarchy of Planck constants has brought additional details to this picture.

There is experimental evidence for what might be called dark hydrogen associated with water. The chemical formula of water is $H_{1.5}O$ in atto-second time scale and this could be explained if $1/4$ of hydrogens are in dark phase. The dark portion of water could explain the numerous anomalies of water as a condensed matter phase. Water memory can be assigned with the magnetic bodies of the water molecule clusters and braiding would again be an excellent candidate for memory representations. Cyclotron Bose-Einstein condensate provide representation of water memory as temporal radiation patters. They could be generated in the liquid flows inducing braiding. An interesting idea is that archetypal liquid flows are selected as asymptotic self-organization patterns and are accompanied by characeristic radiation patterns making possible "naming" of these patterns and symbolic dynamics.

A simple model for dark nucleons, their states of dark predicts that the dark nucleon states are in one-one correspondence with DNA, RNA, tRNA, and amino-acids in a natural manner and that vertebrate genetic code emerges in a natural manner from the model. This suggests

that genetic code is realized at nucleon level for the dark component of water and chemical realization is only secondary realization. This leads to a dramatic modification of views about the evolution of genome. It would not be anymore random choice followed by selection but much more like R&D in industry. The assumption that there is transcription of dark variants of the basic biomolecules to their chemical counterparts would make the new view possible. The basic mechanism of homeopathy would be basic mechanism of evolution allowing to modify genome as a response to environmental factors and also transfer the modifications to offspring.

The identification of bio-photons as ordinary photons resulting in the phase transition reducing the Planck constant assignable to dark photons is very natural and revises the model suggested in the article A model for bio-photons. Dark photons propagating along magnetic flux tube would play a key role also in the physics of biological body and brain and would provide an additional very fast communication channel besides nerve pulse transmission and various biochemical signalling mechanisms. This leads to a proposal for a model of cell membrane.

Direct experimental evidence for the notion of magnetic body carrying dark matter

The list of nice things made possible by the magnetic body is impressive and one can ask whether there is any experimental support for this notion. The evidence from water memory has been already mentioned. An explanation for the impressive list of anomalies of water [D9] discussed in [K21] provide one possible manner to justify the notion. For instance, it is known that in atto-second time scales water behaves as $H_{1.5}O$ [D8, D10, D12] as if part of hydrogen atoms would be dark.

The findings of Peter Gariaev and collaborators give evidence for the representation of DNA sequences based on the coding of nucleotide to a rotation angle of the polarization direction as photon travels through the flux tube and for the decoding of this representation to gene activation [I52], for the transformation of laser light to light at various radio-wave frequencies having interpretation in terms of phase transitions increasing $\hbar$ [I2], and even for the possibility to photograph magnetic flux tubes containing dark matter by using ordinary light in UV-IR range scattered from DNA [I84].

Fractal hierarchy of magnetic flux sheets and the hierarchy of genomes

The notion of magnetic body is central in the TGD inspired theory of living matter. Every system possesses magnetic body and there are strong reasons to believe that the magnetic body associated with human body is of order Earth size and that there could be an entire hierarchy of these bodies with even much larger sizes. Therefore the question arises what one can assume about these magnetic bodies. The quantization of magnetic flux suggests an answer to this question.

1. The quantization condition for magnetic flux reads in the most general form as $\oint (p - eA) \cdot dl = n\hbar$. If supra currents flowing at the boundaries of the flux tube are absent one obtains $e \int B \cdot dS = n\hbar$, which requires that the scaling of the Planck constant scales up the flux tube thickness by r^2 and scaling of B by $1/r$. If one assumes that the radii of flux tubes do not depend on the value of r, magnetic flux is compensated by the contribution of the supra current flowing around the flux tube: $\oint (p - eA) \cdot dl = 0$. The supra currents would be present inside living organism but in the faraway region where flux quanta from organism fuse together, the quantization conditions $e \int B \cdot dS = n\hbar$ would be satisfied.

2. From the point of view of EEG especially interesting are the flux sheets which have thickness $L(151) = 10$ nm (the thickness of cell membrane) carrying magnetic field having strength of endogenous magnetic field. In absence of supra currents these flux sheets have very large total transversal length proportional to r^2. The condition that the values of cyclotron energies are above thermal energy implies that the value of r is of order 2^{k_d}, $k_d = 44$. Strongly folded flux sheets of this thickness might be associated with living matter and connect their DNAs to single coherent structure. One can of course assume the presence of supra currents but outside the organism the flux sheet should fuse to form very long flux sheets.

3. Suppose that the magnetic flux flows in head to tail direction so that the magnetic flux arrives to the human body through a layer of cortical neurons. Assume that the flux sheets

traverse through the uppermost layer of neurons and also lower layers and that DNA of each neuronal nuclei define a transversal sections organized along flux sheet like text lines of a book page. The total length of DNA in single human cell is about one meter. It seems that single organism cannot provide the needed total length of DNA if DNA dominates the contribution. This if of course not at all necessarily since supra currents are possible and outside the organism the flux sheets can fuse together. This implies however correlations between genomes of different cells and even different organisms.

These observations inspire the notion of super- and hyper genes. As a matter fact, entire hierarchy of genomes is predicted. Super genes consist of genes in different cell nuclei arranged to threads along magnetic flux sheets like text lines on the page of book whereas hyper genes traverse through genomes of different organisms. Super and hyper genes provide an enormous representative capacity and together with the dark matter hierarchy allows to resolve the paradox created by the observation that human genome does not differ appreciably in size from that of wheat.

Genetic code and dark nucleon states

New realization of the genetic code in terms of dark proton sequences identified as dark nucleons was discovered [L10, K37].

1. The states of dark proton are in natural one-one correspondence with DNA, RNA, tRNA, and amino-acids and vertebrate genetic code is realized in a natural manner. Dark nucleons realized DNA codons as entangled quark triplets. The effective chemical formula $H_{1.5}O$ for water in atto-second time scale supports this view [K19]. How the notion of dark nucleon relates to negentropic entanglement of electrons? Could dark electron pairs and dark nucleons correspond to the same value of Planck constant? Could both dark protons and dark electrons play a key role in metabolism.

2. The simplest guess is that DNA strands are accompanied by dark nuclei with one dark proton per DNA nucleotide. The resulting positive charged would stabilize the system by partially neutralizing the negative charge density due to the phosphorylation (2 negative charges per nucleotide). Dark proton sequences could be associated also with other important bio-polymers. If the spins of the dark protons are parallel the dipole magnetic fields give rise to flux tubes connecting the protons and one can assign to the large $\hbar$ protons a macroscopically quantum coherent phase.

3. The natural guess would be that dark nucleus realization of the genetic code induces the biological realization as evolution assigns to dark nucleon sequences DNA, RNA, and amino-acid sequences with 1-1 correlation between dark nucleon state and basic unit of the sequence. The dark realization of genetic code suggest a totally new view about biological evolution as a process, which is analogous to R&D in high tech industry rather than being completely random [K37]. The candidates for new genes could be tested at dark matter level and in the case that they work they would be transcribed to their chemical equivalents.

5.2.7 How to build a quantum computer from magnetic flux tubes

Magnetic flux tubes play a key role in TGD inspired model of quantum biology. Could the networks of magnetic flux tubes containing dark particles with large $\hbar$ in macroscopic quantum states and carrying beams of dark photons define analogs of electric circuits? This would be rather cheap technology since no metal would be needed for wires. Dark photon beams would propagate along the flux tubes representing the analogs of optical cables and make possible communications with maximal signal velocity.

I have actually made much more radical proposal in TGD inspired quantum biology. According to this proposal, flux tube connections are dynamical and can be changed by reconnection of two magnetic flux tubes. The signal pathways $A \rightarrow C$ and $B \rightarrow D$ would be transformed to signal pathways to $A \rightarrow D$ and $B \rightarrow C$ by reconnection. Reconnection actually represents a basic stringy vertex. The contraction of magnetic flux tubes by a phase transition changing Planck constant

could be fundamental in bio-catalysis since it would allow distant molecules connected by flux tubes to find each other in the molecular crowd.

DNA as a topological quantum computer is the idea that I have been developing for 5 years or so. I have concentrated on the new physics realization of braids and devoted not much thought to how the quantum computer problems might run in this framework. I was surprised to realize how little I know about what happens in even ordinary computation. Instead of going immediately to Wikipedia I take the risk of publicly making myself fool and try to use my own brain.

What can one learn from ordinary computer programs

One could begin with the question what happens in classical computation. How the program is realized and how it runs? The notion of Turing machine represents an extreme abstraction mentioning nothing about the technical side and does not help much in attempts to answer these questions. Turing paradigm also assumes that program is a temporal sequence of operations. These operations could however correspond to a linear spatial sequences and inputs and outputs in this case would correspond to boundary values at the ends of the linear structure. This requires that the dynamics is such that evolution in spatial direction is analogous to a deterministic time evolution. In this case it is much easier to imagine biological realizations of quantum computer programs in TGD inspired bio-world.

To develop concrete ideas, one can start from the picture provided by ordinary computer program.

1. Programs consist of temporal/spatial sequences of commands and commands represent basic functions from which one can build more complex functions by the composition of functions having some numbers of input and output arguments. The eventual output variable can be expressed by printing of a piece of text or as an image in the computer screen. Each step in the program corresponds to a composition of functions: $f_{n+1} = g_{n+1} \circ f_n$. There is some minimal set of primitive/prime functions from which one builds up more complex functions by composition.

2. How this is realized at the level of hardware? One can assume that the basic functions are at some fixed places in the computer memory having addresses given by integers represented as bit sequences. This address represents the command - a name of the function. The names for input variables and output variables are bit sequences giving the addresses of the places containing the values of these variables. Program is a sequence of commands represented as bit sequences giving the address of the function to be computed at a given step and the addresses of inputs and outputs. As the processing unit reads the command, it generates/activates connections from the addresses of inputs to the address representing the function and from this address to the addresses of outputs.

   Essentially the challenge is to reconnect, build/activate connections. An interesting question is whether learning identified as strengthening of synaptic connections [J24] is one particular example of this process.

3. How the sequence of bits representing command address is realized? As the processing unit reads the address of command it should automatically create/activate a connection from this address to the command address. The connections from the processing unit to the addresses could exist physically as wirings.

4. It is not necessary that program is dynamical so that the inputs and outputs would be initial and final values of variables. Inputs and outputs could also correspond to values of variables at the ends of a linear structure. In topological quantum computation space-like entanglement would represent superposition of input-output pairs characterizing a function as a rule with instances represented as instances appearing in the superposition.

If this picture is roughly correct, re-connection would be the basic process. Reconnection is the basic process for magnetic flux tubes and ADP$\leftrightarrow$ATP has been assigned to this process with ATP molecule serving as a relay activating the flux tube connection. Maybe ADP-ATP process, which is usually seen as a basic step of metabolism, could be seen as the core step for quantum computation

performed by living matter. One expects that the presence ATP makes the rule represented by negentropic quantum entanglement conscious.

Quantum computation magnetic flux tubes as connections

Consider now quantum computation could take place in a circuitry having magnetic flux tubes as wires and some bio-molecules of groups of them as units defining prime functions. DNA as topological quantum computer could be taken as a starting point. The outcome of quantum computation is determined statistically as ensemble average so that a large number of copies of the program should be present and realized in terms of groups of cells or molecules connected by braidings if the quantum computation is space-like. This option seems more natural than time-like quantum computation realized as a 2-D liquid flow of lipids in the lipid layers of the cell membrane.

1. The hardware

Consider first the hardware of topological quantum computation using space-like braids.

1. Magnetic flux tubes would represent the wires along which inputs and outputs travel in the case of classical computation or dynamical quantum computation. In the case of space-like topological quantum computation entanglement is between the ends of the flux tubes.

2. Variables could be represented in many manners. For space-like quantum computations they could correspond to spin states of dark electrons at flux tubes or to polarization states of dark electrons at the flux tubes. In the original model of DNA as topological quantum computer quarks and antiquarks where proposed as a representation of genetic codons: also this quite science fictive option could make sense in TGD Universe since TGD predicts scaled versions of QCD like dynamics and presence of elementary particles in several p-adic scales and in scales dictated by value of Planck constant for given p-adic length scale.

   The spin states of electron pair has been proposed as one possible representation of the 4 genetic codons. Quantum variables would be represented by qubit sequences and the measurement of qubit would give a bit sequence characterizing the classical value of the variable. Bio-molecules would be natural places for storing the values of the variables. For dynamical computations the values of variables could be transmitted using dark photons.

3. There would exist basic processing units calculating the prime functions from which more complex functions would be obtained as composites. Basic units could correspond to bio-molecules. In the case of classical computation the inputs to molecules and outputs from them would travel along the flux tubes. In quantum computation these signals could be used to control the initial values of the variables. Molecules could also serve as gates for quantum computation.

2. Representation of programs

The basic program units in the case of quantum computation would be represented by braidings.

1. If the ends of braid strands are able to move freely when needed, it becomes possible to re-write programs. Lipid layers of cell membrane can be in liquid crystal state so that these are ideal for this purpose. The time-like braiding resulting from lipid flow and representing running topological quantum computation program would induce space-like braiding representing space-like topological quantum computation or a rule. A particular quantum computer program represented as space-like braiding of the flux tubes would result as liquid crystal melts for a moment and freezes again.

   The process in which proteins covered by ordered water analogous to ice temporarily melt and form aggregates [I15] is basic process induced by the feed of energy to the cellular system and could be compared to cellular summer. This process could mean quite generally molecular re-programming induced by the flow of cellular water inducing molecular flows inducing re-braidings. The braiding would also store the highlights of the cellular summer to cellular memory! This could be also seen learning by a modification of various quantum computer programs.

2. Negentropic entanglement is highly suggestive and would conform with the idea that the rule represented by entanglement represents conscious information or information which can become conscious. The process of becoming conscious information could involve ATP$\rightarrow$ ADP and de-activating the flux tube and destroy the information. Time-like braiding represented by liquid flow would modify space-like braiding.

It is not quite clear whether the information is conscious when negentropic entanglement (and ATP) is present - as Bohm's notion of active information [J3] would suggest - or when ATP is transformed to ADP and connection becomes passive. Negentropic entanglement can be stable with respect to NMP [K49] so that the presence of ATP could mean period of conscious experience - negentropic entanglement could be analogous to active information.

TGD based model for the memory recall by sending negative energy signals to geometric past suggests that the absorption of negative energy photon transforms ATP to ADP. Conscious experience is regenerated in the geometric now where the negative energy signal came from - perhaps by transforming ADP to ATP by using the negative resulting by sending of negative energy signal! Conscious reading would be actually memory recall and analogous to teleportation? The destruction of the representation of memory in the geometric past would have interpretation in terms of no-cloning theorem [B4].

3. Static realizations of the programs are easier to imagine since no temporal codes are needed for the transfer of bits. An attractive idea is that the computations are represented by static entanglements for linear structures and that time-like braiding allows to modify the programs.

3. The realization of program

The program would be basically a sequence of address lists. Address list would contain the address of the function to be performed and the addresses of the input molecules and output molecules. How to represent the address physically?

1. The simplest manner to realize this would use existing flux tubes connecting the processing unit to all possible input and output addresses as well as command addresses, and activate those flux tubes to which input and output data are assigned and reconnect them to the flux tubes connecting processing unit to the unit representing the function. The processing unit would have flux tubes coming from all possible inputs, going to all possible outputs, flux tubes going to places representing functions and coming from these places. Processing unit would be like a relay station or old fashioned telephone center whose sole purpose would be to create connections by reconnecting flux tubes. ATP molecule would be probably involved with the activation and - allowing a sloppy language - one could say that communication line becomes conscious when ATP is attached to it.

   (a) Addressing would be just selection of activated molecules and analogous to that used in telephone network or computer network connected by cables. This would require static flux tube network and flux tubes could be either active or passive. In passive state flux tubes could be short-cut by a reconnection with hydrogen bond so that the ends of cut flux tube would end up to water molecules. This is however not necessary. Activation in absence of the short cut would involve reconnection of a flux tube with a flux tube connecting two parts of ATP - possibly hydrogen bond again- so that ATP becomes part of the flux tubes. If also short cut is involved, the strands coming to the two water molecules reconnect and generate hydrogen bond and flux tube to which ATP would attach in the proposed manner. As ATP is used it transforms to ADP and de-attaches from the flux tube.

   (b) One can imagine also a dynamical addressing based on the generation of magnetic flux tubes between inputs and submodules. The computational process could be still space-like. The first manner to realize dynamical addressing would be by attaching to the ends of dynamical flux tubes biomolecules, which bind to specific receptors. Receptor mechanism would allow to connect distant cells to each other and build a

magnetic flux tube connection between them. Computational unit specialized to run a specific program could excrete biomolecules binding to the input and output receptors: this program would realized function in terms of space-like entanglement. Glands emit hormones binding to receptors and various glands could in principle serve as computational units. Various information molecules bind very selectively and this might also relate to quantum space-like computations.

(c) Second mechanism of dynamical addressing would use dark photons. In this case resonant interaction selecting the target would replace the receptor mechanism. In this kind of situation one can claim that flux tubes are un-necessary, one can use just resonance to build connection to a desired place just as one does in radio communications. Of course, topological light rays could be accompanied by flux tubes. For instance, DNA nucleotide could attach by flux tube to its conjugate in distant DNA molecule and if the connection is based on resonance only similar nucleotide sequences could connect with each other. I have discussed this kind of mechanism in a model for remote replication of DNA [K120] based on the experimental work by Peter Gariaev and his group. The resonance mechanism could also make possible to establish flux tube connections and the quantum computation could be a static operation.

2. DNA as topological quantum computer vision gives some idea about how the computer program could be realized as a spatial linear structure.

(a) Program would be a sequence of topological quantum computations. Given topological quantum computation would be represented by a braiding of flux tubes connecting DNA nucleotides with the lipid molecules of the inner lipid layer. Program would correspond to a linear sequence of cells with the outer lipid layer connected to the DNA of the second cell.

(b) Lipid flows at given lipid layer could be used to rewrite programs and the programs could respond to the changes in environment in this manner: this would require that the lipid layer is in liquid crystal state during the period when program is changed. Also nerve pulse patterns would induce these flows. Programs would also represent memories as rules realized as quantum abstractions or as quantum functions.

(c) The program would "run" in the spatial direction. The selection of active input and output variables would be by acting the connection from molecule in question by attaching ATP as a relay through which the reconnected flux tube would traverse. This would be also part of the writing of the program. The superposition of entangled inputs and outputs could be seen as a quantum superposition of classical programs assigning outputs to inputs. Also microtubule-lipid layer braiding suggested also to play a key role in the realization of memories could give rise to similar space-like quantum computation representing rules.

(d) The effective 2-dimensionality implied by strong form of holography implied in turn by strong form of general coordinate invariance means that the physics depends on partonic 2-surfaces and 4-D tangent space data at them. This suggests that the dynamics on space-like 3-surfaces and light-like orbits of partonic 2-surfaces is fixed by a process analogous to gauge selection. Does just this effective gauge symmetry make possible to write quantum computer programs? Already ordinary deterministic computer program means selection of one particular dynamics from several alternative options suggesting that strict determinism is broken.

3. What could be the role of bio-catalysis in the computation? Bio-catalysis is a central part of the biological information processing and it would not be surprising if the catalysts connected by flux tubes to substrate molecules were involved with the computations. An attractive idea is that various information molecules binding to receptors involved with bio-control (neurotransmitters, hormones, etc...) are involved with building the flux tube connections between cells. These bio-molecules could carry the ends of flux tubes to special places for

which receptors serve as addresses and in this manner build hardware for topological quantum computation involving inputs and outputs in distant parts of the body. The final output could be transformed to controlled gene expression. Quite generally, catalysts bind very selectively and could play a role similar that played by information molecules in building up the quantum computer programs.

4. One can imagine also purely classical computation based on catalytic mechanism probably allowing generalization to quantum case. The idea is that computer program - understood now as dynamical structure - is analogous to what happens in fairy tale in which hero finds a key which fits to a lock of a room containing a key which... There exists a beautiful realization of classical computation in terms of chemical concentrations using DNA. The output of given reaction representing computational step appears in the next reaction provide the system contains additional participating molecules, which could be both substrate molecules and catalysts. The program could be represented as concentrations of molecules needed at intermediate steps and lock-to-key mechanism guarantees that they are performed in the correct temporal order. Inputs and output molecules could be connected by flux tubes to bio-molecules which bind to specific receptors associated with the molecule representing the particular subprogram. This would automatically create a large number of classical computations proceeding in fixed order, maybe even quantum computations.

5.2.8   DNA as topological quantum computer

The vision about how DNA might act as a topological quantum computer (TQC) [K97] is few years old [K23]. TQC means that the time-like braidings of braid strands define TQC programs and M-matrix (generalization of S-matrix in zero energy ontology) defining the time-like entanglement between states assignable to the end points of strands define the TQC program coded as unitary time evolution for Schrödinger equation in the standard framework. One can end up to the model in the following manner.

1. Darwinian selection for which the standard theory of self-organization provides a model, should apply also to TQC programs. TQC programs should correspond to asymptotic self-organization patterns selected by dissipation in the presence of metabolic energy feed. The spatial and temporal pattern of the metabolic energy feed characterizes the TQC program - or equivalently - sub-program call.

2. Since braiding characterizes the TQC program, the self-organization pattern should correspond to a hydrodynamical flow or a pattern of magnetic field inducing the braiding. Braid strands must correspond to magnetic flux tubes of the magnetic body of DNA. If each nucleotide is transversal magnetic dipole it gives rise to transversal flux tubes, which can also connect to the genome of another cell. As a matter fact, the flux tubes would correspond to what I have used to call wormhole magnetic fields [K101] having pairs of space-time sheets carrying opposite magnetic fluxes. The wormholes themselves could have interpretation as dark scaled variants of ordinary elementary particles. The large value of Planck constant would zoom up the magnetic fields associated with ordinary elementary particles from weak scale to much longer length scale given by cell size or even a longer length scale.

3. The output of TQC sub-program is probability distribution for the outcomes of state function reduction so that the sub-program must be repeated very many times. It is represented as four-dimensional patterns for various rates (chemical rates, nerve pulse patterns, EEG power distributions,...) having also identification as temporal densities of zero energy states in various scales.

   By the fractality of TGD Universe there is a hierarchy of TQCs corresponding to p-adic and dark matter hierarchies. Programs (space-time sheets defining coherence regions) call programs in shorter scale. If the self-organizing system has a periodic behavior each TQC module defines a large number of almost copies of itself asymptotically. Generalized EEG could naturally define this periodic pattern and each period of EEG would correspond to an initiation and halting of TQC. This brings in mind the periodically occurring sol-gel phase transition inside cell near the cell membrane. There is also a connection with hologram idea:

EEG rhythm corresponds to reference wave and nerve pulse patters to the wave carrying the information and interfering with the reference wave.

4. Fluid flow would naturally induce the braiding which requires that the ends of braid strands must be anchored to the fluid flow. Recalling that lipid mono-layers of the cell membrane are liquid crystals and lipids of interior mono-layer have hydrophilic ends pointing towards cell interior, it is easy to guess that DNA nucleotides are connected to lipids by magnetic flux tubes and hydrophilic lipid ends are stuck to the flow. Also nerve pulse patterns could induce the flow of lipids inducing the braiding so that nerve pulse patterns would define TQC programs and be coded into memories.

5. The topology of the braid traversing cell membrane cannot be affected by the hydrodynamical flow. Hence braid strands must be split during TQC. This also induces the desired magnetic isolation from the environment. Halting of TQC reconnects them and make possible the communication of the outcome of TQC.

This is one possible realization and it is of course clear that one can imagine several alternatives. There are several problems related to the details of the realization.

1. How nucleotides A,T,C,G are coded to the strand color and what this color corresponds to physically? The original proposal was that there are two options which could be characterized as fermionic and bosonic.

   (a) Magnetic flux tubes having quark and anti-quark at their ends with u,d and u_c, d_c coding for A,G and T,C. CP conjugation would correspond to conjugation for DNA nucleotides.

   (b) Wormhole magnetic flux tubes having wormhole contact and its CP conjugate at its ends with wormhole contact carrying quark and anti-quark at its throats. The latter are predicted to appear in all length scales in TGD Universe.

   Recently it became clear that there is much simpler realization involving only spin 1/2 fermion pairs assignable to pairs of flux tubes. The spin states of fermion pairs form triplet and singlet and code for A,T,C,G. The first guess is that fermion is proton or electron but this does not allow coding of color qualia. Taking fermion to be u quark one can realize color qualia in terms of quark color and has good hopes about Coulomb stability since the charge assigned to nucleotide reduces from -2 to -2/3 (Coulomb stability of DNA is a well-known problem). Flux tubes are ordinary flux tubes. One ends up also to a concrete model for happens when color qualia are generated. An unexpected bonus is that statistics constraint implies that color and spin entanglement forces spatial entanglement realized as braiding of the flux tubes so that entanglement indeed has classical space-time correlate.

2. How to split the braid strands in a controlled manner? High T_c super conductivity provides a possible mechanism: braid strand can be split only if the supra current flowing through it vanishes. A suitable voltage pulse induces the supra-current and its negative cancels it. The conformation of the lipid controls whether it it can follow the flow or not.

3. How magnetic flux tubes can be cut without breaking the conservation of the magnetic flux? The notion of wormhole magnetic field could save the situation now: after the splitting the flux returns back along the second space-time sheet of wormhole magnetic field. An alternative solution is based on reconnection of flux tubes. Since only flux tubes of same color can reconnect this process can induce transfer of color: "color inheritance": when applied at the level of amino-acids this would give strong constraints on the model of protein folding [K4]. Reconnection makes possible breaking of flux tube connection for both the ordinary magnetic flux tubes and wormhole magnetic flux tubes.

4. How magnetic flux tubes are realized? The interpretation of flux tubes as correlates of directed attention at molecular level suggests a rather concrete picture. Hydrogen bonds are by their asymmetry natural correlates for a directed attention at molecular level. Also

flux tubes between acceptors of hydrogen bonds must be allowed and acceptors can be seen as the subjects of directed attention and donors as objects. Examples of acceptors are aromatic rings of nucleotides, $O =$ atoms of phosphates, etc.. A connection with metabolism is obtained if it is assumed that various phosphates $XMP, XDP, XTP, X = A, T, G, C$ act as fundamental acceptors and plugs in the connection lines. The basic metabolic process $ATP \rightarrow ADP + P_i$ allows an interpretation as a reconnection splitting flux tube connection, and the basic function of phosphorylating enzymes would be to build flux tube connections as also of breathing and photosynthesis.

The model makes several testable predictions about DNA itself. In particular, matter-antimatter asymmetry and slightly broken isospin symmetry at the level of dark quarks have counterparts at DNA level induced from the breaking of these symmetries for quarks and antiquarks associated with the flux tubes. DNA cell membrane system is not the only possible system that could perform TQC like activities and store memories in braidings: flux tubes could connect biomolecules and the negentropic braiding could provide an almost definition for what it is to be living. Even water memory might reduce to braidings.

The model leads also to an improved understanding of other roles of the magnetic flux tubes containing dark matter. Phase transitions changing the value of Planck constant for the magnetic flux tubes could be key element of bio-catalysis and electromagnetic long distance communications in living matter. There is also a fascinating connection with Peter Gariaev's work [I84] suggesting that the phase transitions changing Planck constant have been observed and wormhole magnetic flux tubes containing dark matter have been photographed in his experiments [K90].

5.2.9   What is the role of magnetic body in DNA replication, mitosis, meiosis, and fertilization?

If magnetic body uses biological body as a motor instrument and sensory receptor, the natural question is whether basic process such as mitosis, meiosis. could be induced by more fundamental processes for the magnetic body. One can argue that if magnetic flux tubes are responsible for making living organism and even population a kind of Indra's net, cell division should be induced by magnetic body and should produce automatically this Indra's net.

As a matter of fact, cell division brings strongly in mind division of magnetic dipole but also the reconnection of magnetic flux tubes can be considered as a basic mechanism. At least the following basic mechanisms can be considered.

1. Consider a pair of magnetic flux tubes with opposite fluxes connecting objects A and B. The division of A+B to A and B would be induced by a reconnection process for the members of the pair producing two loops associated with A and B but no connection between A and B anymore. The problem of this option is that the flux tube connection defined in this manner might not be stable enough.

2. Magnetic dipole would correspond to a flux tube at the core of the dipole field itself decomposing to flux tubes with weaker magnetic flux at its ends. The division to two dipoles would correspond to a formation of segment in which flux tube decomposes into several flux tubes, which need not be parallel anymore. Two new dipole ends are formed and the old dipole ends remain connected so that the repetition of this process would yield a kind of Indra's net predicting that all cells of living organism are connected by the flux tubes to single coherent whole.

   The division of flux tube to several flux tubes could also correspond to the increase of Planck constant by integer factor n along a segment of flux tube. The resulting n flux sheets would corresponds to the sheets of the covering. The length of the segment would be scaled up by n.

3. If one has pair of dipoles A-B and C-D with same total flux, a reconnection leading to A-D and C-B is possible.

Could biochemical processes associated with cell division be induced by some of the listed processes? The two latter options would predict that the cells produced in cell division remain

connected by magnetic flux tubes. The division of dipole creates two new dipole ends connected by short flux tube. The already existing ends remain connected by "long" flux tubes carrying weak magnetic fields as compared to that carried by the dipole itself. Also the processes of meiosis and fertilization could respect the presence of long flux tubes connecting the cells participating in the process so that flux tube connections could also exist between parents and offspring. The members of population could form a kind of super-organism. Remote interactions between DNA and other biomolecules of closely related members of species and even shared use of DNA (and its TGD variant "dark DNA") can be imagined.

1. Consider first DNA replication and reshuffling taking place in meiosis [I11] essential for the sexual reproduction in eukariotes. The dividing nucleus (of form MMFF) is ordinary nucleus and contains two pairs of chromosomes coming both mother (MM) and father (FF). Division produces four haploid cells containing only two chromosomes (AB) with A and B obtained by reshuffling the DNAs of mother and father to obtained 4 unique chromosome pairs. In sexual reproduction these cells fuse to form diploid cells (MMFF).

   (a) The reshuffling of a pair MF of DNA strands from father and mother could be induced by a repeated reconnection process for flux tubes parallel to DNA strands. The simplest reconnection for strands A-B and C-D produces strands A-X-D and C-Y-B where A-Z and C-Y are pieces of A-B and C-D with same number of codons.

   (b) The replication of DNA takes place for all four chromosomes before reshuffling. One obtains a nucleus containing 4 pairs of doubled chromosomes. This double nucleus divides to two daugher nuclei containing 2 doubled chromosomes each.These divide further to two nuclei each containing only two chromosomes each (AB).

   The DNA reshuffling could correspond to a multiple reconnection process if the two DNA strands are accompanied by by long magnetic dipoles (flux tubes). Note that in absence of additional restrictions many combinations (28) are possible.

   (c) After replication and reshuffling the division of the nucleus two two intermediaries could be induced either by splitting of a flux tube connecting pairs of doubled chromosomes to flux tubes not anymore parallel to each other. The flux could diverge to a larger volume in this segment. Second possibility is that the increase of Planck constant increases the length of segment and at the same time divides the flux into sub-fluxes. Dipole field flux tube would give long flux tubes and split dipole shorter flux tubes connecting the resulting cells together.

   (d) Also the chromosome pairs of the resulting intermediate nuclei could be connected to each other by flux tubes to form a connected structure A-B-C-D and reconnection process could divide it to A-B plus C-D (say) and lead to a division of the nucleus producing 4 ordinary daughter nuclei.

2. In mitosis [I12] the initial nucleus corresponds to MMFF and DNA replication leads to pairs of doubled chromosomes but without re-shuffling. One doubled pair from mother and one pair from father the members of doubled chromosomes are connected by a kind of bridge. In the mitosis proper the doubled chromosome pairs are split and two chromosome pairs containing one chromosome from father and mother are formed. After this division leads to two diploid cells similar to the dividing cell.

3. In fertilization [I7] gametes from father and mother fuse together to form a single cell with two pairs of chromosomes from both father and mother. The question is how the two gametes are able to find each other. The reconnection of closed magnetic flux tubes associated with the gametes could lead to a formation of bridges connection the two gametes and a phase transition reducing the value of Planck constant could lead the two gametes near each other and make possible the fusion.

DNA replication [I5] is clearly the fundamental process, and the question is whether also this step could be reduced to a reconnection for a pair flux tubes: first would connect the separated DNA strands and second one free nucleotide and its conjugate.

1. Suppose that there are flux tubes connecting nucleotides of DNA and corresponding nucleotides of the conjugate strand: they could be rather short flux tubes of length shorter than 1 nm in the normal situation but could grow longer when DNA strands separate. This might involve a phase transition increasing temporarily the value of Planck constant assignable to these flux tubes and increasing the length of the segment and of connecting flux tube and therefore the distance of DNA strands.

2. There are also free DNA nucleotides and their conjugates in the environment which can be used in the replication process as building bricks. If also free nucleotides and their conjugates are connected in a pairwise manner by similar flux tubes and if the value of magnetic flux characterizes a given pair then reconnection could take place for these two kinds of flux tubes and lead to a correct pairing of DNA strand with conjugate nucleotides. Same would happen for the conjugate strand. The reduction of Planck constant would lead to a pair of ordinary DNA double strands.

3. The details of the dynamics would be determined by other factors but the outcome would be fixed by the nucleotide-conjugate pairing and dependence of the flux on the nucleotide pair. In particular, conservation of magnetic flux would guarantee that the nucleotides can be assigned only with their conjugates.

These arguments suggest that reconnection of magnetic flux tubes, temporary change of the Planck constant, and coding of nucleotide-conjugate pairs by magnetic flux could be key element of meiosis, mitosis, and reshuffling of chromosomes in meiosis. Also higher level processes - such as cell division and fertilization - could involve reconnection process as a fundamental step. These mechanisms would appear in several length scales corresponding to DNA, nucleus, and cell length scale. In an approach based on mere chemistry, this must be assumed as a result of kinematics.

5.3 The relationship between information processing and metabolism in TGD Universe

After the writing of the first version of this chapter for about decade ago several new ideas have emerged and the challenge is to unify these ideas.

5.3.1 Three different views about living matter as a macroscopic quantum system

There are three different views about how living system manages to be a macroscopic quantum system.

1. The first vision is based on various kinds of super-conductivities [K12]. Electronic super-conductivity is assigned with the cell membrane and plays a key role in the model of cell membrane as a Josephson junction. Furthermore, the effects of ELF em fields on vertebrate brain [K20] suggest that biologically important ions form macroscopic quantum states and cyclotron Bose-Einstein condensates of bosonic ions have been suggested. The TGD based view about atomic nuclei predicts exotic nuclei chemically equivalent with ordinary ones but being bosons rather than fermions. Also these exotic ions could also form cyclotron Bose-Einstein condensates. Large value of Planck constant would guarantee that cycloctron energies proportional to $\hbar$ are above thermal energy.

2. A more precise view about hierarchy of Planck constants as an implication of the enormous vacuum degeneracy of Kähler action has emerged [K24]. According to this view non-standard values of Planck constant are only effective.

   As the idea about the hierarchy of Planck constants emerged, I proposed that favored values of Planck constant could comes are powers of 2^{11}. This was just a first guess inspired partially by the observation that the mass ratio of proton and electron is $940/.5 = 1880 \sim 2^{11}$. I managed to find indications supporting this hierarchy and also this chapter contains traces of this idea. I became later skeptic but one could actually imagine a mechanism implying this

kind of hierarchy. Dark protons with say $r = \hbar/\hbar_0 = 1836 = 4 \times 3^3 \times \times 17$ would correspond to approximately same Compton length as ordinary electrons. It is natural to assign this value of $\hbar$ also to electrons and this gives Compton length 44.6 Angstroms not far from the p-adic length scale $L(149) \simeq 50$ Angstroms assigned with the lipid layer of cell membrane. The condition that dark proton corresponds to this Compton length gives $r = 1836^2$: the electron Compton length comes now 8.1 μm, which corresponds to cell size scale. One could continue the resulting hierarchy of Planck constants indefinitely.

3. The notion of negentropic entanglement making sense for rational and even algebraic entanglement probabilities has emerged as a possible characterizer of living matter [K49]. Quantum arithmetics [K104] allows to generalize the notion of rational so that p-adic real correspondence mediated by canonical identification is fixed uniquely and is both continuous and respects symmetries [K104]. One implication is an explanation for Shnoll effect [K5], which could be important also in living matter.

This raises several questions.

1. How high T_c super conductivity based on dark electron pairs and negentropic entanglement relate?

2. Could it be that electron pairs in valence bonds are the carriers of negentropic entanglement (see fig. `http://www.tgdtheory.fi/appfigures/cat.jpg` or fig. 21 in the appendix of this book) and that they generate the magnetic flux tubes as parts of their magnetic bodies? This makes sense only if the valence electron pairs in living matter have spin 1. The Cooper pairs of high T_c super-conductors are ineed known to have spin 1 [?] If this view is correct, biological evolution would favor the maximization of covalent electron pairs and this indeed seems to be the case.

3. Why large $\hbar$ would make possible negentropic entanglement or even force it? Is there some purely number theoretic reason for this?

5.3.2   New ideas related to metabolism

Also new ideas related to metabolism have emerged at the same time when evidence for quantal aspects of photosynthesis has been emerging [I57, I20, I17, I6]. The ideas about the detailed relationship between metabolism and negentropic entanglement are still in a state of turmoil. Let us sum up those concepts and ideas which could serve as starting point.

1. Negentropic entanglement is the first basic notion. There is a strong tendency to consider the presence of a magnetic flux tube connecting two objects and carrying negentropically entangled quantum state as a fundamental structure giving rise to a directed attention. Negentropic entanglement would be basic element of conscious cognition, and one can assign to it various attributes like experience of understanding. The mildest assumption is that negentropic entanglement is associated with the flux tube. A stronger assumption is that it is between states assignable to the ends of the flux tube identifiable as observer and target of attention.

   An analogy with Orch OR is suggestive. The period of negentropic entanglement - period of directed attention - would correspond to Orch Or and its end to state function reduction.

2. Negentropic entanglement leads also to the idea about energy metabolism and negentropy transfer as different sides of the same coin. The model for DNA as topological in turn suggest that ADP $\rightarrow$ ATP and its reverse can be interpreted as a standardized reconnection process re-organizing connections between distant molecules connected by magnetic flux tubes by the relay defined by ATP molecule. Metabolic energy would - or at least could - go to the re-organization of the flux tube connections and therefore of the negentropic quantum entanglement. The question is how to fuse this vision with the hypothesis about metabolic currencies as differences of zero point kinetic energies for space-time sheets.

3. An attractive interpretation is that the presence of ATP at magnetic flux tube serves as a signature of negentropic entanglement. The period of negentropic entanglement could be seen as the analog of Orch OR period ending with state function reduction. This period would be accompanied by consciousness to which one can assign various attributes such as experience of understanding and positively colored emotions. It is of course difficult to say what the counterparts of these experiences are at the level of flux tubes. One can imagine two options.

    (a) The high energy phosphate bond in ATP is the carrier of the negentropic entanglement. The transformation of ATP to ADP would liberate the metabolic energy and mean end of the period during which one can assign negentropic entanglement to the flux tube. ATP would be the correlate for consciousness at the flux tube level - the molecule of consciousness.

    (b) ATP →ADP transfers metabolic energy quantum to the magnetic flux tube and creates a excited with negentropic entanglement. This process could correspond to either generation of negentropic entanglement (period of negentropic entanglement would begin with ATP→ ADP rather than end) or transfer of it from ATP to the flux tube.

4. The radiation from Sun defines the fundamental metabolic currency. Solar radiation cannot be said to negentropic since negentropic entanglement is a 2-particle property. Solar photons could possess a large value of $\hbar$ or - more plausibly - suffer at the magnetic body of the living system a phase transition increasing the value of $\hbar$. Could the absorption of large $\hbar$ photons arriving from Sun or from magnetic body by electrons generate spin 1 valence electron pairs pairs or provide the metabolic energy needed to re-arrange the flux tube connections between distant molecules by $ADP + P_i \to ATP$ process?

5. The identification of the increments zero point kinetic energies as universal metabolic energy quanta is one of the oldest hypothesis of TGD inspired theory of consciousness. Zero point kinetic energy is associated with the zero point motion of particle at space-time sheet. The finite size of the space-time sheet gives rise to this energy for which non-relativistic parameterization is $E_0 = k \times 3\hbar^2\pi^2/2mL^2(k)$. $L(k) = 2^{(-k+151)/2}L(151)$, $L(151) \simeq 10$ nm is the p-adic length scale of the space-time sheet, and k numerical factor not far from unity. Particle in 3-D box gives $k = 1$.

    As particle is transferred to a larger space-time sheet the zero point kinetic energy is reduced, and the difference is liberated as usable metabolic energy. For proton the size scale of this space-time sheet could be atomic size scale $k = 137$. For electron it could electron Cooper pair $k = 149$ (prime) corresponding to a lipid layer of cell membrane could be in question. Entire hierarchy of metabolic energy quanta is predicted and the energy scale depends on the particle mass and p-adic length scale and geometric factors characterizing the shape of space-time sheet only.

    One can ask whether the high energy phosphate bond in the phosphate of ATP molecule contains this kind of smaller space-time sheet and in the transition ATP → ADP, electron or proton drops from this kind of space-time sheet. The following considerations show that this hypothesis is not necessary, and that one can also modify the identification of the fundamental metabolic energy quantum as zero point kinetic energy without losing anything. Therefore the details of the scenario are far from being fully nailed down.

6. Magnetic flux tubes are carriers of charged particles and the hypothesis is that cyclotron Bose-Einstein condensates for fermionic Cooper pairs and bosonic ions are relevant for consciousness. In particular, cyclotron transitions in which bosons in these condensates are excited would be important for the generation of conscious experiences. The hierarchy of Planck constants and the fact that cyclotron energy is proportional to $\hbar$ allows to have arbitrarily high cyclotron energies in given magnetic field. This is essential in the model for the effects of ELF em fields on living matter [K7].

7. Becker's finding about the relevance of DC currents for healing of wounds lead to an idea about how electromagnetic radiation interacts with the charged particles at magnetic flux

tubes [L27]. What would happen is that charged particles experience the electric and magnetic fields of the radiation field described in terms of massless extremals (topological light rays). Electric field would generate acceleration in the direct of the flux tube and could excite Becker currents which would give rise to biological effects - healing of wound in the simplest case. The proposal has been that this process gives rise to what could be seen as a loading of metabolic batteries.

The combination of this view with the notion of cyclotron BE condensate leads to a slightly more complex picture. Radiation field can excite single boson states both in transversal and longitudinal degrees of freedom. Transversal ones correspond to cyclotron states with energies $E_{c,n} = (n + 1/2)E_c$, $E_c = \hbar qB/m$ and the energies of excitations are of form nE_c. Longitudinal degrees of freedom correspond to a particle in 1-D box -possibly in presence of longitudinal electric field: a simple model for the states was derived in the model for Becker's DC currents.

In the absence of longitudinal electric field the energy spectrum is $E_n = n^2 E_0$, $E_0 = \hbar^2\pi^2/2mL^2$, L the length of the flux tube. Longitudinal excitations correspond to energies $(n_f - n_i)^2 E_0$ and would classically correspond to the acceleration in the electric field component parallel to the flux tube giving rise to Becker currents. For both excitations negentropically entangled states result very naturally as superpositions of single particle excitations and possibly also multi-particle excitations. Both incoming photons and liberation of metabolic energy quantum as photon can induce the excitation.

One could reinterpret the idea about universal metabolic energy quanta by interpreting them as increments of longitudinal energies at flux tube. For the excitation $n = 1 \to 2$ the energy would be $3\hbar^2\pi^2/2mL^2$ which is same as zero point kinetic energy for a particle in 3-D box of side L. Quantitative prediction is therefore same as that of the original model. One can of course consider also the original option that the transfer of particles from the flux tube to a larger space-time sheet indeed liberates metabolic energy.

Let us now try to weave these ideas to an internally consistent picture. It is perhaps best to proceed by making questions.

1. Could one assign negentropic entanglement with high energy phosphate bond? If so, the period of negentropic entanglement (having Orch OR as a counterpart) would correspond to the presence of ATP and the end of this period to $ATP \to ADP$. I have considered this possibility earlier. The problem is that it is difficult to understand how negentropic entanglement could be assigned simultaneously both to ATP and to the magnetic flux tube whose length and thickness are proportional to $\hbar$ and therefore varies. One should treat ATP and flux tube as single basic structure and this does not sound convincing since the scales of flux tubes are expected to be much longer than the size scale of ATP molecule. Therefore there are two options.

   (a) ATP is just what it is believed to be: provider of metabolic energy only. One can leave also open the question whether high energy phosphate bond can be interpreted in terms of zero point kinetic energy or not.

   (b) ATP carries both metabolic energy and negentropic entanglement assignable to the phosphate bond and metabolic energy corresponds to zero point kinetic energy difference. In $ATP \to ADP$ a possibly dark photon or photons are emitted and is absorbed by a magnetic flux tube containing cyclotron Bose-Einstein condensate and the resulting de-localized single particle excitation as quantum superposition of various single particle excitations carries negentropic entanglement in the length scale associated with the magnetic flux tube, which can be much longer. Even several flux tubes could be excited simultaneously. This would regenerate long range negentropic entanglement stable under NMP. Transfer of negentropic entanglement would be in question.

2. Could the non-local excitations of cyclotron Bose-Einstein condensates by large $\hbar$ photon give rise to the negentropically entangled states? Excitation of cyclotron BE condensate requires

energy so that metabolic energy is required. ATP could provide this energy. Cyclotron energy quantum is given by $E_c = \hbar q B/m$, q and m are charged and mass of the boson. As already found, the energy of boson is sum of two contributions: energy $E_n \propto n^2$ associated with free longitudinal motion and magnetic energy $E_{c,n} \propto n + 1/2$. Longitudinal excitations could be assigned to the generation of Becker currents. This proposal would integrate metabolism, negentropy generation, and quantum like behavior of ELF em fields in living matter to single picture.

3. Could it be that ATP - instead of being a carrier of negentropic entanglement as suggested earlier - only provides the metabolic energy quantum transformed to cyclotron energy quantum or longitudinal energy quantum when negentropic entanglement is generated by exciting the cyclotron BE condensate? Or could ATP carry both metabolic energy and negentropic entanglement and both of them are transferred to the magnetic flux tube in ATP$\rightarrow$ ADP process?

   (a) Cyclotron energies are quite too small for this to make sense for the ordinary value of Planck constant. The nominal value of the metabolic energy quantum is $E_0 = 0.5$ eV which by $E_0 = h_0 f_0$ corresponds to frequency $f_0 = 5 \times 10^{13}$ Hz in near infrared. The value of electron's cyclotron frequency in the endogenous magnetic field $B_{end} = .2 \times 10^{-4}$ Tesla postulated to explain the effects of ELF em fields on vertebrate brain is $f_{c,e} \simeq 6 \times 10^5$ Hz. If metabolic energy quantum is to excite cyclotron state ($n \to n+1$), one must have $E_c = E_0$.

   Even for electron E_c is much below E_0 small for $B = B_{end}$ and $\hbar = \hbar_0$. One can however scale both B from B_{end} and $\hbar$ from $\hbar_0$. Requiring $E_c(\hbar, B) = E_0$ and using $E_c = hf$ gives $f_{ce}/f_0 = r_1 r$, $r_1 = \frac{B}{B_{end}}$ and $r = \frac{\hbar}{\hbar_0}$, where $\hbar_0$ denotes the standard value of Planck constant. This gives $r_1 r \simeq (5/6) \times 10^8$.

   (b) There are many manners to achieve the desired upwards scaling of cyclotron energies. Magnetic flux quantization gives further constraints. One could require that magnetic flux is quantized, and that for $\hbar = \hbar_0$ the flux quantum has radius of order $L(151)$ (1 nm, cell membrane thickness) corresponding to the thickness of a flux tube assignable to single DNA nucleotide.

   The radius of flux quantum corresponds to the magnetic length $r_B = \sqrt{\hbar q B}$. In the scaling $B_{end} \to 1$ Tesla ($r_1 = 2.5 \times 10^4$), magnetic length scales as $r_B \simeq 2.5$ μm $\to 11$ nm. From the condition $r_1 r = (5/6) \times 10^8$ one has for the scaling of Planck constant $r \sim 3.3 \times 10^3$. The scaling of the flux tubes length of $L(151)$ would give flux tube length of order 3×10 μm, which corresponds to cell size so that a flux tube connecting DNA and cell membrane could be in question. Note that the scaling of $\hbar$ does not affect zero point kinetic energy in the longitudinal direction since L scales as $\hbar$.

   (c) For flux tube length $L(151)$ and for $\hbar = \hbar_0$ the energy of the lowest longitudinal excitation is same order of magnitude as metabolic energy quantum so that the excitation of longitudinal states could be in key role in the generation of Becker's currents. There is evidence about non-local excitations of electrons in photosynthesis, [I24], which suggests that the longitudinal energy excitation could indeed play the role of fundamental metabolic energy quantum transferred to the the energy of high energy phosphate bond of ATP. This interpretation leaves open the structure of high energy phosphate bond and there is no absolute need to assign zero point kinetic energy with it.

   Longitudinal energies are negligible, one must require flux tube length to be considerably longer than $L(151)$ for the ordinary value of $\hbar$. Longitudinal energies are significant only for electron for given flux tube length. Indeed, Becker currents are known to be carried by electrons.

   (d) If one allows ionic Bose Einstein condensates the value of Planck constant must be scaled up by the mass ratio m_I/m_e, where m_I and m_e are the masses of ion and electron. For proton this would give scaling ratio $r = 2^{11}$ and one would end up with the hierarchy of Planck constants coming as powers of 2^{11} suggests years ago. What

is remarkable that in cyclotron degrees of freedom also protons and ions can play a signification role: the quantal effects of ELF em fields on vertebrate brain suggest that this is the case.

4. What happens if one has just electrons rather than Cooper pairs? In both transversal and longitudinal degrees of freedom one would have the analog of Fermi sphere with electron states filled up to some maximum values integers characterizing cyclotron energy and longitudinal momentum. Transitions induce also now negentropic entanglement. For cyclotron states the energy increment would be E_c so that basic metabolic energy quantum can induce the transitions. In longitudinal degrees of freedom the minimal energy increment would be $(2N+1)E_0$, where N characterizes the populated state with maximal longitudinal momentum. This energy should be equal to the metabolic energy quantum. This can be arranged but is not so natural. Experimental work is sooner or later bound to reveal whether electrons or their Cooper pairs are in question.

The option developed above is perhaps the most elegant found hitherto: it would raise the BE condensates of electronic and ionic Cooper pairs in a special position, it would lead to an explicit proposal for what negentropic entanglement is at the level of flux tubes, and in minimal form it would require no modification of the ideas related to ATP, even the standard view about ATP can be kept. Also the original hypothesis that ATP carries metabolic energy as zero point kinetic energy makes sense and also ATP could carry negentropic entanglement.

This view suggests that electronic cyclotron BE condensates are essential also for the understanding of photosynthesis. The absorption of dark photon would generate a non-local excitation of BE condensate of electron Cooper pairs - also a negentropically entangled state. The energy gain in this process could be also interpreted as a fundamental metabolic energy quantum - the interpretation is to some degree a matter of taste- and the subsequent steps in photosynthesis would only take care of the storage of the energy transferred eventually to ATP. Also chemical storage could be storage of negentropic entanglement. The metabolic energy liberated in ATP$\rightarrow$ ADP could be realized universally as IR dark photon absorbed by cyclotron BE condensate at magnetic flux tube so that dark photon beams would become the key actors of metabolism and negentropy generation. Note that a maximal negentropy gain is obtained if the number of Cooper pairs in the condensate is power of prime. Relatively small primes in the scale defined by the p-adic length scales assignable to elementary particles would be in question.

5.3.3   Pessimistic generalization of the second law of thermodynamics

The possibility of negentropic entanglement raises the question about the fate of the second law of thermodynamics. The proposal for a generalization of the second law of thermodynamics (see chapter *Negentropy Maximization Principle* of [**?**] based on the most pessimistic vision is that entropy indeed increases also when negentropic entanglement is generated in state function reduction. If the generation of negentropic entanglement is accompanied by a compensating entropic entanglement, how it is generated? Or is the maximally pessimistic generalization really necessary? Is it implied automatically in time scales longer than the characteristic time scale associated with the causal diamonds serving as the basic correlates for conscious selves. One must apply ensemble description in these time scales: does the non-determinism of quantum jump imply second law at the level of ensemble automatically. If this argument is correct, second law would cease to hold in time scales than that characterizing the relevant causal diamond (CD). based on the most pessimistic vision is that entropy indeed increases also when negentropic entanglement is generated in state function reduction. If the generation of negentropic entanglement is accompanied by a compensating entropic entanglement, how it is generated? Or is the maximally pessimistic generalization really necessary? Is it implied automatically in time scales longer than the characteristic time scale associated with the causal diamonds serving as the basic correlates for conscious selves. One must apply ensemble description in these time scales: does the non-determinism of quantum jump imply second law at the level of ensemble automatically. If this argument is correct, second law would cease to hold in time scales than that characterizing the relevant CD.

5.3.4 How to understand differentiation and de-differentiation?

Differentiation and de-differentiation are fundamental processes in biology. Differentiation means specialization and more restricted gene expression and de-differentiation a reversal of this process. De-differentiation to the stem cell state takes place in healing of wounds and is induced by Becker's DC currents. Note that cancer cells are de-differentiated cells but Becker currents induce a further de-differentiation making them omnipotent.

De-differentiation and differentiation are strongly time-irreversible processes. Could differentiation and de-differentiation be seen as time reversals of each other and correspond to state function reductions at opposite boundaries of CD? De-differentiation would mean change of geometric arrow of time but basically a dissipative process would be in question.

The following argument based on purely entropic entanglement shows that this view cannot be correct.

1. There are two manners to see arrow of time corresponding to imbedding space level and space-time level. The arrow of geometric time alternates only at the level of imbedding space at space-time level alone it does not if irreversibility of quantum dynamics has space-time correlates as quantum classical correspondence requires. Space-time surface is not able to detect its own effective folding forth and back in time in the imbedding space and the internal arrow of time remains the same. CD is able to detect the imbedding space arrow of time for its sub-CD:. sub-CD seems to develop in reverse direction of geometric time. Dissipation occurs always in subjective time so that second law remains true.

2. Suppose that it makes sense to think that CD scans given sub-CDs again and again in time direction, which corresponds to its own arrow of geometric time. Suppose for definiteness that the scale of sub-CD is 1 year. CD observes evolution of sub-CD from 1 to 2 years then from 3 to 2 years, then from 5 to 4 years. Ageing occurs on the average. System would get 2 years older in sudden steps at both boundaries. The sudden agings by 2 years are compensated by 1 year of apparent rejuvenation between state function reductions. The interpretation as dedifferentiation is not possible. For instance, return to omnipotent stem cell stage is not possible for differentiated cells.

What is lacking is the notion of negentropic entanglement. Illness is a loss of negentropic entanglement and healing its regeneration. Aging is a loss of negentropic entanglement and de-differentiation identified as rejuvenation is regeneration of negentropic resources.

1. De-differentiation must involve a generation of negentropic entanglement defining the fundamental step in rejuvenation. Ageing is due to to state function reductions destroying entanglement. Negentropically entangled states can be however stable under NMP and NMP can even force the reversal of ageing.

2. At the level of basic metabolism generation of ATP accompanies the generation of negentropic entanglement and its transformation to ADP to its disappearance. The creation of ATP would be fundamental process of rejuvenation, and ATP could be seen as elixir of youth at the molecular level. The analogy between ATP-ADP cycle and Karma's cycle is also rather precise. This picture conforms also with the model for healing currents as a tool to generate metabolic energy, ATP, and negentropic entanglement.

5.4 Exotic charge transfer between cell interior and exterior as fundamental control mechanism

The notions of ionic channels and pumps associated with the cell membrane are central for the standard cell biology [I91] . There are however puzzling observations challenging this dogma and suggesting that the currents between cell interior and exterior have quantum nature and are universal in the sense that they not depend on the cell membrane at all [I74, I40, I105, I94, I34]. One of the pioneers in the field has been Gilbert Ling [I74] , who has devoted for more than three decades to the problem, developed ingenious experiments, and written several books about

the topic. The introduction of the book [I86]) gives an excellent layman summary about the paradoxical experimental results.

It was a pleasant surprise to find that these experimental findings give direct support for the existence of an exotic charge transfer between cell interior and exterior.

Ionic supra currents and Josephson currents or the exchange of exotic W bosons could be in question. For the first option, the experimental data led to a model for cell homeostasis as a flow equilibrium in which very small densities of super-conducting ions (also molecular ions) and ionic supercurrents at cellular and other super-conducting space-time sheets dictate the corresponding densities at the atomic space-time sheets. Z^0 super-conductivity possible for almost vacuum extremals in principle allows to generalize the model also to the control of the densities of neural atoms and molecules at atomic space-time sheets.

This control mechanism need not be the only one. Magnetic flux tubes serving as colored braid strands connecting different bio-molecules in highly selective manner and phase transitions reducing or increasing $\hbar$ could explain the mysterious precision of bio-catalysis as how the prebiotic evolution has led to the known biology [K23] . Magnetic flux tubes could also act as Josephson junctions between widely separated structures.

5.4.1 Strange behavior of the intracellular water

The basic strange feature of cellular interior is related to its gelatinous nature and is in fact familiar for everyone. Although 80 percent of hamburger is water, it is extremely difficult to extract this water out. Ling [I40] has demonstrated this at cellular level by using a centrifuge and cells for which cell membrane is cut open: centrifugal accelerations as high as 1000 g fail to induce the separation of the intracellular water.

The assumption that cytoplasm behaves like gel explains these findings. Egg is very familiar example of gel phase so that this proposal could have been made already by the pioneers. The dipolar nature of bio-molecules and induced polarization are basis prerequisites for the formation of gels. Ling raises the cohesion between water and protein molecules caused by electric dipole forces as a fundamental principle and calls this principle association-induction hypothesis [I74] . This cohesion gives rise to liquid [F6] [D4] like structure of water implying among other things layered structures and internal electric fields orthogonal to the plane of the layers [I61, I67, I74] . For instance, cell membranes can be understood as resulting from the self-organization of liquid crystals [K14] . The fundamental importance of electret nature of biomatter was also realized by Fröhlich [J104] and led him to suggest that macroscopic quantum phases of electric dipoles might be possible. This concept, which is in central role in many theories of quantum consciousness, has not been established empirically.

5.4.2 Are channels and pumps really there?

5.4.3 Are channels and pumps really there?

Standard neurophysiology relies strongly on the concepts of what might be called hydro-electro-chemistry. The development of the theory has occurred through gradual improvements saving the existing theory.

The development began from the basic observation that cells are stable gelatinous entities not mixing with the surrounding water. This led to the hypothesis that cell membrane takes care that the contents of the cell do not mix with the cell exterior. It was however soon found that cell membrane allows some ions to flow through. The interaction between theory and experiment led gradually to the notions of ion channel and ion pump, which are still central for the standard paradigm of the cell [I91] . Note that also 'electric pump' taking care that membrane potential is preserved, is needed.

These notions developed gradually during the period when cell was seen as a bag containing water and a mixture of various biochemicals. If cell biology would have started to develop during the latter half of this century and after the discovery of DNA, cell as a computer metaphor might have led to a quite different conceptualization for what happens in the vicinity of the cell membrane. Also the notion of liquid crystals [D4] would have probably led to different ideas about how homeostasis between cell interior and exterior is realized [I61, I67, I74] .

For me it was quite a surprise to find that pump-channel paradigm is not at all so well-established as I had believed as an innocent and ignorant outsider. The first chapter of the book "Cells, Gels and the Engines of Life" of Gerald Pollack [I86] provides a summary about the experimental paradoxes (the interested reader can find the first chapter of this book from web).

The standard theoretical picture about cell is based on the observation that cell exterior and interior are in a relative non-equilibrium. The measured concentrations of various atomic ions and organic molecules are in general different in the interior and exterior and cell membrane seems to behave like a semi-permeable membrane. There is also a very strong electric field over the cell membrane. In standard approach, which emerged around 1940, one can understand the situation by assuming that there are cell membrane pumps pumping ions from cell interior to exterior or vice versa and channels through which the ions can leak back. Quite a many candidates for proteins which seem to function like pump and channel proteins have been identified: even a pump protein for water [I86] ! This does not however prove that pumping and channelling is the main function of these proteins on the case of basic biological ions or that they have anything to do with how ionic and molecular concentrations in the interior and exterior of the cell are determined. It could quite well be that in the case of basic ions pump and channel proteins are receptors involved with the transfer of information rather than charges and only effectively act as pumps and channels.

There are several serious objections of principle against the vision of cell as a bag of water containing a mixture of chemicals. Even worse, the hypothesis seems to be in conflict with experimental data.

Selectivity problem

Cell membrane is extremely selective and this leads to an inflation in the complexity of channels and pumps. The problem might be christened as a dog-door problem: the door for dog allows also cat go through it. Channels cannot be simple sieves: it is known that channels which let some ions through do not let much smaller ions through. There must be more complicated criteria than geometric size for whether the channel lets the ion go through. Quite generally, channels must be highly selective and this seems to require complicated information processing to decide which ion goes through and which not. As a consequence, the models for channels inflate in their complexity.

The only reasonable way to circumvent the problem is to assume that there is kind of binary coding of various chemical compounds but it is difficult to see how this could be achieved in the framework of the standard chemistry. The notion of fractional atom proposed in [K21] to give rise to the emergence of symbols at the level of biochemistry could however allow this kind of coding. Channels and pumps (or whatever these structures actually are) could be also generated by self-organization process when needed.

Inflation in the number of pumps and channels

Channels and pumps for atomic ions and channels and pumps for an astronomical number of organic molecules are needed. The first question is where to put all those channels and pumps? Of course, one could think that pumps and channels are constructed by the cell only when they are needed. But how does the cell know when a new pump is needed if the cell as never met the molecule in question: for instance, antibiotic or curare molecule?

To realize how weird the picture based on channels and pumps is, it is useful to imagine a hotel in which there is a door for every possible client letting only that client through but no one else. This strange hotel would have separate door for every five point five milliard humans. Alternatively, the building would be in a continual state of renovation, new doors being built and old being blocked.

There is however an TGD based objection against this slightly arrogant argument. In TGD framework cell is a self-organizing structure and it might be that there is some mechanism which forces the cell to produce these pumps and channels by self-organization. Perhaps the basic characteristic of quantum control in many-sheeted space-time is that it somehow forces this kind of miracles to occur.

Why pumping does not stop when metabolism stops?

One can also wonder how metabolism is able to provide the needed energy to this continual construction of pumps and channels and also do the pumping. For instance, sodium pump alone is estimated to take 45-50 per cent of the cell's metabolic energy supply. Ling has studied the viability of the notion of the ionic pump experimentally [I74] by exposing cell to a coctail of metabolic poisons and depriving it from oxygen: this should stop the metabolic activities of the cell and stop also the pumping. Rather remarkably, nothing happened to the concentration gradients! Presumably this is the case also for the membrane potential so that also the notion of metabolically driven electrostatic pumps seems to fail. Of course, some metabolism is needed to keep the equilibrium but the mechanism does not seem to be a molecular mechanism and somehow manages to use extremely small amount of metabolic energy.

How it is possible that ionic currents through silicon rubber membrane are similar to those through cell membrane?

A crucial verification of the channel concept was thought to come in the experiment of Neher and Sakmann [I95] (which led to a Nobel prize). The ingenious experimental arrangement was following. A patch of membrane is sucked from the cell and remains stuck on the micropipet orifice. A steady voltage is applied over the patch of the membrane and the resulting current is measured. It was found that the current consists of discrete pulses in consistency with the assumption that that a genuine quantum level current is in question. The observation was taken as a direct evidence for the postulate that the ionic currents through the cell membrane flow through ionic channels.

The later experiments of Fred Sachs [I94] however yielded a complete surprise. Sachs found that when the patch of the cell membrane was replaced by a patch of silicon rubber, the discrete currents did not disappear: they remained essentially indistinguishable from cell membrane currents! Even more surprisingly, the silicon rubber membrane showed ion-selectivity features, which were essentially same as those of the cell membrane! Also the currents through synthetic polymer filters [I34] were found to have essentially similar properties: as if ion selectivity, reversal potential, and ionic gating would not depend at all on the structure of the membrane and were more or less universal properties. Also experiments with pure lipid-layer membranes [I105] containing no channel proteins demonstrated that the basic features – including step conductance changes, flickering, ion selectivity, and in-activation– characterized also cell membranes containing no ionic channels.

The in-escapable conclusion forced by these results seems to be that the existing 60-year old paradigm is somehow wrong. Ionic currents and the their properties seem to be universal and depend only on very weakly on the properties of the membrane. This conclusion need not apply to the currents of polar molecules for which genetically coded pump and channel proteins certainly exists. Neither does it imply that pumps and channels could not be used to achieve a more efficient transfer of ions. Pump - and channel proteins seem to be a well-established notion and TGD approach suggests that they serve as Josephson junctions.

This however requires a generalization of the ordinary thermodynamical approach to cell membrane by starting from zero energy ontology and replacing Boltzmann weight with the complex square roots. Chemical potentials giving dominant part to the change of energy as it goes through cell membrane is replaced with the difference of cyclotron energy which is in visible and UV range from the condition that dark EEG photons have energies of bio-photons [K20]. One ends up with a generalization of Josephson junction: the generalized Josephson energy includes besides Coulombic energy difference also the cyclotron energy difference. Dark cyclotron contribution raises the energy scale of .05-.1 eV associated with cell membrane to .5-10 eVs and one can understand the nominal value .5 eV of metabolic energy currency.

5.4.4   Cytoplasm as gel

The solution to the above described anomalies proposed by Pollack is that cytoplasm is gel phase [I86] . Pollack describes in detail various aspects of cytoplasm as a gel phase and here only short summary can be given.

1. Cytoplasm can be regarded as a network consisting of cross-linked negatively charged proteins. Water is condensed around the proteins to form structured water. If protein is hydrophilic, water self-organizes around it as a multilayered structure: the number of molecular layers can as high as 600 and the thickness of the layered structure is a considerable fraction of micrometer. If the protein is hydrophobic, water forms another structured phase known as clathrate water: in this case the number of hydrogen bonds between water atoms is large. These phases can be regarded as intermediate between ice and water. Also ordinary ions have this kind of layered structure around them. Chemical cross-links tend to be stable with heat, pH, and solvent composition whereas physical cross-links formed by intermolecular interactions are sensitive to environmental interactions and are of special interest from the point of view of phase transitions.

2. Pollack proposes that the formation of polymers takes place in an environment containing layered water for the simple reason that monomers cannot diffuse to the layered water so that the probability of association with the end of the growing polymer increases.

3. Cell interior is populated by micro-tubules, various filamentary structures, and the so called micro-trabecular matrix. Micro-trabecular network divides cell into a compartments in such a manner that the typical distance between two proteins in water is about 5 nm: this corresponds to the p-adic length scale $L(149)$, the thickness of the lipid layer of cell membrane. This is probably not an accident and the micro-trabecular network might be closely involved with the highly folded network of intracellular membranes. There would be a layer of thickness of about 6 water molecules per given protein surface so that a dominating portion of intracellular water could be structured.

4. The layered water has several tell-tale signatures that have been observed in gels. It freezes at much lower temperature than ordinary water; various relaxation times are shorter since the energy transfer to the water lattice occurs faster than to non-structure water; the diffusion rates of particles into the structured water are much slower than to ordinary water by entropy argument; a simple geometric argument tells that the larger the size of the hydrated ion the lower the diffusion rate; strong gradients of ionic concentrations can form in gel phase as has been observed.

The identification of the cytoplasm as a gel has profound implications for the standard views about cell.

1. The original motivation for postulating semipermeable cell membrane, channels, and pumps was the need to hinder the diffusion of various ions between cell interior and exterior taking place if cytoplasm is ordinary water into which molecules are dissolved. If cytoplasm is in gel phase, cell membrane need not perform pumping and channeling anymore except perhaps in situations involving the formation of a local sol phase. This raises the question about the proper functions of the cell membrane.

2. It is possible to drill to cell membrane holes with size of order 1 μm without an appreciable effect on the functioning of the cell and also show that these holes remain as such for long periods of time [I86] . It is also possible to splice cells into pieces continuing to function for days. That K^+ flux through cell membrane does not change when lipids are partially removed. These findings force to ask whether the assumption about the continuity of the cell membrane might be too strong [I86] . Electron micrographs however demonstrate the presence of the bi-layered structure. What is intriguing that this structure is seen even in the absence of lipid layers. In TGD framework this paradoxical finding might be understood in terms of a presence of space-time sheets corresponding to p-adic length scales $L(k)$, $k = 149, 151$ as vacuum structures predicted also by TGD inspired model of high T_c super-conductivity [K12] .

3. There is also the strange finding that water flux through cell membrane is much higher than the flux through isolate lipid bi-layer as if some unidentified channels were present. In TGD framework this might be seen as an evidence for the presence of (wormhole) magnetic flux tubes as carriers of water molecules.

4. The fundamental assumptions about ionic equilibrium must be reconsidered, and the Hodkin-Huxley model for the generation of nerve pulse becomes more or less obsolete. Indeed, it has been found that action potentials can be generated even in absence of Na^+ and K^+ ions playing a key role in Hodkin-Huxley model. Rather remarkably, the high concentration of K^+ ions and low concentration of Na_+ ions in cytoplasm could be understood on basis of gel property only. Also new view about cell (note membrane-!) potential emerges. The standard paradigm states that the resting potential is over the cell membrane. Potentials of same order of magnitude have been however seen in de-membraned cells (50 mV in slight excess of action potential and critical potential), colloidal suspensions, and gels which suggest that larger part of cell than mere cell membrane is involved with the generation of the action potential and one should thus speak of cell potential instead of membrane potential.

5. Pollack suggests that the phase transitions of the gel phase make possible to realize various functions at molecular and cellular level and represents empirical evidence for the phase transition like aspects assigned to these functions including sensitivity to various factors such as pH, temperature, chemical environment, electromagnetic fields, mechanical forces, etc... and the threshold behavior [I86] . Also the responses are typical for phase transitions in that they involve dramatic changes in volume, shape, di-electric constant, etc.. With these motivations Pollack discusses phase transition based models for contraction, motility, secretion, transport or molecules, organized flow of particles during cell division, cell locomotion, contraction of muscle, generation of action potentials, etc.. For instance, the transport of bio-molecules along micro-tubule could involve propagating gel-sol-gel phase transition meaning also propagating melting of the layered water around micro-tubule.

6. Divalent ions, such as Mg^{+2} and Ca^{+2} can act as cross links between negatively charged proteins binding them to form networks. Monovalent ions cannot do this. Peripheral cytoskeleton is this kind of network consisting of micro-tubules and actin molecules cross-linked - according to Pollack- by Ca^{+2} ions. On the other hand, it is known that Mg^{+2} (Ca^{+2}) ions dominate in the cell interior (exterior) and that the presence of Ca^{+2} ions in the cell exterior is crucial the for generation of nerve pulse. The influx of Na^+ ions having higher affinity to proteins can induce a phase transition to sol-like phase. Pollack suggests a model of nerve pulse based on this mechanism of gel-sol phase transition for peripheral cytoskeleton: this model does not actually explain why Ca^{+2} ions in the exterior of axon are necessary.

5.4.5   TGD based vision inspired by the findings

The vision about dark matter and the model of nerve pulse formulated in terms of Josephson currents brings an additional perspective to the role of pumps and channels and allows to achieve harmony with the standard views about their role.

1. In long length scales visible matter forms roughly 5 per cent of the total amount of matter. In TGD Universe the dark matter would correspond to matter with large Planck constant including dark variants of ordinary elementary particles. In living matter situation could be the same and visible matter could form only a small part of the living matter. Dark matter would be however visible in the sense that it would interact with visible matter via classical electromagnetic fields and photon exchanges with photons suffering Planck constant changing phase transition. Hence one can consider the possibility that most of the biologically important ions and perhaps even molecules reside at the magnetic flux quanta in large $\hbar$ phase.

2. Bosonic ions could form Bose-Einstein condensates at the flux tubes in which case supra currents flowing without any dissipation would be possible. The model for high T_c super-conductivity suggests that only electronic and protonic super-conductivity are possible at room temperature. If so, Cooper pairs of fermionic ions are excluded. New nuclear physics predicted by TGD could however come in rescue here. The TGD based model for atomic nucleus assumes that nuclei are strings of nucleons connected by color bonds having quark and antiquark at their ends. Also charged color bonds are possible and this means the existence of nuclei with anomalous charge. This makes possible bosonic variants of fermionic ions with

different mass number and it would be interesting to check whether biological important ions like Na^+, Cl^-, and K^+ might actually correspond to this kind of exotic ions.

This leads to the following TGD inspired vision about cell as a gel.

1. DNA as TQC hypothesis and cell membrane as sensory receptor provide possible candidates for the actual functions of the cell membrane and ionic channels and pumps could act as kind of receptors. That standard physics is able to to describe gel phase is of course a mere belief and (wormhole) magnetic flux tubes connecting various molecules (DNA, RNA, amino-acids, biologically important ions) would be "new physics" cross-links could explain the strong correlations between distant molecules of the gel phase.

2. Dark ionic currents are quantal currents. If the dark ions flow along magnetic or wormhole magnetic flux tubes connecting cell interior and exterior, their currents through cell membrane would be same as through an artificial membrane.

3. Pumps and channels could serve the role of sensory receptors by allowing to take samples about chemical environment. One cannot exclude the possibility that proteins act as pumps and channels in sol phase if magnetic flux tubes are absent in this phase since also in TGD Universe homeostasis and its control at the level of visible matter in sol phase might requires them. The metabolic energy needed for this purpose would be however dramatically smaller and a reliable estimate for this would allow an estimate of the portion of dark matter in living systems.

4. Quantum criticality suggests that the phase transitions for the gel phase are induced by quantum phase transitions changing the value of Planck constant for magnetic flux tubes and inducing the change of the length of the flux tube. Macroscopic quantum coherence would explain the observed co-operativity aspect of the phase transitions. Concerning locomotion and transport mountain climbing using pickaxe and rope inspires a guess for a general mechanism. For instance, a packet of molecules moving along actin molecule or a molecule carrying a cargo along micro-tubule could repeat a simple basic step in which a magnetic flux tube with large $\hbar$ is shot along the direction of the electric field along micro-tubule and stuck to a rachet followed by a phase transition reducing the value of $\hbar$ and shortening the flux tube and forcing the cargo to move forward. The metabolic energy might be provided by the micro-tubule rather than molecular motor.

5. The reconnection of flux tubes would be a second phase transition of this kind. This phase transition could lead from a phase in phase proteins are unfolded with flux tubes connecting amino-acids to water molecules and thus possessing a large volume of layered water around them to a phase in which they become folded and flux tubes connect amino-acids to each other in the interior of protein. The phase transition could be associated with the contraction of connecting filaments of muscle cell. The phase transitions are also seen in "artificial protein" gels used for drug delivery applications, and are built from polymers arranged in alpha helices, beta sheets and common protein motifs [I86] . If wormhole magnetic flux are taken are taken as a basic prerequisite of life, one must ask whether these "artificial proteins" represent artificial life.

6. The fact that cytoskeleton rather than only cell membrane is involved with the generation of action potential conforms with the idea that nerve pulse propagating along axon involves also axonal micro-tubules and that Josephson currents between axon and micro-tubules are involved in the process.

7. Di-valent ions (Ca^{+2} ions according to Pollack) serve as cross links in the peripheral cytoskeleton. The influx of monovalent ions from the exterior of axon induces gel-sol phase transition replacing di-valent ions with monovalent ions. One can consider two models.

   (a) The minimal assumption is that this phase transition is induced $\hbar$ increasing phase transition the flow of the monovalent ions like Na^+ from the cell exterior along the magnetic flux tubes connecting axonal interior and interior. Suppose that in the original

situation the flux tubes end to axonal membrane (this is not the only possibility, they could also end to Ca^{+2} ions). The flux tubes extending to the axonal exterior could result by $\hbar$ increasing phase transition increasing the length of the flux tubes connecting peripheral cytoskeleton to the axonal membrane so that they extend to the exterior of axon. This option is rather elegant since gel-sol phase transition itself can be understood in terms of "standard chemistry". In this model the very slow diffusion rate of the ions to gel phase would have explanation in terms of new physics involving dark matter and (wormhole) magnetic flux tubes.

(b) One can consider also an option in which divalent ions such as Ca^{+2} or Mg^{+2} are connected by two flux tubes to amino-acids of two negatively charged proteins whereas monovalent biological ions like Na^+ would have single flux tube of this kind and could not act as cross links. In the phase transitions removing the cross links the replacement of divalent ion with two monovalent positively charged ions would take place. If one believes in standard chemistry, Na^+ ions would flow in automatically. First the increase of Planck constant would induce the lengthening of the magnetic flux tubes and thus the expansion of the gel phase making possible the influx of monovalent ions. If Na^+ ions are dark, flux tubes connecting peripheral cytoskeleton to the axonal exterior are required and the mechanism of option i) is also needed.

8. The mechanisms i) and ii) could be fused to a single one. The hint comes from the presence of Ca^{+2} ions in the exterior of axon is necessary for the generation of action potential. The simplest possibility is that the flux tubes connecting proteins to intracellular Ca^{+2} cross links in gel phase connects them after the length increasing phase transition to extracellular Ca^{+2} ions and Na^+ ions flow along these flux tubes.

9. The increase of the Planck constant would induce the expansion of the peripheral cytoskeleton making possible the inflow of Na^+ ions, and divalent ions binding negatively charged actin molecules to a network would be replaced with inflowing Na^+ ions. After this a reverse phase transition would occur. Both phase transitions could be induced by a quantal control signal (Josephson current) inducing quantum criticality and a change of Planck constant.

10. A propagating Ca^{+2} wave inducing the gel-sol-gel phase transition of peripheral cytoskeleton would accompany nerve pulse. Quite generally, Ca^{+2} waves are known to play a fundamental role in living matter as kind of biological rhythms. Irrespective of whether one believes option a) or b), this might relate to the cross-linking by flux tubes and gel-sol-gel phase transitions induce by phase transitions increasing Planck constant temporarily. The velocities and oscillation periods of Ca^{+2} waves vary in an extremely wide range: this can be understood if the flux tubes involved correspond to a very wide spectrum of Planck constant.

Besides basic ions cell membrane is non-permeable to various polar molecules such as the basic building bricks of DNA and amino-acids. The safest assumption is that genetically coded pump and channel proteins make possible the transfer. One must of course consider the possibility that channels and pumps are used to make the transfer of basic ions more effective. Taking this into account, the proposed vision does not differ so radically from the standard one as one might think first and only the model for nerve pulse generation must be modified radically.

To sum up, the strange discoveries about the behavior of cell membrane provide direct experimental evidence for the presence of dark matter in living systems, for the prediction that it interacts with ordinary matter via classical electromagnetic fields, and for the assumption that it does not dissipate appreciably and could therefore have large value of $\hbar$ and form macroscopic quantum phases.

5.5 Quantum model for the direct currents of Becker

Robert Becker [J42] proposed on basis of his experimental work that living matter behaves as a semiconductor in a wide range of length scales ranging from brain scale to the scale of entire body. Direct currents flowing only in preferred direction would be essential for the functioning of living manner in this framework.

One of the basic ideas of TGD inspired theory of living matter is that various currents, even ionic currents, are quantal currents. The first possibility is that they are Josephson currents associated with Josephson junctions but already this assumption more or less implies also quantal versions of direct currents.

TGD inspired model for nerve pulse assumes that ionic currents through the cell membrane are quantal currents. If they are Josephson currents, the situation is automatically stationary and dissipation is small as various anomalies suggest. One can criticize this assumption since the Compton length of ions for the ordinary value of Planck constant is so small that magnetic flux tubes carrying the current through the membrane look rather long in this length scale. Therefore either Planck constant should be rather large or one should have a non-ohmic quantum counterpart of a direct current in the case of ions and perhaps also protons in the case of neuronal membrane: electronic and perhaps also protonic currents could be still Josephson currents. This would conform with the low dissipation rate.

In the following the results related to laser induced healing, acupuncture, and DC currents are discussed first. The obvious question is whether these direct currents are actually supracurrents and whether they could be universal in living matter. A TGD inspired model for quantal direct currents is proposed and its possible implications for the model of nerve pulse are discussed.

Whether the model for quantum direct currents is consistent with the proposed vacuum extremal property of the cell membrane remains an open question but both options explain the special role of Ca^{++} currents and current of Na^{+} Cooper pairs in the generation of nerve pulse as in would take place in TGD Universe. In fact, it is not clear what one exactly means with the vacuum extremal property of cell membrane. Many-sheeted space-time (see fig. `http://www.tgdtheory.fi/appfigures/manysheeted.jpg` or fig. 9 in the appendix of this book) allows to consider space-time sheets which can be both almost vacuum extremals and far from vacuum extremals. Also space-time sheets for which Planck constant is so large that both electronic and protonic Josephson currents become possible. Various pumps and channels could actually correspond to magnetic flux tubes along which various ionic supra currents or even Josephson currents can flow. The condition that both electronic and protonic supra currents are possible in same length scale leads to the hierarchy of Planck constants coming approximately as powers of $m_p/m_e \simeq 2^{11}$ proposed originally as a general truth. Radiation at Josephson frequency serves as a signature for Josephson currents.

In the following a TGD inspired quantum model for the direct currents of Becker as direct quantum currents is developed and shown to be consistent with what is known about nerve pulse generation.

5.5.1 Connection between laser induced healing, acupuncture, and association of DC currents with the healing of wounds

The findings of Robert Becker (the book "The Body Electric: Electromagnetism and the Foundation of Life" by Becker and Selden can be found from web [J42]) meant a breakthrough in the development of bioelectromagnetics. One aspect of bioelectromagnetic phenomena was the discovery of Becker that DC currents and voltages play a pivotal role in various regeneration processes. Why this is the case is still poorly understood and Becker's book is a treasure trove for anyone ready to challenge existing dogmas. The general vision guiding Becker can be summarized by a citation from the introduction of the book.

Growth effects include the alteration of bone growth by electromagnetic energy, the restoration of partial limb regeneration in mammals by small direct currents, the inhibition of growth of implanted tumors by currents and fields, the effect upon cephalocaudal axis development in the regenerating flatworm in a polarity-dependent fashion by applied direct currents, and the production of morphological alterations in embryonic development by manipulation of the electrochemical species present in the environment. This partial list illustrates the great variety of known bioelectromagnetic phenomena.

The reported biological effects involve basic functions of living material that are under remarkably precise control by mechanisms which have, to date, escaped description in terms of biochemistry. This suggests that bioelectromagnetic phenomena are fundamental attributes of living things, ones that must have been present in the first living things. The traditional approach to biogenesis postulates that life began in an aqueous environment, with the development of complex molecules

and their subsequent sequestration from the environment by membranous structures. The solid-state approach proposes an origin in complex crystalline structures that possess such properties as semi-conductivity, photoconductivity, and piezoelectricity. All of the reported effects of electromagnetic forces seem to lend support to the latter hypothesis.

Observations relating to CNS

The following more quantitative findings, many of them due to Becker, are of special interest as one tries to understand the role of DC currents in TGD framework.

1. CNS and the rest of perineural tissue (tissue surrounding neurons including also glial cells) form a dipole-like structure with neural system in positive potential and perineural tissue in negative potential. There is also an electric field along the neuron in the direction of nerve pulse propagation (dendrites correspond to - and axon to +) (note that motor nerves and sensory nerves form a closed loop). Also microtubules within axon carry electric field and these fields are probably closely related by the many-sheeted variants of Gauss's and Faraday's laws implying that voltages along two different space-time sheets in contact at two points are the same in a static situation.

2. A longitudinal potential along front to back in the brain with the frontal lobes in negative potential with respect to occipital lobes and with a magnitude of few mV was discovered. The strength of the electric field correlates with the level of consciousness. As the potential becomes weaker and changes sign, consciousness is lost. Libet and Gerard observed traveling waves of potentials across the cortical layers (with speeds of about 6 m/s: TGD inspired model of nerve pulse predicts this kind of waves [K66]). Propagating potentials were also discovered in glial cells. The interpretation was in terms of electrical currents.

3. It was found that brain injury generated positive polarization so that the neurons ceased to function in an area much larger than the area of injury. Negative shifts of neuronal potentials were associated with incoming sensory stimuli and motor activity whereas sleep was associated with a positive shift. Very small voltages and currents could modulate the firing of neurons without affecting the resting potential. The "generating" potentials in sensory receptors inducing nerve pulse were found to be graded and non-propagating and the sign of the generating potential correlated with sensory input (say increase/reduction of pressure). Standard wisdom about cell membrane has difficulties in explaining these findings.

4. The natural hypothesis was that these electric fields are accompanied by DC currents. There are several experimental demonstrations for this. For instance, the deflection of assumed DC currents by an external magnetic field (Hall effect) was shown to lead to a loss of consciousness.

Observations relating to regeneration

The second class of experiments used artificial electrical currents to enhance regeneration of body parts. These currents are nowadays used in clinical practice to induce healing or retard tumor growth. Note that tissue regeneration is a genuine regeneration of an entire part of the organism rather than mere simple cell replication. Salamander limb generation is one of the most studied examples. Spontaneous regeneration becomes rare at higher evolutionary levels and for humans it occurs spontaneously only in the fractures of long bones.

1. An interesting series of experiments on Planaria, a species of simple flatworm with a primitive nervous system and simple head-to-tail axis of organization, was carried out. Electrical measurements indicated a simple head-tail dipole field. The animal had remarkable regenerative powers; it could be cut transversely into a number of segments, all of which would regenerate a new total organism. The original head-tail axis was preserved in each regenerate, with that portion nearest the original head end becoming the head of the new organism. The hypothesis was that the original head-tail electrical vector persisted in the cut segments and provided the morphological information for the regenerate. The prediction was that the reversal of the electrical gradient by exposing the cut surface to an external current source of

proper orientation should produce some reversal of the head-tail gradient in the regenerate. While performing the experiment it was found found that as the current levels were increased the first response was to form a head at each end of the regenerating segment. With still further increases in the current the expected reversal of the head-tail gradient did occur, indicating that the electrical gradient which naturally existed in these animals was capable of transmitting morphological information.

2. Tissue regeneration occurs only if some minimum amount of neural tissue is present suggesting that CNS plays a role in the process although the usual neural activity is absent. The repeated needling of the stump had positive effect on regeneration and the DC current was found to be proportional to innervation. Hence needling seems to stimulate innervation or at least inducing formation of DC currents. Something like this might occur also in the case of acupuncture.

3. Regeneration involves de-differentiation of cells to form a blastema from which the regenerated tissue is formed. Quite early it was learned that carcinogens induce de-differentiation of cells because of their steric properties and by making electron transfer possible and that denervation induces tumor formation. From these findings Becker concluded that the formation of blastema could be a relatively simple process analogous to tumor growth whereas the regeneration proper is a complex self-organization process during which the control by signals from CNS are necessary and possibly realized in terms of potential waves.

4. Regeneration is possible in salamanders but not in frogs. This motivated Becker and collaborators to compare these situations. In an amputated leg of both salamander and frog the original negative potential of approximately -1 mV was raised first to a positive value of about +10 mV. In the frog it returned smoothly to its original value without regeneration. In the salamander it returned over a period of three days to the original base line and then went to a much higher negative value around -20 mV (resting potential is around -70 mV) followed by a return to the original value once regeneration had occurred. Thus the large negative potential is necessary for the regeneration and responsible for the formation of blastema. Furthermore, artificial electron current also induced regeneration also in the case of the frog, even in the denervated situation. Thus the flow of electrons to the stump seems to be necessary for the formation of blastema and the difference between salamander and frog is that frog is not able to provide the needed electronic current although positive potential is present.

5. It was also learned that a so called neuroepidermal junction (NEJ) formed in the healing process of salamander stump was responsible for the regeneration in the presence of denervation. The conclusion was that the DC voltage and electronic current relevant for regeneration could be assigned the interface between CNS and tissue rather than to the entire nerve and the regeneration seemed to be a local process, perhaps a feed of metabolic energy driving self-organization. Furthermore, NEJ seemed to make possible the flow of electrons from CNS to the stump.

6. The red blood cells of animals other than mammals are complete and thus possess nuclei. Becker and collaborators observed that red blood cells also dedifferentiated to form blastemas. Being normally in a quiescent state, they are ideal for studying de-differentiation. It was found that the electric current acted as a trigger at the level of cell membrane inducing de-differentiation reflected as an increased amount of mRNA serving as marker of gene expression. Also pulsed magnetic field was found to trigger the de-differentiation, perhaps via induced electric field. By the way, the role of the cell membrane fits nicely with the TGD inspired view about DNA-cell membrane system as topological quantum computer with magnetic flux tubes that are assumed to connect DNA and cell membrane and serve as braid strands in TGD inspired model of DNA as topological quantum computer [K23].

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7. The experiments of Becker and collaborators support the identification of the charge carriers of DC currents responsible for the formation of the stump's large negative potential as electrons. The test was based on the different temperature dependence of electronic and protonic

conductivities. Electronic conductivity increases with temperature and protonic conductivity decreases and an increase was observed.

Gene activation by electrostatic fields?

The basic question concerns the method of activation. The discovery of chemists Guido Ebner and Guido Schuerch [J17] raises the hope that these ideas might be more than over-active imagination and their work also provides a concrete proposal for the activation mechanism. Ebner and Schuerch studied the effect of electrostatic fields on the growth and morphogenesis of various organisms. Germ, seeds, or eggs were placed between conducting plates creating an electric field in the range .5-2 kV/m: note that the Earth's electric field is in the range $.1 - 4$ kV/m and of the same order of magnitude.

The outcome was rather surprising and in the year 1989 their employer Ciba Geigy (now Novartis) applied for a patent "Method of enhanced fish breeding" [J17] for what is called Ciba Geigy effect. The researchers describe how fishes (trouts) develop and grow much better, if their eggs have been conditioned in an electrostatic field. The researchers also reporedt [J17] that the morphology of the fishes was altered to what seems to represent an ancient evolutionary form: this was not mentioned in the patent.

The chemists founded their own Institute of Pharmaceutical Research near Basel, where Guido Ebner applied for another very detailed patent, which was never granted. In the patent he describes the effect of electrostatic fields on several life forms (cress, wheat, corn, fern, micro-organisms, bacteria) in their early stage of development. A clear change in the morphogenesis was observed. For instance, in one example fern had all sort of leaves in single plant apparently providing a series of snapshots about the evolution of the plant. The evolutionary age of the first leaf appeared to be about 300 million years whereas the last grown-up leaf looked close to its recent form.

If one takes these finding seriously, one must consider the possibility that the exposure to an electrostatic field can activate passive genes and change the gene expression so that older morphologies are expressed. The activation of not yet existing morphologies is probably more difficult since strong consistency conditions must be satisfied (activation of program requires activation of a proper hardware). This would suggest that genome is a kind of archive also containing also older genomes even potential genomes or that topological quantum computer programs [K23] determine the morphology to a certain extent and that external conditions such as electric fields determine the self-organization patterns characterizing these programs.

It is known that the developing embryo has an electric field along the head-tail axis and that this field plays an important role in the control of growth. These fields are much weaker than the fields used in the experiment. p-Adic length scale hierarchy however predicts an entire hierarchy of electric fields and living matter is indeed known to be full of electret structures. The strength of the electric field in some p-adic length scale related to DNA might somehow serve as the selector of the evolutionary age. The recapitulation of phylogeny during ontogeny could mean a gradual shift of the activated part of both genome and "memone" (as as menetic analog of genome: for a proposal of memetic code see [K36]), perhaps assignable to topological quantum computer programs realized as braidings, and be controlled by the gradually evolving electric field strength.

The finding that led Ebner to his discovery was that it was possible to "wake up" ancient bacteria by an exposure to an electrostatic field. The interpretation would be in terms of loading of metabolic batteries. This would also suggest that in the case of primitive life forms like bacteria the electric field of the Earth has served as metabolic energy source whereas in higher life forms endogenous electric fields have taken the role of Earth's electric field.

A TGD based model for the situation

On the basis of these observations one can try to develop a unified view about the effects of laser light, acupuncture, and DC currents. It is perhaps appropriate to start with the following - somewhat leading - questions inspired by a strong background prejudice that the healing process - with control signals from CNS included - utilises the loading of many-sheeted metabolic batteries by supra currents as a basic mechanism.

The first series questions, observations, and ideas relates to the connection of DC currents with metabolism and ordinary biochemistry. The hierarchy of Planck constant is expected to be

involved somehow.

1. How the DC currents relate to metabolism and ordinary biochemistry? For what purpose they are needed? The crucial point is that the energy of order 1 meV gained by electron in the electric field is much below the metabolic energy quantum and also thermal energy so that the interpretation in terms of metabolic energy quantum does not look promising. This forces to consider the possibility that the basic role of electric field is to drive electrons to where they are needed, say wounded part of tissue in positive potential and thus attrracting electrons. Electrons are indeed needed by the electron transport cycle appearing in both photosynthesis and cell respiration since the transport cycle induces leakage of electrons due to the formation of ROS (reactive oxygen species) such as O_2^-. The purpose of electronic Becker currents would be therefore the re-establishment of metabolism.

   The change of the sign of the Becker potential to positive induce a loss of electrons and reduced metabolism. This could explain why consciousness is lost when the sign of Becker potential is changed or electrons are deviated by Hall effect. Wound damages the connections of the tissue to the organism and the transfer of electrons compensating for leaked electrons is prevented since Becker potential changes sign. The regeneration induced by an artificial Becker potential of correct sign would induce healing by re-establishing the electron feed.

   The crucial question concerns the role of electrons. It seems that in all situations electron flow to the damaged tissue induces healing. Why electrons generating negative potential should help in healing? The first input is TGD model [K106] [L38] for the findings of Pollack [L38] involves the connection of dark matter hierarchy $h_{eff} = n \times h$ with negentropic entanglement characterized by density matrix reducing to $n \times n$ unit matrix for unitary entanglement matrix. A further input is the observation that the gravitational Planck constant h_{gr} explaining planetary Bohr quantization rules can be equal to h_{eff} in living matter for microscopic systems like elementary particles, atoms, and ions, even molecules [K118, K64].

1. Pollack's findings about fourth phase of water formed when external energy feed induces formation of negatively charged exclusion zones of water obeying stoichiometry $H_{1.5}O$ with 1/4:th of protons going to the complement of exclusion zone. Something similar might happen also now.

2. In TGD framework this process is explained as a formation dark phase of protons at the magnetic flux tubes associated with the exclusion zone with dark protons realizing genetic code so that one obtains what might be regarded as primitive primordial life form.

3. There is evidence for a huge anomalous gravimagnetic Thomson field in rotating super conductors. Thomson field is proportional to square of Planck constant h_{eff} and TGD explanation is that large h_{gr} phase is formed at gravitational flux tubes. The assumption $h_{gr} = h_{eff}$ in elementary particle and atomic scales is possible and is consistent with the hypothesis that bio-photons in visible and UV energy range correspond to decay products of dark EEG photons.

4. $\hbar_{gr}$ can be generalized to $\hbar_{em} = -Z_1 Z_2 e^2 / v_0$: v_0 would be typical rotational velocity in a system with opposite charges Z_1 and Z_2. Exclusion zone would be good example. For ATP v_0 would be rotational velocity of ATP. For exclusion zone v_0 could be rotational velocity of Cooper pairs in magnetic field associated with flux tubes or walls or rotational velocity of magnetic body. $Z_2 = -Z_1$ is natural assumption by charge neutrality.

5. In this framework the feed of electrons would increase the value of h_{eff} by increasing the negative charge associated with the analog of exclusion zone accompanying the wound and induce also a flow of dark protons to the magnetic flux tubes associated with the magnetic body of the analog of exclusion zone.

6. The DC currents would be needed because the damage of the tissue means that the $\hbar_{eff} = \hbar_{em} = Z^2 e^2 / v_0$ is reduced for a pair formed by damaged system and its complement. Healing would be essentially attempt to increase h_{eff} to its original value. The parameter Z^2 is reduced and must be increased to its original value and perhaps even to a higher value

since the larger ger the value of h_{eff} is, the richer the negentropic resources of system are. The transfer of electrons to the system analogous to exclusion zone induces transfer of dark protons to the magnetic flux quanta of the magnetic body of the system. Recall that dark proton strings at flux tubes could be analogs of dark nuclei and that the model for dark nucleons allows to identify nucleon states as counterparts of DNA,RNA, amino-acids and even tRNA. This leads to a model of prebiotic lifeforms [K37].

7. ATP synthase transforming ADP to ATP involves rotating shaft and one can ask whether the velocity parameter v_0 appearing in the expression for $\hbar_{em}$ equals to the rotation speed of the shaft. This predicts that the value of $\hbar_{em}$ to be same order as $\hbar_{eff}$ and $\hbar_{gr}$ for Earth-electron system assuming that v_0 corresponds to the rotation velocity at the surface of Earth. The assumption $h_{eff} = h_{gr} = h_{em}$ makes it possible for the gravitational and em flux tubes to reconnect.

8. The original guess was that electrons to provide energy giving rise to the formation of ATP in cell respiration and photosynthesis. Electrons themselves receive their energy either from the oxidation of molecules or from solar photons. This model is consistent with the model above since electron transport chain is crucial for cell transpiration and needs both electrons and dark protons located at the dark flux tubes associated with the exclusion zones. Dark protons would flow through the ATP synthase attached to mitochodrial membrane and liberate dark cyclotron energy if the value of the magnetic fields associated with the flux tube is different for the interior and exterior portions of the flux tube [K20, K62].

The experimental support for the role of bio-photons in living matter is accumulating and a natural question concerns their role in metabolism. In TGD framework dark photons with large value of $\hbar_{eff}$ with energy of visible photon can transform to ordinary photons of same energy with some - presumably rather small - probability, and would be interpreted as bio-photons. Could dark photons take the role of solar photons and provide in some situations energy to the electrons in the electron transport cycle? This would mean a non-conventional non-local mechanism of metabolism. The effects of laser light on tissue suggest that laser light indeed takes the role of solar light and feed energy to the electron transport cycle transforming it to the energy of high energy phosphate bond of ATP. A more detailed TGD inspired view about what might happen is discussed in [K40].

One can consider also the possibility that quantum credit card mechanism (remote metabolism) could be at work in some the situations when chemical metabolic energy sources are absent. Damaged tissue might define this kind of exceptional situation. This brings in mind the strange ability of plants suffering under-nutrition to attract insects responsible for their pollination observed by Callahan, who has also reported that plants and insects communicate using infrared light which according to his findings serves as a sensor input in insect olfaction [I22]: also in this case quantum credit card mechanism building magnetic flux tube bridges guiding the insects to the plant might be at work. The electrons which have gained 1 meV energy during travel along pairs formed by MEs and parallel magnetic flux tubes (meridians), could send negative energy dark photons with energy of order -.5 eV to gain same positive energy allowing to get over the semiconductor junction after they have arrived to the damaged tissue. These negative energy photons would be absorbed by a metabolic energy store (ATP in mitochondria transforming to ADP) in the healthy part of the organism.

$h_{br} = h_{em}$ implies that the spectrum of bio-photons originating from dark cyclotron photons is universal having no dependence on ion mass and in visible and UV range, which is also the range for molecular excitation energies. Dark cyclotron photons decaying to bio-photons would therefore allow magnetic body to control biochemistry by resonant absorption inducing transitions of molecules.

The original model for the charging of the metabolic batteries and for effective semi-conductor junction assumed that the electrons of supra current are transferred to smaller space-time sheets.

1. For ground state electrons this requires energy which is at least the difference of zero point kinetic energies of electron at the two space-time sheets. This energy should be of the order of fundamental metabolic energy quantum of about .5 eV.

   For Cooper pairs of electrons the sheet should correspond to p-adic length scale of order $L_e(k_e = 149) = 10$ nm, the thickness of lipid layer of cell membrane. For single pro-

ton corresponding scale would be $L_e(k_p = 139) \simeq 2^{-12}L_e(151)$ from $m_p/2m_e \simeq 2^{10}$ and $E_{0,p}/E_{0,2e} = (2m_e/m_p) \times (L_e(k_e)/L_e(k_p))^2 = (2m_e/m_p) \times 2^{k_e - k_p} \sim 1$.

This suggests that electron Cooper pair is kicked to a smaller space-time sheet assignable to a mitochondrial lipid layer having $k_e = 149$. The larger space-time sheet could be that of cell membrane with $k = 151$. For protons the zero point kinetic energies at these space-time sheets are by a factor $2m_e/m_p$ lower and of the order of .5 meV. This happens to be of the same order of magnitude as the energy gained by proton or electron in the Becker potential. May be this is not an accident.

There is also a second intriguing quantitative co-incidence. In the absence of an action potential, acetylcholine vesicles spontaneously leak into the synaptic junction and cause very small de-polarizations in the postsynaptic membrane known as miniature end plate potentials (mEPSP) of magnitude .5 mV (see `http://en.wikipedia.org/wiki/End-plate_potential`). These potentials are too small to generate action potential but together they can sum up to the needed action potential. Maybe the interpretation in terms of proton kicked to lipid layer space-time sheet might make sense.

2. The re-charging mechanism should relate directly to ADP$\rightarrow$ ATP process occurring during electronic transport cycle in mitochondrial membrane. The connection with metabolism forces to ask how the formation of high energy phosphate bond in the addition of phosphate to ADP relates to the transfer of electrons to smaller space-time sheet. Somehow the energy of electrons must go to the formation of this bond: perhaps the dropping of electron back to larger space-time sheet transfers the energy to the high energy phosphate bond.

In many-sheeted space-time particles topologically condense at all space-time sheets having projection to given region of space-time so that this option makes sense only near the boundaries of space-time sheet of a given system. Also p-adic phase transition increasing the size of the space-time sheet could take place and the liberated energy would correspond to the reduction of zero point kinetic energy. Particles could be transferred from a portion of magnetic flux tube portion to another one with different value of magnetic field and possibly also of Planck constant h_{eff} so that cyclotron energy would be liberated.

3. The transfer of particles between space-time sheets with different p-adic length scales is not the only one that one can consider, and recently a more elegant mechanism has emerged [K40]. If the particles are free, a phase transition in which the p-adic prime of the space-time sheet containing particles decreases adiabatically increases the scale of kinetic energy but leaves particle quantum numbers unchanged. If the same happens for charge particles at magnetic flux tubes, similar increase of cyclotron energy scale takes place since magnetic field strength increase to conserve magnetic flux. The predictions are in good approximation the same as for the original model. If the phase transition reducing p-adic length scale is accompanied by a compensating increase of Planck constant, the size scale of space-time sheet remains unaffected but metabolic batteries are loaded. The reversal of this phase transition liberates metabolic energy. What is important that metabolic energy and negentropic entanglement (measured in terms of the value of Planck constant) are closely correlated for this mechanism. The loading/liberation of energy is also a quantum coherent process.

4. Acupuncture and the application of DC current are known to induce the generation of endorphins. Do endorphins contribute to well-being by reducing the pain? In TGD framework the deeper level interpretation of metabolism is as a provider of negentropic entanglement in turn giving rise to well-being. Are endorphins kind of negentropy packets or just conscious signals about the improved situation?

Second series of questions, observations, and ideas relates to the meridians, acu points, and "chi".

1. A permanent potential difference of same sign between head and tail could mean an accumulation of positive and negative charges to the ends of the of the system if only electron currents are present. If both electron and proton currents with opposite directions are present, there is no accumulation of charge but there is an accumulation of protons and electrons. Probably there exists a pumping mechanism forcing the electrons (and possibly also protons) to

move against the potential gradient from the tail back to the head. This however requires metabolic energy and the simplest source of this energy would be just the energy of electrons otherwise used to generate ATP. If so, the leakage would not be an unavoidable dissipative effect but a manner to avoid charge accumulation.

If the pumping mechanism is not at work, this situation cannot continue for ever and the sign of the potential difference must eventually change and induce loss of consciousness. The simplest possibility is that the potential difference changes sign rhythmically. A natural question is whether the sleep-awake rhythm is unavoidable and corresponds to the oscillatory behavior of the head-to-tail voltage.

2. "Chi" would correspond electrons or their Cooper pairs in this picture. Abnormal chi flow (reduced flow, flow in wrong direction, accumulation of chi) would cause various problems including also insomnia in which too much electron charge tends to accumulate.

3. What is the nature of acupuncture meridians, what kind of currents flow along them, and why are they not directly observed? The most natural identification in TGD Universe would be in terms of magnetic flux tubes accompanied by parallel massless extremals (MEs) making possible also the propagation of dark photons used for control purposes and perhaps even in metabolism as already discussed. Dark currents along pairs of MEs and magnetic flux tubes are ideal for the transfoer of particles and energy.

   If the length of the superconducting "wire" is long in the scale defined by the appropriate quantum scale proportional to $\hbar$, the classical picture makes sense and charge carriers can be said to accelerate and gain energy ZeV. For large values of $\hbar_{eff}$ an oscillating Josephson current would be in question. Since Becker currents are associated with CNS, it would be natural to associate the meridians with neural pathways although this assignment is not necessary. Magnetic flux tube system defined kind of magnetic circulation which could serve as a template for the neural pathways. The transfer of energy with minimal dissipation would explain why a semiconductor like property is needed and why acupuncture points have a high conductivity value.

4. What about acu-points? Acu points are known to be in negative potential normally. This suggests that the density of electrons or their Cooper pairs at them is higher than elsewhere in the meridian. Could they server as kind of electron stores providing electrons to their environment to compensate for losses caused by ROS. This would make possible higher metabolic activity in presence of nutrient molecules since the rate for the electron transform cycle should be proportional to the density of energizable electrons, "chi".

   When the potential of the acu-point is reduced or become positive, under-nutrition follows. This should relate to various symptoms like pain at acupuncture points. Acupuncture needle as an electronic conductor would develop a charge distribution with a concentration of electrons to the acu-point, and would re-establish the metabolic activity. Pain would be signature of lack of negentropic entanglement (see fig. `http://www.tgdtheory.fi/appfigures/cat.jpg` or fig. 21 in the appendix of this book) and positive/negative coloring of emotions and sensations would quite generally correlate with the amount of negentropic entanglement.

5. Nanna Goldman et al have provided empirical evidence [I49] for the expectation that the healing effect of the acupuncture involves metabolism (see the popular article in Sciencedaily [I23]).

   The group has found that adenosine is essential for the pain killing effects of acupuncture. For mice with a normal adenosine level acupuncture reduced dis-comfort by two-thirds. In special "adenosine receptor knock-out mice" acupuncture had no effect. When adenosine was turned on in the tissues, the discomfort was reduced even in the absence of acupuncture. During and after an acupuncture treatment, the level of adenosin in tissues near the needles was 24 times higher than before the treatment. In the abstract of the article it is stated that it is known for long time that acupuncture generates signals which induce brain to generate natural pain killing endorphins but that also adenosine acts as a natural pain killer.

   Adenosine is the basic building block of AXP, X=M,D,T (adenosin-X-phosphate, X=mono,di,tri). Therefore the findings suggest that the flow of electrons from the needle to acu point loads

metabolic batteries by providing electrons to electron transport cycle needed to generate ATP. Adenosine could be partially generated as decay products of AXPs. Tissue itself could increase adenosine concentration to make possible its transformation to AXP utilizing electric field energy. From the popular article one cannot conclude whether the authors propose a connection with metabolism. The results are consistent with the assumption that the AXPs generated from adenosin accompany negentropic entanglement. This can occur in the scale of entire body and meridians could also make possible direct signalling with brain.

How can understand the semiconducting character of Becker's DC currents?

1. Becker assigns to the system involved with DC currents an effective semiconductor property. Could the effective semiconductor property be due the fact that the transfer of charge carriers to a smaller space-time sheet by first accelerating them in electric field is analogous to the transfer of electrons between conduction bands in semiconductor junction? If so, semiconductor property would be a direct signature of the realization of the metabolic energy quanta as zero point kinetic energies. For metabolic energy quantum of order .5 eV this however makes sense only if the electrons transferred to the smaller space-time sheet have energy slightly below the minimum energy for the transfer to the smaller space-time sheet in absence of the Becker potential. The situation would be critical and 1 mV voltage could serve as a kind of control knob.

   One can imagine the analog of this mechanism also when the external energy feed corresponds to a phase transition reducing p-adic length scale and increasing Planck constant so that the size of the space-time sheet remains unaffected. Again 1 mV voltage would have the role of control knob.

2. Supra currents flowing along magnetic flux tubes would make possible dissipation-free loading of metabolic energy batteries. This even when oscillating Josephson currents are in question since the transformation to ohmic currents in semiconductor junction makes possible energy transfer only during second half of oscillation period. Could this be a universal mechanism applying to various stages of the regeneration process? In quantal situation the metabolic energy quanta have very precise values as indeed required.

3. The findings of Becker provide support for electronic DC currents. The Cooper pairs of electrons are indeed the best candidates for the carriers of supra current by their small mass. In the minimal situation the currents defined by leaked electrons moving against potential gradient (utilising the energy used otherwise to generate ATP) could compensate the Becker currents and give rise to closed current loops without charge accumulation. If the electronic DC currents observed by Becker are much stronger than needed to compensate for the local electron leakage, a larger metabolically driven return current is needed to guarantee local charge neutrality. These currents seem to be assignable to CNS: maybe the two electron currents could be associated with sensory and motor pathways. An interesting question whether sympathetic-parasympathetic dichotomy also relates to electron currents in opposite directions.

4. Could also dark protonic and even ionic DC currents be present and running along their own flux tubes and perhaps defining cyclotron Bose-Einstein condensates? How large the scale of flux tubes can be: could it be much larger than that of biological body (by simple argument magnetic body should have layers with even size scale of Earth). What is the possible connection with cell respiration? When single ATP is generated, three protons are are pumped through the mitochondrial membrane utilising the energy liberated in electron transport cycle. This does not however require protonic currents in longer scales.

5. In regeneration process NEJs are formed. They could consist of pairs of MEs and magnetic flux tube mediating the electronic DC current during blastema generation and regeneration proper during which also control signals from CNS would be present. Since NEJs seems to resemble cell membranes in some respects, the ideas inspired by the model of cell membrane and DNA as TQC can be used. The model for nerve pulse and the model for DNA as topological quantum computer suggest that dark ionic currents flowing along magnetic flux

tubes characterised by a large value of the effective Planck constant are involved with both meridians and NEJs. Magnetic flux tubes can act as DC current wires or Josephson junctions generating oscillatory supra currents of ions and electrons. Also for large values of the effective Planck constant meridians look short in the relevant dark length scale and could act as Josephson junctions carrying oscillatory Josephson currents.

One can raise also questions about the relationship between DC currents and de-differentiation.

1. Could cell de-differentiation be caused by the presence of Becker's DC current? Also acupuncture is known to induce de-differentiation. Could the mere ability to charge metabolic energy batteries provided by electron feed induce de-differentiation, which manifests as an increased genetic expression? Can one see differentiation as an eliminative process forced by the reduction of the electron feed and inducing a selective reduction of gene expression? If this were the case, de-differentiation could be induced by a feed of surplus electrons to the system using either external electron current or additional electric field. Local electron density would correlate negatively with the degree of differentiation.

2. In this framework it might be possible to understand the claimed effects of external electric fields on the development of plants and fishes. In this case rejuvenation means return to the earlier evolutionary stages. Maybe ontogeny-recapitulates-phylogeny principle might allow to understand this if genome in some sense contains archive about earlier stages of evolution. This archive might be virtual and realised by an epigenetic mechanism selecting different patterns of gene expression using the same genome.

    If this is the case, the density of electrons or their Cooper pairs - "chi" - possessed by the cell would serve as a measure for the biological age of the cell and the meridian system feeding "chi" would serve as a rejuvenating agent with respect to gene expression. The average density of dark electrons would serve as a measure for the age of cell: the larger the density the higher the metabolic activity and the lower the biological age.

5.5.2   Quantum model for effective semiconductor property

Becker [J42] summarizes his findings by stating that living matter is an effective semiconductor. There are pairs of structures in positive and negative potential in various scales and the current between the plates of this effective capacitor flows when above some minimum potential difference. The current flows from positive to negative pole and could be an electron current. Also proton current in the opposite direction can be considered but the electron current is experimentally favored. For instance consciousness is lost when a magnetic field is used to deflect the current.

In TGD framework natural carriers of these currents would be magnetic flux tubes also carrying electric fields. A very simple deformation of the imbedding of a constant longitudinal magnetic field also gives longitudinal electric field. With a slight generalization one obtains helical electric and magnetic fields. A crucial difference is that these currents would be quantal rather than ohmic currents even in the length scale of the biological body and even longer scales assignable to the magnetic body.

The following argument allows us to understand the physical situation.

1. A precise everyday analogy is vertical motion in the gravitational field of the Earth between surface and some target at given height h. If the kinetic energy is high enough, the particle reaches the target. If not, the particle falls back. In the quantum case one expects that the latter situation corresponds to a very small probability amplitude at the target (tunnelling to classically forbidden kinematic region).

2. Now the electric field replaces the gravitational field. Suppose that the classical electric force experienced by the particle is towards the capacitor plate taking the role of the surface of Earth. Below critical field strength the charged particle cannot reach the target classically and quantum mechanically this occurs only by tunnelling with vanishingly small probability.

3. Particles with opposite value of charge experience a force which accelerates them and classically they certainly reach the second plate. What happens in a quantum situation? It seems

that this situation is essentially identical with the first one: one has linear potential in finite interval and wave functions are localized in this range. One can equivalently regard these states as localized near the second capacitor plate.

4. A good analogy is provided by atoms: classically the electron would end down at the nucleus but quantization prevents this. One can imagine also now stationary solutions for which the electric currents for individual charges vanish at the plates although classically there would be a current in another direction. Also quantum mechanically non-vanishing conserved current is possible: all depends on boundary conditions.

Basic model

Consider now the situation at more quantitative level.

1. One can assign complex order parameters Ψ_k to various Bose-Einstein condensates of supra phases and obey Schrödinger equation

$$i\partial_t \Psi_k = (-\frac{\hbar^2}{2m_k}\partial_z^2 + q_k Ez)\Psi_k \ . \tag{5.5.1}$$

Here it is assumed that the situation is effectively one-dimensional. E is the value of constant electric field.

2. The Schrödinger equation becomes non-linear, when one expresses the electric field in terms of the total surface charge density associated with the plates of effective capacitor. In absence of external electric field it is natural to assume that the net surface charge densities σ at the plates are of opposite sign so that the electric field inside the capacitor is proportional to

$$\sigma = E = \sum \sigma_i = \sum_i q_i \overline{\Psi}_i \Psi_i \ . \tag{5.5.2}$$

This gives rise to a non-linear term completely analogous to that in non-linear Schrödinger equation. A more general situation corresponds to a situation in which the region interval $[a, b]$ bounded by capacitor plates a and b belongs to a flux longer tube like structure $[A, B]$: $[a, b] \subset [A, B]$. In this case one has

$$E_{tot} = E + E_0 \ . \tag{5.5.3}$$

This option is needed to explain the observations of Becker that the local strengthening of electric field increases the electron current: this would be the case in the model to be discussed if this field has a direct opposite to the background field E_0. One could also interpret E as quantized part of the electric field and E_0 as classical contribution.

3. The electric currents are given by

$$j_k = \frac{i\hbar q_k}{2m_k}\overline{\Psi}_k\partial_z^{\leftrightarrow}\Psi_k \ . \tag{5.5.4}$$

In stationary situation the net current must vanish:

$$\sum_k j_k = 0 \ . \tag{5.5.5}$$

A stronger condition is that individual currents vanish at the plates:

$$j_k = 0 \ .$$ (5.5.6)

It must be emphasized that this condition does not make sense classically.

Explicit form of Schrödinger equation

Consider now the explicit form of Schrödinger equation in a given electric field.

1. The equation is easy to solve by writing the solution ansatz in polar form (the index k labelling the charge particle species will be dropped for notational convenience).

$$\Psi = R(a\,exp(iU) + b\,exp(-iU))exp(-iE_n t)$$ (5.5.7)

For real solutions current vanishes identically and this is something which is not possible classically. It is convenient to restrict the consideration to stationary solutions, which are energy eigen states with energy value E_n and express the general solution in terms of these.

2. The Schrödinger equation reduces with the change of variable

$$z \rightarrow \frac{(z-z_0)}{z_1} \equiv x \ ,$$
$$z_0 = \frac{E_n}{qE} \ , \quad z_1 = (\frac{\hbar^2}{2mqE})^{1/3} \ .$$ (5.5.8)

to

$$(\partial_x^2 + x)\Psi = 0 \ .$$ (5.5.9)

The range $[0, z_0]$ for z is mapped to the range $[-z_0/z_1, 0]$. z_0/z_1 has positive sign as is easy to verify. The value range of x is therefore negative irrespective of the sign of qE. This is the differential equation for Airy functions [B1]. Airy functions are encountered in WKB approximation obtained by linearing the potential function: $V(x) = ax + b + O(x^2)$.

The change of variable leads automatically to solutions restricted near the plate where the situation is completely analogous to that in the gravitational field of the Earth. For stationary solutions a test charge in a given background field would be localized near the capacitor plate with opposite sign of charge. A strong background field could be created by charges which do not correspond to the ionic charges defining ionic currents. Electrons and protons could define this field possibly associated with flux tubes considerably longer than the distance between capacitor plates.

3. Using the polar representation $\Psi = R\,exp(iU)$ Schrödinger equation reduces to two equations

$$\left[(\partial_x^2 - U_x^2 + x)R\right] cos(U) + \left[U_{xx} + 2\partial_x R\partial_x U\right] sin(U) = 0 \ ,$$
$$\left[(\partial_x^2 - U_x^2 + x)R\right] sin(U) - \left[U_{xx} - 2\partial_x R\partial_x U\right] cos(U) = 0 \ .$$ (5.5.10)

Note that both (R, U) and $(R, -U)$ represent solutions for given value of energy so that the solution can be chosen to be proportional to $cos(U)$ or $sin(U)$. The electric current j is conserved and equal to the current at $x = 0$ and given by

$$j \quad = \quad \frac{\hbar}{2m} \frac{U_x}{z_1} R^2 \quad , \quad z_1 = (\frac{\hbar}{2mqE})^{1/3} \quad . \tag{5.5.11}$$

The current vanishes if either U_z is zero or if the solution is of form $\Psi = Rsin(U)$.

Semiclassical treatment

In semiclassical approximation the potential is regarded as varying so slowly that it can be regarded as a constant. In this situation one can write the solution of form $Rexp(iU)$ as

$$\Psi \quad = \quad R_0 exp \left(\frac{i}{\hbar} \int_0^z \sqrt{2m} \sqrt{E - qEz} dz \right) = R_0 exp \left(i \int_0^x x^{1/2} dx \right) \quad . \tag{5.5.12}$$

The plate at which the initial values are given can be chosen so that the electric force is analogous to gravitation at the surface of Earth. This requires only to replace the coordinate z with a new one, vanishing at the plate in question - and gives to the energies a positive shift $E_0 = qE_0h$.

1. The semiclassical treatment of the equation leads to Bohr rules

$$\frac{\oint p_z dz}{\hbar} \quad = \quad \frac{2}{\hbar} \int_0^h p_z dz = n \quad . \tag{5.5.13}$$

   This gives

$$\frac{\oint p_z dz}{\hbar} \quad = \quad \frac{2\sqrt{2m}}{\hbar} \int_0^h \sqrt{E_n - qEz} dz = 2 \int_0^{x_0} x^{1/2} = \frac{4}{3} x_0^{3/2} = n \quad . \tag{5.5.14}$$

   Note that the turning point for classical orbit corresponds to $z_{max} = E_n/qE$.

2. One obtains

$$E_n \quad = \quad \frac{1}{2} \left(\frac{nqE\hbar^2}{r\sqrt{m}} \right)^{2/3} \quad , \quad r = \int_0^1 (1 - u)^{1/2} du = \frac{2}{3} \quad . \tag{5.5.15}$$

   The value of z_{max} is

$$z_{max} \quad = \quad \frac{E_n}{qE} = \frac{n^{2/3}}{2r^{2/3}} \left(\frac{\hbar^2}{qEm} \right)^{1/3} \quad . \tag{5.5.16}$$

3. The approximation $R = R_0 = constant$ can make sense only if the position of the second plate is below z_{max}. This is possible if the value of n is large enough ($n^{2/3}$ proportionality), if the mass m of the charged particle is small enough ($m^{-1/3}$ proportionality) raising the electron and also the proton to a special position, or if the strength of the electric field is small enough ($E^{-1/3}$ proportionality). The value z_{max} is proportional to $\hbar^{2/3}$ so that a phase transition increasing Planck constant can induce current flow.

Possible quantum biological applications

The proposed model for quantum currents could provide quantum explanation for the effective semiconductor property of Becker's DC currents.

1. The original situation would be stationary with no currents flowing. The application of an external electric field in the correct direction would reduce the voltage below the critical value and currents would start to flow. This is consistent with Becker's findings if there is a background electric field E_0 with direction opposite to that of the applied field has a direction opposite to E_0 so that the field strength experienced by charged particles is reduced and it is easier for them to reach the second plate.

2. Becker's DC currents appear in several scales. They are assigned with the pairs formed by CNS and perineural tissue (this includes also glia cells) and by frontal and occipital lobes. Acupuncture could involve the generation of a DC supra current. The mechanism would be essential in the healing. Also the mechanism generating qualia could involve generation of supra currents and dielectric breakdown for them. The role of the magnetic flux tubes in TGD inspired biology suggests that the mechanism could be universal. If this were the case one might even speak about a Golden Road to the understanding of living matter at the basic level.

Even the generation of nerve pulse [K66] might be understood in terms of this mechanism. One can argue that neurons have a higher evolutionary level than the system pairs to which only electron currents or electron and proton currents can be assigned. This is because the value of the effective Planck constant is higher for the magnetic flux tubes carrying the quantal ionic currents.

1. For Bose-Einstein condensate the simplest choice is $n = 1$ at both plates. The energy eigenvalues would naturally differ by the shift $E_0 = qE_0h$ at the two plates for a given particle type. Under these assumptions the current can flow appreciably only if the voltage is below the minimum value. This is certainly a surprising conclusion but brings in mind what happens in the case of neuronal membrane. Indeed, hyper-polarization has a stabilizing - something difficult to understand classically but natural quantum mechanically.

2. The reduction of membrane potential slightly below the resting potential generates nerve pulse. Also a phase transition increasing the value of the effective Planck constant might give rise to quantal direct currents and generate flow of ionic currents giving rise to nerve pulse. Stationary solutions are located near either capacitor plate. What comes to mind is that the nerve pulse involves a temporary change of the capacitor plate with this property.

3. If the electron and proton currents flow as direct currents, one encounters a problem. Nerve pulse should begin with direct electronic currents and be followed by direct protonic currents and only later ions should enter the game if at all. The existing model for nerve pulse however assumes that at least electrons flow as oscillating Josephson currents rather than direct quantal currents. This is quite possible and makes sense if the cell membrane thickness is small - that is comparable to electron Compton length as assumed in large $\hbar$ model for the nerve pulse. This assumption might be necessary also for proton and would make sense if the Planck constant for protonic flux tubes is large enough. For ions the Compton length would be much smaller than the thickness of cell membrane and direct currents would be natural.

   If the value of the effective Planck constant is the same for biologically important ions, direct quantum currents would be generated in definite order since in $h < z_{max}$ one has $z_{max} \propto m^{-1/3} \propto A^{-1/3}$. The lightest ions would start to flow first.

   (a) Nerve pulses canbe generated by voltage gated channels for potassium and calcium. Voltage gated channels would correspond to magnetic flux tubes carrying electric field. For voltage gated channels Na^+ ions with atomic weight $A = 23$ and nuclear charge $Z = 11$ start to flow first, then K^+ ions with atomic weight $A = 39$ and $Z = 19$ follow. This conforms with the prediction that the lightest ions flow first. The nerve pulse duration is of the order of 1 millisecond at the most.

(b) Nerve pulses can be also generated by voltage gated Ca^{+2} channels. In this case the duration can be 100 ms and even longer. Ca has $A = 40$ and $Z = 20$. The proper parameter is $x = r^2/qA$, $r = \hbar/\hbar_0$. One has

$$\frac{x(Ca^{++})}{x(Na^+)} = (\frac{r(Ca^{++})}{r_(Na^+)})^2 \times \frac{23}{2 \times 40} \quad . \tag{5.5.17}$$

$r^2(Ca_{++}) \sim 2r^2(Na_+)$ would allow to compensate for the increased weight and charge of Ca_{++} ions.

4. The objection is that Na^+ and K^+ are not bosons and therefore cannot form Bose-Einstein condensates. The first possibility is that one has Cooper pairs of these ions. This would imply

$$\frac{x(Ca^{++})}{x(2Na^+)} = (\frac{r(Ca^{++})}{r_(Na^+)})^2 \times \frac{23}{20} \quad .$$

Ca^{++} and Na^+ pair would be in very similar position for a given value of Planck constant. This is a highly satisfactory prediction. Another manner to circumvent the problem is more science fictive and assumes that the Na^+ ions are exotic nuclei behaving chemically as Na^+ but having one charged color bond between nucleons [L10].

It remains to be seen whether this model is consistent with the model of cell membrane as almost vacuum extremal or whether the vacuum extremal based model could be modified by treating ionic currents as direct currents. In the vacuum extremal model classical Z^0 gauge potential is present and would give a contribution to the counterpart of Schrödinger equation. The ratio $x(Ca^{++})/x(2Na^+)$ for the parameter $x = r^2/q(A - Z)A$ (em charge q is replaced with neutron number in good approximation) equals to 1.38 and is not therefore very far from unity.

The many-sheetedness of space-time is expected to play a key role and one should precisely specify which sheets are almost vacuum extremals and which sheets are far from vacuum extremals. One expects that magnetic flux tubes are far from vacuum extremals and if voltage gated ionic channels are magnetic flux tubes, the proposed model might be consistent with the model of cell membrane as almost vacuum extremal.

The effects of ELF em fields on vertebrate brain

The effects of ELF em fields on vertebrate brain occur both in frequency and amplitude windows. Frequency windows can be understood if the effect occur at cyclotron frequencies and correspond to absorption of large $\hbar$ photons. A finite variation width for the strength of magnetic field gives rise to a frequency window. The observed quantal character of these effects occurring at harmonics of fundamental frequencies leads to the idea about cyclotron Bose-Einstein condensates as macroscopic quantum phases. The above considerations support the assumption that fermionic ions form Cooper pairs.

I have tried to understand also the amplitude windows but with no convincing results. The above model for the quantum currents however suggests a new approach to the problem. Since ELF em fields are in question they can be practically constant in the time scale of the dynamics involved. Suppose that the massless extremal representing ELF em field is orthogonal to the flux tube so that the ions flowing along flux tube experience an electric force parallel to flux tube. What would happen that the ions at the flux tube would topologically condensed at both the flux tube and massless extremal simultaneously and experience the sum of two forces.

This situation is very much analogous to that defined by magnetic flux tube with longitudinal electric field and also now quantum currents could set on. Suppose that semiconductor property means that ions must gain large enough energy in the electric field so that they can leak to a smaller space-time sheet and gain one metabolic quantum characterized by the p-adic length scale in question. If the electric field is above the critical value, the quantum current does not however

reach the second capacitor plate as already found: classically this is of course very weird. If the electric field is too weak, the energy gain is too small to allow the transfer of ions to smaller space-time sheet and no effect takes place. Hence one would have an amplitude window.

The amplitude window occur in widely separate ranges 1-10 V/m and around 10^{-7} V/m. Of course, also other frequency ranges might be possible. Fractality and the notion of magnetic suggests a possible explanation for the widely different frequency ranges. Both p-adic length scale hypothesis and the hierarchy of Planck constants suggest that some basic structures associated with the cell membrane have fractal counterparts in a wide length scale range and correspond to binary structures. Magnetic flux tubes carrying quantal DC currents of Becker would be the most natural candidate in this respect since these currents appear in several length scales inside organism. Also the counterparts of lipid layers of cell membrane could be involved. If so, one must include to the hierarchy of amplitude windows also fields in the range corresponding to the cell membrane resting potential of about 6×10^6 V/m. This is of course only a rough order of magnitude estimate since perturbations of these field are in order.

By fractality the most natural guess is that the voltage along the flux tube is invariant under the scaling of Planck constant. This would mean that the electric field would behave as $1/L^2 \propto 1/\hbar^2$ as a function of the length scale characterizing the scale variant of the structure. If so the range $E = 1 - 10$ V/m assignable also to EEG would correspond to a length scale of $7.7 - 24$ μm corresponding to cell length scale. Perhaps the direct currents run between cells layers. $E = 10^{-7}$ V/m would in turn correspond to 7.8 cm which corresponds to size scale of human brain hemisphere (experiments were carried out for vertebrates). Could the direct quantum currents in question run between brain hemispheres along corpus callosum?

Effects of 50 Hz magnetic fields on living matter

The vision about the role of cyclotron Bose-Einstein condensates was inspired by the effects of ELF em fields on vertebrate brain. The magnetic field strength explaining the effects was about .2 Tesla, 2/5 of the nominal value for the strength of Earth's magnetic field.

There are also other experiments have demonstrated that oscillating electromagnetic fields have effects on living matter. In particle oscillatory magnetic fields with frequency of 50 Hz and with field strengths typically in the range .1-1 mT are used: these effects are summartized in [J146]. Even fields of order .14 Tesla are used.

It is interesting to look at the values of basic parameters associated with these fields.

1. For 50 Hz oscillation frequency the wave length λ is 6000 km to be compared with the radius of Earth which is 6371 km. If one takes seriously the notion of magnetic body this need not be an accident. I do not know how essential it is to have just 50 Hz frequency. The magnetic field is nearby oscillating dipole field up to distances of order λ and radiation field at much longer distances. Therefore the field in question is in good approximation nearby field as fart as biological body is considered. For magnetic body the radiation field could dominate

2. For the endogenous magnetic field $B_{end} = .2$ Gauss cyclotron frequencies of ions are in EEG range: Ca^{++} cyclotron frequency is 15 Hz. The scaling up to r= .1-1 mT means scaling of cyclotron frequencies by a factor $5 - 50$. For Ca^{++} this would give frequency range 75-750 Hz. For K^+ and Cl^+ ions the frequency range would be about 35-375 Hz.

3. The magnetic length $r = \sqrt{2/eB}$ characterizing flux tube thickness for flux quantization with minimum value of flux is for $B = .05$ mTesla equal to 5 μm. For the fields in the range .1-1 mTesla it is in the range 3.5 μm- 1.1 μm. 2.5 μm corresponds to p-adic length scales $L_e(k)$ associated with Gaussian Mersenne $M_{G,k} = (1+i)^k - 1$, $k = 167$, and Gaussian Mersenne correspondng to $k = 163$ would correspond to p-adic length scale .36 μm. .14 Tesla corresponds to magnetic length of 9.4 nm rather near to cell membrane thickness of 10 nm which corresponds to p-adic length cale $L_e(151)$ assignable to Gaussian Mersenne $M_{G,151}$.

The effects of polarized light on living matter

Polarized light is known to have effects on living matter [J146]. For instance, Peter Gariaev has found that the polarized light generated by living matter sample irradiated by polarized laser light

has effects on distant organism and there are even indications that genetic code might be realized in terms of radiation patterns [K120]. The quantum model for Becker currents suggest that these effects result as a modification of the voltage between the ends of magnetic flux tubes If the flux tubes are near criticality for the generation of quantal DC currents, polarized light could be utilized both communication and control purposes wheres the acceleration in the electric fields along flux tubes would serve as a provider of metabolic energy allowing to load metabolic batteries. This process could be initiated by an electromagnetic signal inducing generation of quantal currents. The same basic mechanism could be at work also in DNA transcription, replication and other similar processes.

If the polarized low frequency radiation corresponds to a massless extremal (ME) orthogonal to the flux tube such that the polarization of the radiation is parallel to the flux tube, the voltage is affected by a contribution given by $\Delta V = Ed$, d the thickness of ME. If the flux tube is near criticality to a generation of quantal currents this change of voltage could serve as a signal inducing the generation of quantal currents.

The maximal effect is obtained for the flux tubes having direction parallel to the electric polarization so that the effect is highly selective. In the case of DNA double strand the direction of flux tube changes so that the effect would be maximal on DNAs which correspond to the same angular position on the super-coil of radius of order 10 nm formed by DNA double helix. This allows to imagine signals for which temporal variation of polarization direction means scanning of DNA.

It is known that the energy of radiation can be transformed to metabolic energy. For instance, IR light for which photons have energies of order metabolic quantum has biological effects [I69]. The mechanism could be following. Suppose that the electric field of IR photon is parallel to the flux tube which carries an electric field and is near criticality for the generation of quantal DC currents. If the direction of polarization is correct, the additional contribution to electric field induces direct current and acceleration of electrons and protons and their transfer to smaller space-time sheets and therefore loading of metabolic batteries. This could also make generation of ATP possible.

Suppose that one takes seriously the model for remote replication of DNA [K120] involving flux tubes connecting identical DNA nucleotides and that the radiation propagating along them induces quantal currents along the receiving DNA inducing replication and perhaps even transcription. The direction of polarization for the emitted radiation should be parallel to the DNA strand locally and during its travel to the target the polarization should remain orthogonal to the flux tube so that one would have what might be called polarization window. Parallel translation of the polarization vector in the induced metric suggests itself.

Support for the proposed interaction mechanism of em radiation fields with flux tubes

The basic prediction of the interaction mechanism is that the effects of em field with a given frequency occur only at the second half period when the direction of electric field is "correct". This prediction might be testable. In fact, there is evidence for this interaction mechanism in the case of theta waves of EEG. The memory storage occurs only at the second half of the theta wave This is discussed from different point of view in [K23].

The place coding by phase shifts was discovered by O'Reefe and Recce [J131]. In [J166, J167]. Y. Yamaguchi describes the vision in which memory formation by so called theta phase coding is essential for the emergence of intelligence. It is known that hippocampal pyramidal cells have "place property" being activated at specific "place field" position defined by an environment consisting of recognizable objects serving as landmarks. The temporal change of the percept is accompanied by a sequence of place unit activities. The theta cells exhibit change in firing phase distributions relative to the theta rhythm and the relative phase with respect to theta phase gradually increases as the rat traverses the place field. In a cell population the temporal sequence is transformed into a phase shift sequence of firing spikes of individual cells within each theta cycle.

Thus a temporal sequence of percepts is transformed into a phase shift sequence of individual spikes of neurons within each theta cycle along linear array of neurons effectively representing time axis. Essentially a time compressed representation of the original events is created bringing in mind temporal hologram. Each event (object or activity in perceptive field) is represented by a firing of one particular neuron at time τ_n measured from the beginning of the theta cycle. τ_n is obtained by scaling down the real time value t_n of the event. Note that there is some upper bound

for the total duration of memory if scaling factor is constant.

One can say that neurons in ensemble provide a representation for the external world and the location of the rodent in the external world is represented as a firing of a neuron in this landscape. Besides this also temporal scaling down by a factor about ten is carried out so that actual event is represented as much shorter copies of it. Obviously this represents temporal fractality.

This scaling down - story telling - seems to be a fundamental aspect of memory. Our memories can even abstract the entire life history to a handful of important events represented as a story lasting only few seconds. This scaling down is thought to be important not only for the representation of the contextual information but also for the memory storage in the hippocampus. Hierarchy of Planck constants and phase transitions changing Planck constant make this story building possible.

The finding of Yamaguchi and collaborators relevant in the recent context is that the gradual phase shift occurs at half theta cycle whereas firings at the other half cycle show no correlation [J166]. The proposed model for the interaction of theta waves with flux tubes could explain this naturally. The relevant neural sub.system would be critical to the generation of quantal DC current only when the direction electric field of synchronizing theta wave generated by magnetic body is correct. Hence synchronous neural activity would be induced only at second half cycle of theta wave and firing would be random during the other half cycle.

5.5.3   A model for remote gene expression based on Becker currents

If one accepts the notion of magnetic body as intentional agent, the basic challenge is to understand how magnetic body realizes its intents as remote mental interactions on biological body. This model must of course apply also to the more conventional remote mental interactions such as remote realization of intent.

The hypothesis is that electromagnetic and possibly also other massless classical fields assignable to so called massless extremals are in a key role. Also cyclotron frequencies characterizing magnetic bodies play a key role. The vision is that magnetic flux sheets traverse many-sheeted DNA in various scales giving rise to a hierarchy of genomes and coherent gene expression in scales of cell, organelles, organism, and even population, and species. Hierarchy of Planck constants is in an essential role in realizing this hierarchy in terms of photons with energies above the thermal energy at physiological temperature and having spectrum of wavelengths coming as multiples $\lambda = n\lambda_0$, $n = \hbar/\hbar_0$.

The findings of Benveniste and followers relating to water memory and homeopathy, the recent work of group led by HIV Nobelist Luc Montagnier coupling the findings with genetics and suggesting a new nanoscale realization of genetic code (see this [L22]), the work of the group of Popp with bio-photons identified as decay produces of large $\hbar$ photons with visible energies (in particular dark EEG photons), and the work of Peter Gariaev and collaborators supporting remote gene expression and replication discussed here suggest that electromagnetic radiation is indeed involved [K120]. In the case of water memory and homeopathy the spectrum of cyclotron frequencies for the chemical invader characterizes it and induces immune response trying to eliminate it. I have also proposed a model for how genes coding for proteins eliminating the invader could be generated almost automatically: the model is based on the predicted realization of vertebrate genetic code in terms of dark proton states (see this [K37]). DNA would like an animal which sniffs the invaders magnetic body and automatically reacts to the smell.

The discussions with Lian Sidorov and people who have realized that new era is beginning in biology have served as a driving force in the attempts to formulate in more detail TGD inspired view about how remote mental interactions - which are basic element of the model in TGD framework - might be realized. As a matter fact, I have added to my homepage a new book summarizing briefly the recent view about quantum TGD and its applications to quantum consciousness, quantum biology, to quantum neuroscience, and to remote mental interactions with some proposals for possible tests [K109]) (see this) .

To start with, suppose that in the case of biological target realization of intent in the simplest situation reduces to expression of genes. This is of course a strong limitation to the type of remote mental interactions. The challenge is to develop a model for remote realization of genetic activities like replication, and transcription. For some time ago I proposed a model with Peter Gariaev [K120] but it was still too clumsy since it required too much of information transfer

between the genomes of sender and receiver. Much simpler model involving only sending of simple commands initiating genetic programs suggests itself. The following proposal tries to achieve this and involves three basic ideas.

1. The idea of password and addressing is familiar from ordinary computers. Collection of frequencies as password/address allows to reach tuned targets without specific targeting of the command. This is a dramatic improvement to the previous model.

2. Password and fractal addressing realized in terms of frequencies coupling resonantly (already in the original model: I did not however realize the implications of resonant coupling!) and the hierarchy of Planck constants to realize the hierarchical addressing. I have discussed analogous addressing based on information molecules and their receptors at the biochemical level to realize magnetic flux tube connections between sender and target inside organism (hormonal action would be very analogous to what I am proposing here).

3. Becker's DC currents as supra currents flowing along DNA and activated optimally when the incoming laser light has polarization parallel to DNA's local direction, activation of super currents would mean activation of the gene. This is second new element to the original model.

In the following I discuss this with more details.

The analogy with ordinary computer

Consider first the analog of remote mental interactions for ordinary computer. Computer sends a password to the other computer and after that it can use it to run programs of the other computer. Whisling to a dog is another example: extremely simple command activates arbitrary complex programs.

In the recent case electromagnetic radiation with a given frequency coupling resonantly like radio signal to a tuned radio receiver would be the simplest command activating the target. There would no need to specify the direction or distance of the target precisely since essentially mass communications would be in question: intent would be enough. Password could consist of several frequencies which must be received simultaneously by the target before it would activate and tunes to receive more frequencies representing simple commands - perhaps acting on the intronic portion of DNA and activating the genome to remote gene expression or something else such as activating DNAs of other cells by sending similar em addresses!

I have discussed topological quantum computer programs based on braiding could look like in this framework [L26]. Also here addressing but now realized as information molecule-receptor pair would play a key role.

Hierarchy of Planck constants and hierarchical addressing

Fractal hierarchy of frequencies (in Peter's experiment laser light induced generation of radiation at frequencies down to about 10 kHz) would allow to transform passwording to addressing. Very naively, the longest wavelengths: about 10^4 meters would reach the tuned receivers in nearly the same phase in a region of this size. One would have some subregions in tune. The shorter wavelengths would allow to pinpoint the tuned receivers inside each of these subregions and so on. This would be fractal addressing with most significant bits correspond to the longest wavelengths. Only those receivers which would be tuned to all frequencies would start to express the gene in the case of AND logic. Of course, also other Boolean functions of tuned-not tuned bits can be considered.

A good guess is that all photons correspond to the same energy of visible photon and only Planck constant varies. For ordinary value of Planck constant one would have a photon with wavelength of order size scale of single cell, and the frequencies in this range would select single gene in the genome ofa particular kind of cell, say neuron within particular region of brain.

In Peter Gariaev's experiment involving 2 eV incoming red laser light the outgoing photons would have same energy but larger Planck constant so that also wavelengths would be longer and range down to at least 3×10^4 meters corresponding to radiofrequency scale of 10 kHz. What is interesting that 2 eV is 4 times the nominal value of the metabolic energy quantum of .5 eV

identifiable as zero point kinetic energy of electron or proton for the p-adic length scale $L_e(151)$ corresponding to cell membrane thickness and Gaussian Mersenne $M_{151} = (1 + i)^{151} - 1$. Could it be that 2 eV could be preferred photon energy or is its use simply due to the unavailability of continuous frequency spectrum for laser light. And why the laser light induces the generation of the command inducing remote gene expression?

This picture conforms with Peter's experiment and with the reports of Benveniste and followers about the possibility of representing homeopathic remedy using very low frequency spectrum - presumably cyclotron frequencies - assignable to remedy. These frequencies would be addresses for genes activating genes transcribing building bricks of biomolecules of immune response eliminating the substance from the organism. The proposal could be seen as a generalization of Benveniste's observation and realization of wave DNA proposal.

DNA supra currents and activation of genes by Becker mechanism

The third bulding brick of the model would be quantum model for Becker currents [L27] as supra currents or quantal DC currents [L27]: also this element is new. Assume - in accordance with the general vision - that these supra currents can flow also along the strands of many-sheeted DNA (flux sheets associated with the strand, entire hierarchy labelled by the values of $\hbar$). Assume also that the interaction of polarized photons addressing for genes with DNA is such that the electric fields of DNA flux tube and "massless extremal" representing laser beam superpose and charges (electrons) experience the superposition of field already present and the field of ME. If the net electric field is near criticality originally (think as analog neuronal membrane) and becomes over-critical, quantal Becker current starts to flow and the machinery responsible for gene activation is activated.

This means also the activation of metabolic machinery since the acceleration of electrons in the electric field gives them energy making possible a transfer to smaller space-time sheets where they form Cooper pair like states with negentropic entanglement. Metabolic energy corresponds to zero point kinetic energy and negentropic entanglement is relevant from the point of view of consciousness: in the case of healing understood as a regeneration of negentropic resources this aspect is especially important. This mechanism generates high energy phosphate bonds in ATP and the decay ATP $\rightarrow$ ADP liberates the metabolic energy and destroys the negentropic entanglement possibly associated with ATP so that the second law in generalized form [L23] allowing local generation of genuine negentropy (but assigned to information carried by entanglement defining a quantum rule) wins after all.

It could also happen that the decay of ATP generates dark photon or photons absorbed by cyclotron condensate at magnetic flux tube. The excited state is non-local single particle excitation and involves very simple negentropic entanglement between the particles of the condensate. In this case the negentropy of ATP would be transformed to the negentropy of the magnetic flux tube or even several of them if large value of Planck constant is associated with the photon. This mechanism could allow the generation of negentropic entanglement associated with attention. The storage of metabolic energy in photosynthesis could involve similar excitation of cyclotron state at the first step. The most plausible candidate is cyclotron condensate for electron Cooper pairs. Also electrons filling state up to some Fermi energy could be in question. In this case the excitations would be excitation in longitudinal degrees of freedom of the flux tube generating current.

5.5.4 DNA, speech, music, and ordinary sound

Peter Gariaev's group has made rather dramatic claims about DNA during years [I50, I51, I84, I58].

1. The group has proposed that the statistical distributions of nucleotides and codons in the intronic portion of DNA resemble the distribution of letters and words in the natural languages [I58]. For instance, it is proposed that Zipf law [J169] applying to natural languages applies to the distributions of codonds in the intronic portion of DNA. One can study the popularity of the words in natural languages and order them against their popularity. Zipf law states that the integer characterizing popularity is in constant proportion to the number of times it appears in given long enough text.

2. It has been also claimed that DNA can be reprogrammed using modulated laser light or even radio waves. I understand that reprogramming means a modified gene expression. Gariaev's group indeed proposes that the meaning of the third nucleotide (having a rather low significance in the DNA-amino-acid correspondence) in the genetic codon depends on the context giving rise to a context dependent translation to amino-acids. This is certainly a well-known fact for certain variants of the genetic code. This context dependence might make possible the re-programming. The notion of dark DNA allows to consider much more radical possibility based on the transcription of dark DNA to mRNA followed by translation to amino-acids. This could effectively replaced genes with new ones.

3. Also the modulation of the laser light by speech is claimed to have the re-programming effect. The broad band em wave spectrum resulting in the scattering of red laser light on DNA is reported to have rather dramatic biological effects. The long wave length part of this spectrum can be recorded and transformed to sound waves and these sound waves are claimed to have the same biological effects as the light. The proposal is that acoustic solitons propagating along DNA represent this effect on DNA.

I do not have the competence to make statements about the plausibility of these claims. TGD view about quantum biology makes also rather strong claims. The natural question is however whether a justification for the claims of Gariaev and collaborators could be found in TGD framework? In particular, can one say about possible effects of sound on DNA. One intriguing fact about sound perception is that music and speech have meaning whereas generic sounds to not. Could one say something interesting about how this meaning is generated at the level of DNA?

Basic picture

Before continuing it is good to restate the basic TGD inspired ideas about the generation of meaning.

1. The generation of the negentropic entanglement is the correlate for the experience of the meaning. In the model inspired by Becker's findings [L27], the generation of negentropic entanglement (see fig. http://www.tgdtheory.fi/appfigures/cat.jpg or fig. 21 in the appendix of this book) involves a generation of supra currents along flux tubes moving in the electric field parallel to them. This is a critical phenomenon taking place when the voltage along the flux tube is near critical value. The generation of nerve pulse near critical value of the resting potential is one example of this criticality. Becker's direct currents involved with the healing of wounds is another example.

   The flow of the supra current gives rise to the acceleration of charges along the flux tubes and generation of Cooper pairs or even many-electrons systems at smaller space-time sheets in negentropically entangled state and carrying metabolic energy quantum as zero point kinetic energy. The period of negentropic entanglement gives rise to a conscious experience to which one can assign various attributes such as understanding, attention, and so on. Negentropic entanglement would measure the information contained by a rule having as instances the state pairs in the quantum superposition defining the entangled state. When the period of negentropic entanglement ceases, the metabolic energy is liberated.

2. Remote activation of DNA by analogs of laser beams is another essential piece of TGD inspired quantum biology [L27]. In the proposed addressing mechanism a collection of frequencies serves as a password activating intronic portions of DNA. This would take place via a resonance for the proposed interaction between photons and dark supra currents flowing along magnetic flux tubes and perhaps also along DNA strands or flux tubes parallel to them. The superposition of electric fields of photons (massless extremals) with the electric fields parallel to flux tubes (so that massless extremals serving as correlates for laser beams would traverse the flux tube in orthogonal direction).

3. The flux tubes, and more generally flux sheets labelled by the value of Planck constant, and along which the radiation arrives would be transversal to DNA and contain DNA strands. This kind of flux tubes and sheets also define the connections to the magnetic body, and form

parts of it. A given flux sheet would naturally select the portion of DNA, which is activated by the radiation: it could be a portion of intronic part of DNA activating in turn a gene. These flux tubes and sheets could be connected to the lipids of nuclear and cell membranes - also cell membranes of other cells - as assumed in the model of DNA as topological quantum computer [K23]. The sheets could also give rise to a hierarchy of genomes - besides genome one would have super-genome in which genomes are organelles are integrated by flux sheets to a large coherently expressed structure containing individual genomes like page of a book contains lines of text. These pages would be in turn organized to a book - hyper-genome as I called it. One could have also libraries, etc... There would fractal flux quanta inside flux quanta structure.

Phonons and photons In TGD Universe

Consider next phonons and their coupling to photons in TGD Universe.

1. Sound waves could quite well transform to electromagnetic radiation since living matter is piezo-crystal transforming sound to radiation and vice versa. Microwave hearing represents an example of this kind transformation. This would require that photons of given energy and varying value of Planck constant couple to phonons with the same energy, Planck constant, and frequency.

2. Whether one can assign to phonons a non-standard value of Planck constant is not quite clear, but there seems to be no reason preventing this. If so, even photons of audible sounds would have energies above thermal threshold and have direct quantal effects on living matter if they have same Planck constant as the photons with same frequency.

3. Acoustic phonons represent longitudinal waves and this would require longitudinal photons. In Maxwell's electrodynamics they are not possible but in TGD framework photon is predicted to have a small mass and also longitudinal photons are possible.

4. For general condensed matter systems one can have also optical phonons for which the polarization is orthogonal to the wave vector and these could couple to ordinary photons. The motion of the charged particles in the electromagnetic field of massless extremal (topological light ray) would be a situation in which phonons and photons accompany each other. This would make possible the piezo-electric mechanism.

Under these assumptions the collections of audible frequencies could also represent passwords activating the intronic portion of the genome and lead to gene expression or some other activities. If one believes on the hypothesis that DNA acts like topological quantum computer based on the braid strand connections between nucleotides in the intronic portion of DNA with the lipids of the nuclear and/or cell membranes, also topological quantum computation type processes could be activated by the collections of sound frequencies [K23].

What distinguishes speech and music from sounds without meaning?

Speech and music ares very special form of sound in that they have direct meaning. The more one thinks about these facts, the more non-trivial they look. For music - say singing - the frequency of the carrier wave is piecewise constant whereas for speech it remains constant and the amplitude modulation is important. In fact, by slowing down the recorded speech, one gets the impression that carrier frequency is actually modulated like in chirp (frequency goes down and covers a range of frequencies). What is the mechanism giving to speech and music its meaning and in this manner distinguishes them from other sounds?

Besides the frequency also phase is important for both speech and music experience. Speech and reverse speech sound quite different the intensity in frequency space is same. Therefore the relative phases associated with the Fourier coefficients of various frequencies must be important. For music simple rational multiples of the fundamental define the scale. Could it be that also the frequencies relevant to the comprehension of speech correspond to these rational multiples?

Suppose that one indeed believes on the proposed vision based on the fundamental role of negentropic entanglement in generation of meaning and takes seriously the proposed mechanisms

for generating it. Can one understand why music and speech differ from general sounds and what distinguishes between them?

1. With these assumptions suitable collections of frequencies sound wave would indeed activates the intronic portion of DNA by generating negentropic entanglement. Also other dark flux tubes than those assignable to DNA are involved. For instance, hair cells responsible for hearing of sounds around particular frequencies could involved flux tubes and utilize similar mechanism. Allowing only hair cells would define the conservative option. On the other hand, one could well claim that what happens in ear has nothing to do with the understanding of the speech and music, it could take place only at the level of neuronal nuclei.

2. Could the direct interaction of sound waves with magnetic flux tubes generate the experiences of speech and music? In other words, assign meaning to sounds? The criterion for sound to have an interpretation as speech or music would be that it contains the resonance frequencies needed to activate the DNA, or more generally generate dark super currents generating Cooper pairs in this manner loading metabolic energy storages. This would apply to both speech and musical sounds.

3. The pitch of the speech and musical sound can vary. We are aware of the key of the music piece and of modulations of the key and remember the starting key, and it is highly satisfactory to make a return to "home" defined by the original key. This would imply that the overall scale of the collection of frequencies can be varied and that the pitch of the speech defines a natural expectation value of this scale. For persons possessing so called absolute ear this scaling symmetry would be broken in a well-defined sense.

4. Musical scales involve frequencies coming as rational multiples of the basic frequency. Octaves - power of two multiples- of the frequency can be said to be equivalent as far musical experience is considered. One might understand the special role of rational multiples of the basic frequency if the Fourier components have same phase periodically so that the experience is invariant under discrete time translations. This requires commensurable frequencies expressible as rational multiples of the same fundamental frequency. The preferred role of p-adic primes comings as powers of two could relate to the octave phenomenon.

5. Are the relative phases of different Fourier components important for music experience? If one requires a periodical occurrence of maximal possible intensity (maximal constructive interference) then the relative phases must vanish at the values of time for maximal possible intensity. What seems essential that the presence of commensurate frequencies gives rise to time translation invariant sensation whereas speech consists of pulses.

Are speech and music quantum duals like position and momentum?

Frequencies are crucial for music experience. In the case of of speech the relative phases are very important as the example of reverse speech demonstrates. How a given phoneme is heard is determined to high degree by the frequency spectrum in the beginning of the phoneme (this distinguishes between consonants). Vowels are nearer to notes in vocalization. Speech consists of pulses and destructive interference between different frequencies is required to generate pulses and different pulse shapes so that phase information is important. At least the harmonics of the basic rational multiples of the fundamental are necessary for speech.

One can criticize the previous discussion in that it has been completely classical. Phase and frequency are in wave mechanics canonically conjugate variables analogous to position and momentum. Is it really possible to understand the difference between music and speech purely classically by assuming that one can assign to sound waves both frequencies and phases simultaneously - just like one assigns to a particle sharp values of both momentum and position? Or should one use either representation either in terms numbers of phonons in different modes labelled by frequencies or as coherent states of phonons with ill defined phonon numbers but well defined amplitudes? Could the coherent states serve as the analogs of classical sound waves. Speech would be as near as possible to classical sound and music would be quantal. Of course, there is a large variety of alternative choices of basis states between these two extremes as a specialist in quantum optics could tell.

Suppose that this picture is more or less correct. What could be the minimal scenario allowing to understand the differences between speech and music?

1. Only a subset of frequencies could activate DNA (or if one wants to be conservative, the hair cells) also in the case of speech. One could still pick up important frequencies for which the ratios are simples rational numbers as in the case of musical scale plus their harmonics If this assumption is correct, then speech from which all frequencies except for the harmonics of the simple rational multiples of the fundamental are removed, should be still be comprehensible as speech. The pitch of the speech would determine a good candidate for the fundamental frequency.

2. The harmonics of frequencies activating DNA would be crucial for speech. Harmonics are present also in music and their distribution allows to distinguish between different instruments and persons. The deviation of musical notes from ideal Fock states would correspond to this.

3. The naive guess is that the simple rational multiples of fundamental and the possibility of having their harmonics could be reflected in the structure of intronic portions of DNA as repetitive structures of various sizes. This cannot be the case since the wavelengths of ordinary photons would be so small that the energies would be in keV range. Neither is this expected to be the case. It is magnetic flux tubes and sheets traversing the DNA which carry the radiation and the natural lengths assignable to these flux quanta should correspond to the wave lengths. The larger, the flux quantum, the lower the frequency and the larger the value of Planck constant. Harmonics of the fundamental would appear for given flux tube length naturally.

   The DNA strands and flux tubes and sheets form a kind of electromagnetic music instrument with flux quanta taking the role of guitar strings and DNA strands and other structures such as lipids and possible other molecules to which flux tubes get attached taking the role of frets in guitar. This analogy suggests that for wave lengths measured in micrometers the basic frequencies correspond to the distances between "frets" defined by cell and nuclear membranes in the tissue in the scale of organism. This would relate the spectrum of resonance frequencies to the spectrum of distances between DNAs in the tissue.

   For wave lengths corresponding to very large values of Planck constant giving rise to frequencies in VLF and ELF range and corresponding also to audible frequencies, the preferred wave lengths would correspond to lengths of flux quanta in Earth size scale. One should understand whether the quantization of these lengths in simple rational ratios could take place for the preferred extremals.

4. Could the pulse shape associated with massless extremals (MEs, topological light rays) allow to distinguish classically between speech and music at the level of space-time correlates? Linear superposition of Fourier components in the direction of ME is possible and this allows to speak about pulse shape. It allows also the notions of coherent state and Fock state for given direction of wave vector. Essential would be the restriction of the superposition of fields in single direction of propagation to be distinguished from the superposition of the effects of fields associated with different space-time sheets on multiply topologically condensed particle. Maybe this would allow to make testable predictions.

5.6   Water and life

5.6.1   Latest view about water memory

The notion of water memory has several aspects. Water memory was introduced by Benveniste [I41, I42] to explain the claimed ability of homeopathically treated water to behave as if it contained the original molecules. Already Benveniste discovered the connection with very low frequency electromagnetic radiation and claimed that the patterns of this radiation carry the information about the molecule and represent its biologically relevant aspects. Water memory has been also assigned to the observation suggesting that the human intent has effect on the crystal structures formed as water near criticality freezes [I104, I21].

Basic aspects of water memory

The first aspect of water memory relates to homeopathy and is discussed from strongly skeptic point of view in Wikipedia article. Mae Wan-Ho takes a more balanced view on homeopathy in her article discussing the recent findings of the research group of HIV Nobelist Luc Montagnier providing strong support for water memory and suggesting also a connection with gene level [I44, I45].

The basic principle of homeopathy is "let like be cured by like". Homeopathic remedies are highly diluted preparations believed to cause in the healthy individuals effects similar to the undesired symptoms of the person treated. Homeopathy is not in accordance with the naive materialistic beliefs about what water is (just the letters H_2O!) and what happens in succussion process producing the remedy. Not surprisingly, hard-nosed skeptics are not able to discuss the subject without bursts of rage. Obviously, the claimed effect of homeopathic remedy resembles that of vaccine and one might say that the harmful substance serves as its own antibody eliminating the effect of the harmful substance. If one takes homeopathy seriously, the challenge is to explain this auto-antibody behavior. One can of course ask whether this behavior could in some sense be the basic mechanism of immune system.

In Benveniste's experiments [I41, I42] antibodies of human basophils were dissolved in water and the claim of experiments was that basophils added to the homeopathically treated water produced allergic reaction serving usually as a signature for the presence of antibody. As if water were able to mimic the antibodies in biologically relevant aspects. Later Benveniste was labeled as a fraud but the research has continued and it has been for long time thought that low frequency electromagnetic fields are essential for water memory. The frequencies in question extend to kHz range and cannot relate to molecular transitions. Cyclotron frequencies assignable to charged particles at the magnetic body of the molecule are the natural candidate in TGD framework.

Second aspect of water memory relates to the claim that human intent has an effect on the molecular structure of water. Clearly a special variant of remote mental interaction would be in question. Masaru Emoto [I104] has photographed water crystals resulting from water contained by a glass and subject to human intent. Depending on the origin of water the resulting water crystals can vary from random to very organized and aesthetic. Words, pictures, and music are used to generate the crystals. It is important to not forget that human intent is a decisive factor so that water need not be able to read as one especially simplistic and aggressive fanatic ridiculing Emoto claimed! Emoto has published several books containing pictures of the crystals and makes explicit that he is not a scientist but photographer who has discovered a fascinating new phenomenon and loves to document it.

Mae Wan-Ho has written an article titled Crystal Clear - Messages from Water [I104] in which she discusses Emoto's work with intellectual honesty and giving primacy for facts instead of dogmas. The basic argument of skeptic is that water is just H_2O as we learned in school and therefore Emoto must be a swindler. The Wikipedia article [I10] about Masaru Emoto's work represents a rather civilized skeptic reaction as compared to Harriet Hall's piece of bad rhetorics filled with nasty ad hominem attacks. More ambitious skeptic believer bothers to develop an argument claiming that aesthetic appeal is highly subjective measure to characterize the water crystals. Here common sense and intellectual honesty clash with materialistic dogmas categorically denying this kind of effects, and the reader of these books must make a personal decision about what might be the truth - unless they decide to become photographers of water crystals.

The reader can also form his or her opinion about this aspect of water memory by looking the You tube video Water has Memory [I21] prepared in Aerospace Institute in Stuttgart illustrating that the effect of human intent on the structure of water droplets is same for droplets from same source, is repeatable, and characterizes the operator. Also the effect of flowers dropped into the water is illustrated. All drops from a given source give rise to same structure characterizing the flower. It is suggested that water is a huge information source and serves as a kind of data medium. This proposal is highly trivial and would mean a profound modification of world view.

A simple model for water memory

Suppose that we just for a moment decide to overcome our intellectual laziness and are not satisfied with the standard rhetoric tricks of skeptics to convince ourselves that water memory researches must be swindlers or fools. In other words, we take the experimental evidence supporting water

memory as something worth of considering seriously and try to build a model for the claimed phenomena. We can indeed imagine when we do not know. The challenge of the model for water memory is to explain the claimed basic aspects of water memory with minimal assumptions. Let us the restrict the model building further by assuming that we live in TGD Universe and that our vision about this Universe is roughly correct.

The ability of water molecule clusters to mimic the possibly harmful substances - call them just H - dissolved in water in some biologically relevant aspects could explain the effectiveness of homeopathic remedies. Water should make possible a symbolic representation of the molecules or their magnetic bodies.

1. Suppose H is a polar molecule so that it is biologically effective and that magnetic body characterizes the relevant biological effects of a polar molecule. Suppose that mechanical agitation causes some polar molecules to lose their magnetic bodies so that they attach to water molecule clusters, which therefore become "actors" representing H. In the dilution the density of the fake molecules is also reduced but if the energy provided by shaking can be used as metabolic energy makes possible for the "actors" to replicate and their population can survive and even evolve in the sequence of "environmental catastrophes" induced by repeated successions possibly also inducing evolution as an increase of Planck constant for the magnetic body of the "actor". Also the replication of the magnetic body of the "actor" is required. Cyclotron frequency spectrum would serve as a characterizer of molecule's magnetic body and cyclotron radiation would make possible communications between fake molecules and their magnetic body.

2. What the dropping of magnetic bodies really means? To answer the question consider a general vision about what happens as energy is fed into a system consisting of proteins dissolved in water. The proteins originally in closed globular configuration open as the ordered water covering their surfaces with "ice" melts. This leads to a protein aggregation during the short "molecular summer" provided by the energy feed. The outcome is braiding and reconnection of flux tubes.

   Suppose that this mechanism is at work also when proteins are replaced with harmful polar molecules. During "molecular summer" a reconnection process for closed loops emerging from water clusters and polar molecules would connect them with water clusters. Also the magnetic bodies of polar molecules would generate connections to water clusters via molecules. Self-reconnection for the flux tubes going through H molecules makes possible the transfer of the magnetic body of H to water molecule cluster. Water molecule cluster would "steal" the magnetic coat of H and H molecules would be left with short-cut closed flux tubes after the reconnection.

3. What is required that these water clusters or something associated with them can replicate and develop to a population representing the original molecules. The needed metabolic energy would come from mechanical agitation. Note that this replication should involve also the replication of magnetic bodies which suggests that linear structures generating planar flux tubes emanating from the basic building bricks of the structure are involved. This will be discussed below.

What could then be the healing mechanism in homeopathy? Why the presence of the fake molecules in organism would prevent the harmful actions of real molecules in the organism? What could be the translation of "Let like be cured by like" to the language of quantum TGD?

1. Suppose that the effects of H on bio-molecules are due to cyclotron radiation along the flux tubes of its magnetic body connecting it to bio-molecules of the organism. Suppose that the fake representatives of H contained by the homeopathic remedy and real molecules H reconnect so that the flux loops associated with H and fake H reconnect to a pair of flux tubes connecting H and fake H. Suppose that this happens with such high a rate that the fraction of the connections to other biomolecules remains low.

2. If so, fake H would effectively act antibody of H and the effects of H via its magnetic body on organism would be minimized. Like would indeed cure like. Could this reconnection

mechanism be at work also when antibody attaches to the harmful molecule? If so, the basic mechanism of immunization would be universal and involved the notion of magnetic manner in an essential manner.

Dark nucleon genetic code as realization of water memory, and homeopathic mechanism as basic mechanism of immune system

The proposal says nothing about the detailed structure of water clusters, and does not mention dark nucleons nor the proposal for the realization of genetic code based on them. A more refined model would include also these and give a connection for how immune system would utilize the reconnection of flux tubes defining the basic mechanism of homeopathy.

1. TGD predicts a realization of vertebrate genetic code at the level of dark nucleons. Dark nucleons correspond to the states of DNA, RNA, tRNA, and amino-acids and represent vertebrate genetic code under rather general assumptions [L10]. One could even consider the extension of the genetic code to a naming of polar molecules by sequences of representatives of DNA letters. Suppose that dark proton sequences are attached to a polar molecule dissolved in water, and define a representation of the molecule in terms of code letters realized as exotic protons with Compton length in nano-scale. The assignment of the magnetic body of the molecule to water cluster would give it the same "name" as for the original molecule. It is of course possible to have other representation and one of them would be in terms of dark u quarks providing representation of A,T,C,G in terms of spin states.

2. If the population of dark DNA molecules assigned with the harmful substance H is able to use the energy provided by the succussion process as a metabolic energy for replication, the disappearance of H is compensated by the replication of dark DNA representing it. Dark DNA becomes the representative of H. The growing population would consist of dark DNA and the flux tubes of the magnetic body connect to dark DNA strands. Replication would be the analog of that for ordinary DNA and involve also the replication of magnetic bodies. The water would contain pairs of dark DNA and its conjugate connected by a flux tube and these flux tubes would reconnect with flux tubes connecting the dark DNA sequence representing H and connected by flux tubes to its conjugate.

3. It is known that the DNA of the immune system evolves with an especially high rate. Could the universal naming mechanism allow the immune system to generate new immune responses via the transcription of the dark DNA sequence representing the harmful molecule to a real DNA, which in turn codes for amino-acid attaching to the harmful molecules along the dark nucleon sequence? A model for homeopathy would extend to a model for the functioning of immune system. This would be of course also a mechanism of evolution as a reaction to changing chemical environment. This would explain also the effect of the homeopathic remedy as an effect at gene level.

   It is difficult to exaggerate the potential significance of this mechanism for biology, genetic engineering, and medicine. Understanding of the contemptible homeopathy could induce decisive step in the understanding of biology. This possibility shows how dangerous it is to take the claims forced by a particular belief system like materialism as final truths.

Reader has certainly noticed that reconnection mechanism pops up again and again in the model and would be also the fundamental mechanism of ordinary DNA replication, transcription, translation of mRNA to proteins, and of process catching tRNA molecules carrying amino-acids to form protein at mRNA. This mechanism would be realized even in the mutual interactions between living organisms and between living organisms and inanimate matter.

Braiding represents as a higher level aspect of water memory

Braiding represents another aspect of water memory relating to the representation as dark nucleon sequences as the quantum computer programs represented by braidings to DNA in the model of DNA as topological quantum computer [K23]. The memories represented by braiding would be about the flow of water and molecules rather than about substances present in the water. The

model of qualia [K32] is based on flux tube connections between system representing self and environment. For polar molecules the qualia would relate to charge and electric polarization. Could the qualia assignable to polar molecule plus environment have scaled down fractal variants at the level of water clusters of environment? If this were the case then water would effectively produce representations about molecule at the level of qualia. Could also these relate to water memory?

Effects of intent on water crystallization

One should understand the effect of intent on water in terms of water memory. The proposed representation of polar molecules in terms of dark DNA sequences is one possible realization of water memory reducing naming of molecules to genetic code letters. Essentially addressing of molecules would be in question. This aspect of water memory is not relevant now. Rather, what matters is the interaction of water with human operator and reconnection of flux tubes of magnetic bodies is a good guess for how this interaction is realized. The same mechanism is involved also with the interaction of homeopathic remedy and harmful substance.

How could one understand the effect of intent on water crystallization, which characterizes the operator involved. The situation would be very much like that in the experiments of Tiller [J153]. The magnetic bodies assignable to the operator and water must interact and produce the effects. This would not be surprising if similar interaction takes place in the case of dissolved substances.

A concrete model for the interaction would be in terms of the reconnections of closed flux tubes emerging from the biological body of subject person with the flux tubes of the magnetic body of water creating direct flux tube contacts between the two bodies. The presence of magnetic flux tube connections between water sample and operator's magnetic and biological body would induce the effects on crystallization of water. Water memory should be stable in human time scales. This requires that these flux tube patterns are rather stable modification of the magnetic body of water. Large values of Planck constant assignable to the magnetic body of human agent would be needed. What is required is that the crystallization patterns and therefore structures of water clusters correlate with the structure of the magnetic body of the water sample.

Magnetic body and migrating birds

What happens when the water glass in the experiments of Emoto is taken to a large distance from operator? Does the effect prevail? If the magnetic flux tubes stretch, this interaction need not cease as the distance between operator and water glass increases unless the double flux tube splits by self-reconnection. If so, water could indeed act as a data medium as proposed in the video about water memory.

Magnetic body could play key role in understanding how birds and fish manage to find their birth places during migration is one of the many unresolved mysteries of biology. It has been suggested that orienteering in magnetic field of Earth using neuron level compass is in question but this proposal has its difficulties. Could it be that the birds and fish are connected by the magnetic flux tubes of their personal magnetic body or of that of the species to the birth place so that they would only follow Ariadne's thread?

5.6.2   Genes and water memory

After long time I had opportunity to read a beautiful experimental article about experimental biology. Yolene Thomas, who worked with Benveniste, kindly sent the article to me. The freely loadable article is *Electromagnetic Signals Are Produced by Aqueous Nanostructures Derived from Bacterial DNA Sequences* by Luc Montagnier, Jamal Aissa, Stephane Ferris, Jean-Luc Montagnier, and Claude Lavall'e published in the journal Interdiscip. Sci. Comput. Life Sci. (2009) [I44] .

Basic findings at cell level

I try to list the essential points of the article. Apologies for biologists: I am not a specialist.

1. Certain pathogenic micro-organisms are objects of the study. The bacteria Mycoplasma Pirum and E. Choli belong to the targets of the study. The motivating observation was that

some procedures aimed at sterilizing biological fluids can yield under some conditions the infectious micro-organism which was present before the filtration and absent immediately after it. For instance, one filtrates a culture of human lymphocytes infected by M. Pirum, which has infected human lymphocytes to make it sterile. The filters used have 100 nm and 20 nm porosities. M. Pirum has size of 300 nm so that apparently sterile fluids results. However if this fluid is incubated with a mycoplasma negative culture of human lymphocytes, mycoplasma re-appears within 2 or 3 weeks! This sounds mysterious. Same happens as 20 nm filtration is applied to a a minor infective fraction of HIV, whose viral particles have size in the range 100-120 nm.

2. These findings motivated a study of the filtrates and it was discovered that they have a capacity to produce low frequency electromagnetic waves with frequencies in good approximation coming as the first three harmonics of kHz frequency, which by the way plays also a central role in neural synchrony. What sounds mysterious is that the effect appeared after appropriate dilutions with water: positive dilution fraction varied between 10^{-7} and 10^{-12}. The uninfected eukaryotic cells used as controls did not show the emission. These signals appeared for both M. Pirum and E. Choli but for M. Pirum a filtration using 20 nm filter canceled the effect. Hence it seems that the nano-structures in question have size between 20 and 100 nm in this case.

   A resonance phenomenon depending on excitation by the electromagnetic waves is suggested as an underlying mechanism. Stochastic resonance familiar to physicists suggests itself and also I have discussed it while developing ideas about quantum brain [K69] . The proposed explanation for the necessity of the dilution could be kind of self-inhibition. Maybe a gel like phase which does not emit radiation is present in sufficiently low dilution but is destroyed in high dilutions after which emission begins. Note that the gel phase would not be present in healthy tissue. Also a destructive interference of radiation emitted by several sources can be imagined.

3. Also a cross talk between dilutions was discovered. The experiment involved two tubes. Donor tube was at a low dilution of E. Choli and "silent" (and carrying gel like phase if the above conjecture is right). Receiver tube was in high dilution (dilution fraction 10^{-9}) and "loud". Both tubes were placed in mu-metal box for 24 hours at room temperature. Both tubes were silent after his. After a further dilution made for the receiver tube it became loud again. This could be understood in terms of the formation of gel like phase in which the radiation does not take place. The effect disappeared when one interposed a sheath of mu-metal between the tubes. Emission of similar signals was observed for many other bacterial specials, all pathogenic. The transfer occurred only between identical bacterial species which suggests that the signals and possibly also frequencies are characteristic for the species and possibly code for DNA sequences characterizing the species.

4. A further surprising finding was that the signal appeared in dilution which was always the same irrespective of what was the original dilution.

Experimentation at gene level

The next step in experimentation was performed at gene level.

1. The killing of bacteria did not cancel the emission in appropriate dilutions unless the genetic material was destroyed. It turned out that the genetic material extracted from the bacteria filtered and diluted with water produced also an emission for sufficiently high dilutions.

2. The filtration step was essential for the emission also now. The filtration for 100 nm did not retain DNA which was indeed present in the filtrate. That effect occurred suggests that filtration destroyed a gel like structure inhibiting the effect. When 20 nm filtration was used the effect disappeared which suggests that the size of the structure was in the range 20-100 nm.

3. After the treatment by DNAse enzyme inducing splitting of DNA to pieces the emission was absent. The treatment of DNA solution by restriction enzyme acting on many sites of

DNA did not suppress the emission suggesting that the emission is linked with rather short sequences or with rare sequences.

4. The fact that pathogenic bacteria produce the emission but not "good" bacteria suggests that effect is caused by some specific gene. It was found that single gene - adhesin responsible for the adhesion of mycoplasma to human cells- was responsible for the effect. When the cloned gene was attached to two plasmids and the E. Choli DNA was transformed with the either plasmid, the emission was produced.

Some consequences

The findings could have rather interesting consequences.

1. The refinement of the analysis could make possible diagnostics of various diseases and suggests bacterial origin of diseases like Alzheimer disease, Parkinson disease, Multiple Sclerosis and Rheumatoid Arthritis since the emission signal could serve as a signature of the gene causing the disease. The signal can be detected also from RNA viruses such as HIV, influenza virus A, and Hepatitis C virus.

2. Emission could also play key role in the mechanism of adhesion to human cells making possible the infection perhaps acting as a kind of password.

The results are rather impressive. Some strongly conditioned skeptic might have already stopped reading after encountering the word "dilution" and associating it with a word which no skeptic scientist in his right mind should not say aloud: "homeopathy"! By reading carefully what I wrote above, it is easy to discover that the experimenters unashamedly manufactured a homeopathic remedy out of the filtrate! And the motivating finding was that although filtrate should not have contained the bacteria, they (according to authors), or at least the effects caused by them, appeared within weeks to it! This is of course impossible in the word of skeptic.

The next reaction of the skeptic is of course that this is fraud or the experimenters are miserable crackpots. Amusingly, one of the miserable crackpots is Nobelist Luc Montagnier, whose research group discovered AIDS virus.

How TGD could explain the findings?

Let us leave the raging skeptics for a moment and sketch possible explanations in TGD framework.

1. Skeptic would argue that the filtration allowed a small portion of infected cells to leak through the filter. Many-sheeted space-time suggests a science fictive variant of this explanation. During filtration part of the infected cells is "dropped" to large space-time sheets and diffused back to the original space-time sheets during the next week. This would explain why the micro-organisms were regenerated within few weeks. Same mechanism could work for ordinary molecules and explain homeopathy. This can be tested: look whether the molecules return back to the the diluted solution in the case of a homeopathic remedy.

2. If no cells remain in the filtrate, something really miraculous looking events are required to make possible the regeneration of the effects serving as the presence of cells. This even in the case that DNA fragments remain in the filtrate.

   (a) The minimum option is that the presence of these structures contained only the relevant information about the infecting bacteria and this information coded in terms of frequencies was enough to induce the signatures of the infection as a kind of molecular conditioning. Experimentalists can probably immediately answer whether this can be the case.

   (b) The most radical option is that the infecting bacteria were actually regenerated as experimenters claim! The information about their DNA was in some form present and was transcribed to DNA and/or RNA, which in turn transformed to proteins. Maybe the small fragment of DNA (adhesin) and this information should have been enough to

regenerate the DNA of the bacterium and bacterium itself. A test for this hypothesis is whether the mere nanoparticles left from the DNA preparation to the filtrate can induce the regeneration of infecting molecules.

The notion of magnetic body carrying dark matter quantum controlling living matter forms the basic element of TGD inspired model of quantum biology and suggests a more concrete model. The discovery of nanotubes connecting cells with distance up to 300 μ [I60] provides experimental support for the notion .

1. If the matter at given layer of the onion-like structure formed by magnetic bodies has large $\hbar$, one can argue that the layer corresponds to a higher evolutionary level than ordinary matter with longer time scale of memory and planned action. Hence it would not be surprising if the magnetic bodies were able to replicate and use ordinary molecules as kind of sensory receptors and motor organs. Perhaps the replication of magnetic bodies preceded the replication at DNA level and genetic code is realized already at this more fundamental level somehow. Perhaps the replication of magnetic bodies induces the replication of DNA as I have suggested.

2. The magnetic body of DNA could make DNA a topological quantum computer [K23] . DNA itself would represent the hardware and magnetic bodies would carry the evolving quantum computer programs realized in terms of braidings of magnetic flux tubes. The natural communication and control tool would be cyclotron radiation besides Josephson radiation associated with cell membranes acting as Josephson junctions. Cyclotron frequencies are indeed the only natural frequencies that one can assign to molecules in kHz range. There would be an entire fractal hierarchy of analogs of EEG making possible the communication with and control by magnetic bodies.

3. The values of Planck constant would define a hierarchy of magnetic bodies which corresponds to evolutionary hierarchy and the emergence of a new level would mean jump in evolution. Gel like phases could serve as a correlate for the presence of the magnetic body. The phase transitions changing the value of Planck constant and scale up or down the size of the magnetic flux tubes. They are proposed to serve as a basic control mechanism making possible to understand the properties and the dynamics of the gel phases and how biomolecules can find each other in the thick molecular soup via a phase transition reducing the length of flux tubes connecting the biomolecules in question and thus forcing them to the vicinity of each other.

Consider now how this model could explain the findings.

1. Minimal option is that the the flux tubes correspond to "larger space-time sheets" and the infected cells managed to flow into the filtrate along magnetic flux tubes from the filter. This kind of transfer of DNA might be made possible by the recently discovered nanotubes already mentioned.

2. Maybe the radiation resulted as dark photons invisible for ordinary instruments transformed to ordinary photons as the gel phase assignable with the dark matter at magnetic flux tube network associated with the infected cells and corresponding DNA was destroyed in the filtration.

   This is not the only possible guess. A phase conjugate cyclotron radiation with a large value of Planck constant could also allow for the nanostructures in dilute solute to gain metabolic energy by sending negative energy quanta to a system able to receive them. Indeed the presence of ambient radiation was necessary for the emission. Maybe that for sufficiently dilute solute this mechanism allows to the nanostructures to get metabolic energy from the ambient radiation whereas for the gel phase the metabolic needs are not so demanding. In the similar manner bacteria form colonies when metabolically deprived. This sucking of energy might be also part of the mechanism of disease.

3. What could be the magnetic field inducing the kHz radiation as a synchrotron radiation?

(a) For instance, kHz frequency and its harmonics could correspond to the cyclotron frequencies of proton in magnetic field which field strength slightly above that for Earth's magnetic field (750 Hz frequency corresponds to field strength of B_E, where $B_E = .5$ Gauss, the nominal strength of Earth's magnetic field). A possible problem is that the thickness of the flux tubes would be about cell size for Earth's magnetic field from flux quantization and even larger for dark matter with a large value of Planck constant. Of course, the flux tubes could make themselves thinner temporarily and leak through the pores.

(b) If the flux tube is assumed to have thickness of order 20-100 nm, the magnetic field for ordinary value of $\hbar$ would be of order .1 Tesla from flux quantization and in the case of DNA the cyclotron frequencies would not depend much on the length of DNA fragment since the it carries a constant charge density. Magnetic field of order .2 Tesla would give cyclotron frequency of order kHZ from the fact that the field strength of .2 Gauss gives frequency of about .1 Hz. This correspond to a magnetic field with flux tube thickness ~ 125 nm, which happens to be the upper limit for the porosity. Dark magnetic flux tubes with large $\hbar$ are however thicker and the leakage might involve a temporary phase transition to a phase with ordinary value of $\hbar$ reducing the thickness of the flux tube. Perhaps some genes (adhesin) plus corresponding magnetic bodies representing DNA in terms of cyclotron frequencies depending slightly on precise weight of the DNA sequence and thus coding it correspond to the frequency of cyclotron radiation are the sought for nano-structures.

4. While developing a model for homeopathy based on dark matter I ended up with the idea that dark matter consisting of nuclear strings of neutrons and protons with a large value of $\hbar$ and having thus a zoomed up size of nucleon could be involved. The really amazing finding was that nucleons as three quark systems allow to realize vertebrate code in terms of states formed from entangled quarks [L10] , [L10] described also in this chapter! One cannot decompose codons to letters as in the case of the ordinary genetic code but codons are analogous to symbols representing entire words in Chinese. The counterparts of DNA, RNA, and amino-acids emerge and genetic code has a concrete meaning as a map between quantum states.

   Without any exaggeration this connection between dark hadronic physics and biology has been one of the greatest surprises of my professional life. It suggests that dark matter in macroscopic quantum phase realizes genetic code at the level of nuclear physics and biology only provides one particular (or probably very many as I have proposed) representations of it. If one takes this seriously one can imagine that genetic information is represented by these dark nuclear strings of nanoscopic size and that there exists a mechanism translating the dark nuclei to ordinary DNA and RNA sequences and thus to biological matter. This would explain the claimed regeneration of the infected cells.

5. Genetic code at dark matter level would have far reaching implications. For instance, living matter - or rather, the magnetic bodies controlling it - could purposefully perform genetic engineering. This forces me to spit out another really dirty word, "Lamarckism"! We have of course learned that mutations are random. The basic objection against Lamarckism is that there is no known mechanism which would transfer the mutations to germ cells. In the homeopathic Universe of TGD the mutations could be however performed first for the dark nucleon sequences. After this these sequences would diffuse to germ cells just like homeopathic remedies do, and after this are translated to DNA or RNA and attach to DNA.

5.6.3   Water electric as protocell

Ulla Matfolk sent to me some interesting material at the web page of Dr. Mae-Wan Ho which provides further insights into the model of cell. The articles are "Water electric" [D18] and "Making Fuel from Water" [D16] . The articles summarize an experimental discovery which could be called Pollack-Zheng effect [D20, D13] . Both articles relate closely to what might be called the holy grail of artificial photosynthesis. The unreasonable effectiveness of photosynthesis in the sense that the

waste of energy during the process is extremely small, makes artificial photosynthesis an excellent candidate for the final solution of energy problems as far energy sources and minimization of wastes are considered. In the following I comment only the first paper in detail from TGD viewpoint.

How photosynthesis manages to be so effective is one of the mysteries of biology. TGD based view about metabolic energy involves two ideas.

1. TGD predicts a hierarchy of metabolic energy quanta [K7, K39] . The basic quanta come as $E(k) = 2^k E_0$, where k is positive or negative integer and $E_0 \simeq .5$ eV holds true. For instance, 2 eV metabolic energy quantum corresponding to red light corresponds to $k = 3$. This is actually oversimplification since there is a cascade of quanta $E(k,n) = (1 - 2 < sup > -n < /sup >)E(k)$ converging to $E(k)$ for each p-adic length scale. These energies correspond to energies liberated when electron or proton drops to a larger space-time sheet at the limit when second space-time becomes very large and the particle starts from rest and remains to rest: this is second idealization as also the particle in a box geometry. The idea is that these universal metabolic energy quanta preceded the metabolism based on chemical storage of energy and that the primary step in photosynthesis is kicking of proton or electron to a smaller space-time sheet.

2. Second idea relies on the hierarchy of Planck constants.

   (a) The rate of dissipation - that this the energy wasted per unit time - is inversely proportional to $\hbar$ in the first naive guess and means that macroscopically quantum coherent dark matter dissipates very little. Could photon kick charged dark particles to smaller space-time sheet where they dissipate very little? Or could photosynthesis capture ordinary or dark photons of sunlight to some layer of the onion like structure formed by the magnetic body of the organism, where it kicks particles to smaller space-time sheets. This light could correspond to bio-photons liberated as the biological body of the organism dies.

   (b) Could this storage of photons have preceded chemical storage of energy in living matter? And could this energy reserve explain some rather mysterious findings about the ability of some people to survive without ordinary metabolic energy feed (usually saints and this kind of people telling that light is enough for them to survive;-). Also animals are capable to these metabolic miracles [I92] : see the article "Researchers Seek to Demystify the Metabolic Magic of Sled Dogs" in Science. Of course, the storage of energy to that of dark matter or dark photons confined to the net defined by magnetic flux tubes could be the eventual manner to avoid energy waste and associated entropy growth inducing environmental problems. Hierarchy of Planck constants would allow the storage in arbitrary long length scales for given energy of photon so that even a community of organisms could have collective metabolic energy resources: maybe synergy has something to do with this.

The first article summarizing the Pollack-Zheng effect gives quantitative support for this picture. I have formatted the text as comments to the summary represented in the article of Mae-Wan Ho [D18] .

Exclusion zones

The article summarizes the sequence of events initiated by the discovery of Gerald Pollack and his student Jian-ming Zheng [D20, D13] . As a matter fact, the fascinating findings described in detail by Gerald Pollack in his book were absolutely crucial for the recent TGD based view about quantum biology in which dark matter plays key role.

1. Pollack and his student discovered that suspensions of colloids and dissolved substances are excluded from a region extending some hundreds of micrometres from the surfaces of hydrophilic gels. An "exclusion zone" (EZ) of this magnitude conflicts the belief that interfacial water forming at liquid-solid, or liquid-air interfaces can be no more than a few layers of molecules thick. What's observed is a million layers or more! 'Exclusion' means that the

water suspension of micro-spheres moved away from the surface of gel with constant velocity and behaving like single structural unit.

Comment: The sizes of cells vary up to hundreds of micrometers and cells are by definition structures which are isolated from the environment. Maybe EZs represent protocells or their predecessors. Pollack and coauthors have indeed proposed that their finding might relate to the origin of life [D13] . That the surface was that of gel might be important. In TGD based model of living matter gels have magnetic bodies and their presence might relate to the formation of the thick water layer in non-standard phase.

2. Similar exclusion zones were found next to any hydrophilic surface including surfaces coated with a monolayer of hydrophilic molecules, and around ion exchange resin beads. Electric charge appears to be important, as EZ failed to form around charge-exhausted resin beads. Although EZ can form in pure water, it is enhanced and stabilized by low concentrations of buffer (2 to 10 mM at pH 7).

   Comment: Hydrophily could correspond to the formation of magnetic flux tubes connecting the hydrophilic surface to water molecules as assumed in the model of protein folding and bio-catalysis [K4] .

3. The EZ phase is very different from the bulk water. An unusually ordered crystalline phase where the molecules are less free to move is suggestive. The UV and visible absorption spectrum gave a single absorption peak at $\lambda \simeq 270$ nm in the UV region completely absent in the bulk phase. The infrared emission record showed that the EZ radiates very little compared with bulk water, as would be expected on account of the reduced mobility of water molecules. The magnetic resonance imaging mapping similarly gave a transverse relaxation time (T2) of 25.4 + 1 ms, which is shorter than the 27.1 + 0.4 ms recorded for the bulk water phase, again indicative of restricted motion.

   Comment: The reduced radiation might mean that part of photons are dark and bound inside magnetic flux tubes defining a structure responsible for the formation of gel like phases inside cell and perhaps also inside EZ. The interpretation as bio-photons is suggestive. This phase of water could be predecessor of the water in cell interior since in the crystalline phase long bio polymers like DNA and amino-acid sequences would be stable against hydration.

4. EZ had a different electrical potential from the bulk phase, by as much as 100 200 mV, depending on the hydrophilic surface. With a negatively charged surface such as polyacrylic acid or Nafion (widely used as a proton exchange membrane), the potential is negative compared with the bulk water away from the EZ. Simultaneously, the hydrogen ion (proton, H^+) concentration is high just outside the EZ, decreasing in a gradient away from it. This indicates that the formation of the EZ is accompanied by a separation of positive and negative electrical charges, which led to the build up of electrical potential between the EZ and the bulk water. In effect, the water has become an electrical battery, and can provide electricity through an external circuit.

   Comment: Cell membrane is also a battery and the potential is around 50-80 mV to be compared with 100 200 mV, and the size scale of cell varies from 5 micrometer to hundreds of micrometers so that EZs could be involved with the formation of cell and cell membranes. The kicking of electrons or protons to smaller space-time sheet could be the mechanism inducing electric potential at a given space-time sheet. The formation of battery would mean that water could some day used to store very effectively the energy of solar radiation.

A connection with photosynthesis

Separating H^+ from e^- (electron) is the first step of photosynthesis in green plants which provides energy for most of the biosphere. In this case the energy comes from solar radiation. The separation of charges requires energy also in the case of EZ and the question is where this energy comes from in the case of EZ.

1. A clue came after having inadvertently left the experimental chamber with the EZ on the microscope overnight. Next morning, the EZ had shrunk considerably. But after turning on

the microscope lamp, it began to immediately grow again, restoring itself within minutes to its former size. The energy for EZ formation comes from light, as in photosynthesis, but it can use the low energy part of the solar spectrum that photosynthesis cannot.

Comment: Could one consider the possibility that photosynthesis involves unknown step and this step is just the kicking of electrons or protons to a smaller space-time sheet. This step would also induce the separation of charges and the generation of electric potential.

2. Although the entire spectrum of visible light appeared effective in making the EZ grow, the most effective part is in the infrared region, peaking at $\lambda \simeq 3100$ nm. A 10 minute exposure at that wavelength expanded the width of an EZ 3.7 times, and after an hour of exposure, the expansion was more than 6 times. After the light was turned off, the EZ remained constant for about 30 minutes before beginning to shrink, reaching halfway to its baseline level in about 15 minutes.

Comment: $\lambda = 3100$ nm corresponds to .4 eV. The nominal value of the fundamental metabolic energy quantum is around $E_0 = .5$ eV and one has $E(k = 0, n = 3) = 0.4375$ eV for this value of E_0. Perhaps the photons indeed kick electrons or protons to a smaller space-time sheet.

   (a) In the case of protons the smaller space-time sheet would correspond to atomic space-time sheets characterized by $p \simeq 2^{137}$: the larger one would correspond to to $k = 141$.

   (b) For electrons the size of the smaller space-time sheet would be by a factor $m_p/m_e = 940/.5 = 1880 \simeq 2^{11}$ larger and would correspond to $k = 137 + 11 = 148$. This served as one motivation for the original $\hbar/\hbar_0 = 2^{11k}$ hypothesis for the preferred values of Planck constant. This is one half of the thickness of the lipid layer of cell membrane. The larger space-time sheet would correspond to cell membrane thickness $L(151) = 10$ nm and perhaps the dark space-time sheet serving as a template for the formation of the cell membrane! If $E = .4$ eV corresponds to electron, then proton would correspond to $E(0, 3) = .44$ eV giving for the metabolic energy quantum the value $E_0(p) = 0.5029$ eV in the case of proton and $E_0(e) = 0.4616$ eV in the case of electron.

3. When the UV and visible range was tested, a peak in the degree of EZ expansion was detected at $\lambda = 270$ nm in the UV region, corresponding to the characteristic absorption peak of EZ that was identified before. However, as the optical power used in the UV and visible region was 600 times that in the IR, the most profound effect was identified in the IR region, particularly at 3 100 nm.

Comment: $\lambda = 270$ nm corresponds to the energy 4.5926 eV. E=4 eV is the nearest metabolic energy quantum. This energy does not correspond directly to any metabolic energy quantum assignable to .4 eV or .43 eV. One must be however cautious with conclusions since the model is very rough.

4. The mechanism of EZ formation is still unknown. But the two wavelengths that expand the EZ most effectively may offer some hint. The UV wavelength 270 nm is close to the 250 nm ($\simeq 5$ eV) required to ionize water under standard state conditions and taking into account the hydration of the resulting ions. The 3 100 nm peak, on the other hand is close to the OH stretch of the ring hexamer identified as the most abundant species in infrared predissociation spectroscopy of large water clusters, and also in neon matrices by infrared spectroscopy. These results suggest that photoexcitation of ring hexamers and photoionisation followed by ejection of protons play synergistic roles in the assembly of the EZ phase. Pollack and colleagues believe that the infrared radiation, though normally insufficient to break OH bonds, can nevertheless work via resonance induced dissociation of large hydrogen-bonded networks.

Comment: Ring hexamers bring in mind the crucial role of aromatic cycles in TGD inspired model of DNA as topological quantum computer which leads also to a model of ADP$\leftrightarrow$ ATP transition involving reconnection of magnetic flux tubes and having also information theoretic interpretation as a change of the topology of the braid structure defining topological quantum computer program [K23] . Magnetic flux tubes carrying dark electrons begin from these and can end up to other bio-molecules or water. Just a guess: could they end on ring hexamers?

Summary

The findings suggest additional details to the TGD based view about living matter.

1. The kicking of electrons or protons or both of them to a larger space-time sheet would be the first step in photosynthesis as I indeed suggested for years ago. The energy of 3100 nm photons indeed corresponds to that for the fundamental metabolic energy quantum. I have also proposed this process to be a fundamental step also in bio-catalysis: the temporary dropping of electron or proton of the catalyst molecule could provide the energy helping the reacting molecules to overcome the potential wall preventing the reaction from running. This metabolic coin could be returned to catalyst with high enough probability or the photons exchanged could be virtual.

   In many-sheeted space-time particles topologically condense at all space-time sheets having projection to given region of space-time so that this option makes sense only near the boundaries of space-time sheet of a given system. Also p-adic phase transition increasing the size of the space-time sheet could take place and the liberated energy would correspond to the reduction of zero point kinetic energy. Particles could be transferred from a portion of magnetic flux tube portion to another one with different value of magnetic field and possibly also of Planck constant h_{eff} so that cyclotron energy would be liberated.

2. The findings suggest also a mechanism for how solar radiation generates proto cells or their predecessors. The resulting phases of water have size extending to those for largest cells and the water could involve a gel like phase in which magnetic flux tubes containing dark matter could play a key role and eventually lead to quantum computer like behavior [K23] . The kicking of electrons (or protons) to smaller space-time sheet would induce ionization at given space-time sheet so that electric potential difference would result. The magnitude of the potential difference is of a correct order of magnitude. Cell membrane scale is present as a p-adic length scale for the space-time sheet of electrons before the kicking to the smaller space-time sheet and these space-time sheets could act as templates for the formation of cell membrane.

3. Interestingly, TGD based model of high T_c super conductivity predicts that both cell membrane length scale and size scale of cell are involved with the super-conductivity [K12] . Cell membrane acts as a Josephson junction in TGD based model of cell membrane, nerve pulse, and EEG.

5.6.4   A model for chiral selection

Chiral selection of bio-molecules is one of the basic mysteries of biology and it is interesting to see whether the existing bits of data combined with vision about quantum TGD could help to build a coherent picture about the situation. Let us first try to identify the most important pieces of the puzzle.

1. Chiral selection requires parity breaking in the scale of biomolecules. Standard model predicts parity breaking interactions but the effects are extremely small above intermediate boson length scale which is by a factor 10^{-7} shorter than atomic length scale. The proposed solution of the problem is that dark variants of intermediate gauge bosons are in question so that the Compton lengths of intermediate gauge bosons are scaled up by a factor $r = \hbar/\hbar_0$. Below the dark Compton length weak gauge bosons would be effectively massless and above it possess ordinary masses. Large parity breaking effects induced by dark intermediate gauge bosons would be possible.

2. For instance, for $r = 2^{44}$ for which EEG photons have energies just above thermal threshold at room temperature, the effective p-adic length scale would correspond to $L(k)$, $k = 89 + 44 = 133$ of about .2 Angstrom. This scale in turn would scale up to $L(133 + 44 = 177)$. Secondary p-adic length scale assignable to $k = 89$ which is important in zero energy ontology would correspond to $k = 2 \times 89 = 178$ which corresponds to about $L(178) \simeq 100$ μm, the length scale assignable to large cells and the thickness of water layers in the experiment of Pollack.

3. Parity breaking interaction is associated with spin and the interaction energy of form $ks \cdot E_Z$, where s is the spin of particle and E_Z is Z^0 electric field. Classical induced gauge fields are very strongly correlated in TGD since they are expressible in terms of four CP_2 coordinates and their gradients. Hence classical electromagnetic field E is in the generic case accompanied by classical Z^0 field $E_Z = aE$. This means that if there is classical electromagnetic field and charge density at the dark space-time sheet, large parity breaking effect is possible at the level of spin. The induced Z^0 electric field could force the spins to become parallel and in this manner induce also magnetization.

The crucial finding about which I learned three years ago is that L glutamate is more stable than R glutamate in water and that heavy water does not induce this effect [I82] . This suggests a connection with Pollack-Zheng effect [D20] . Heavy water nuclei have vanishing spin whereas hydrogen nuclei have spin $1/2$ so that H_2 in water molecules can be in spin singlet or triplet states (para and orto configurations). Could the nuclear spin of water molecules somehow induce parity breaking and the magnetic interaction distinguishing between these molecules?

1. Suppose that bio-molecules in question have magnetic moment and water carries magnetic field, most naturally at dark magnetic flux tubes. The parity breaking interaction energy $-p \cdot E$ with dark electric field remains invariant under reflection and rotation of π changing the orientation of the mirror image of the molecule with respect to electric field. The interaction energy with magnetic field however changes its sign since magnetic moment is not affected by the reflection but changes direction under rotation. The angular momentum of the molecule responsible for the magnetic moment can of course change sign but since the transformation involves acts on angular momenta only, it is not a symmetry of entire system. Indeed, if there is interaction between angular momentum degrees of freedom and geometric degrees of freedom the magnetic interaction energy for the mirror image is different. Suppose that the breaking of reflection symmetry induced by the chirality of the molecule induces internal electric field E_{int}. The parity breaking interaction energy $ks \cdot E_{int}$ would indeed break the symmetry in the transformation changing the directions of angular momenta and spins.

2. It deserves to be emphasize that the parity breaking of the molecule itself would induce the symmetry breaking if molecule possesses dark magnetic body. One can actually imagine a cascade of parity breakings proceeding from shorter to longer length scales in this manner.

3. The mechanism creating electric field could be the charging of water, perhaps by the Pollack-Zheng mechanism and having in TGD framework an interpretation as a basic mechanism storing the energy of sunlight to metabolic energy (kicking of electrons and/or protons to a smaller space-time sheet so that oppositely charge space-time sheets emerge as a consequence). A direct connection with metabolism would be admittedly a highly satisfactory feature of the mechanism.

4. Parity breaking energy $ks \cdot E$ for say dark protons assignable to hydrogen nuclei of bio-molecules in the internal electric field of the molecule or dark protons of water molecules in the electric field induced by Pollack-Zheng effect [D20] does not change sign under the reflection of the molecule so that spin polarization independent of chirality could result form both water molecules in crystal like phase and for bio-molecules possessing dark protons (and dark hydrogen atoms). This could in turn serve as a seed for magnetization essential for the existence of dark magnetic flux tubes.

If water is replaced with heavy water there is no difference between L and R. What distinction H and D could explain this difference?

1. The basic difference between water and heavy water nuclei is that for water nucleus is just proton having spin $1/2$ so that H_2 in water molecule can be in spin triplet and singlet states. Fractions of the two states are $3/4$ and $1/4$ in the absence of external magnetic field.

2. On the other hand, in atto-second time scale (corresponding length scale is 3 Angstroms) water is known to behave effectively as $H_{1.5}O$. A possible explanation is that $1/4$:th of H nuclei/atoms are effectively dark having large Planck constant. The dark protons cannot

correspond to H_2 in spin singlet state since the interaction energy $ks \cdot E$ would be small in this case. Dark spin triplet states of H_2 could however induce parity breaking in water and make crystal like water phase both electret and magnet. If the spin $s_z = 1$ with negative interaction energy with E becomes dark then $1/4$ of hydrogen atoms would be dark and $H_{1.5}O$ formula would hold true. For D_2O this mechanism would not work.

3. The model for homeopathy led to the idea that dark nuclei consisting of scale up variants of nucleons possibly having size of order atomic length scale could be crucial for understanding living matter. The states of nucleons correspond naturally to those DNA, RNA, and aminocids and vertebrate genetic code emerges naturally with DNA code word replaced with 3 quark state with entanglement between the quarks representing the information. Could it be that dark protons of water combine to form dark nuclei providing a fundamental representation of the genetic code and could the spin of protons induce electro-weak chiral symmetry breaking. Also now this mechanism fails for D_2O.

5.6.5   Burning water and photosynthesis

For a physicist liberated from the blind belief in reductionism, biology transforms to a single gigantic anomaly about which recent day physics cannot say much. During years I have constructed several models for these anomalies helping to develop a more detailed view about how the new physics predicted by quantum TGD could allow to understand biology and consciousness.

The basic problem is of course the absence of systematic experimentation so that it is possible to imagine many new physics scenarios. For this reason the article series of Mae-Wan Ho [D18, D16, D14, D17] in ISIS was a very pleasant surprise, and already now has helped considerably in the attempts to develop the ideas further.

The first article "Water electric" [D18] told about the formation of exclusion zones around hydrophilic surfaces, typically gels in the experiments considered [D20] . The zones were in potential of about 100 meV with respect to surroundings (same order of magnitude as membrane potential) and had thickness ranging to hundreds of micrometers (the size of a large cell): the standard physics would suggests only few molecular layers instead of millions. Sunlight induced the effect. This finding allow to develop TGD based vision about how proto cells emerged and also the model for chiral selection in living matter by combining the finding with the anomalies of water about which I had learned earlier.

The article "Can water burn?" [D14] tells about the discovery of John Kanzius - a retired broadcast engineer and inventor. Kanzius found that water literally burns if subjected to a radio frequency radiation at frequency of 13.56 MHz [D1]. The mystery is of course how so low frequency can induce burning. The article "The body does burn water" [D17] notices that plant cells burn water routinely in photosynthesis and that also animal cells burn water but the purpose is now to generate hydrogen peroxide which kills bacteria (some readers might recall from childhood how hydrogen peroxide was used to sterilize wounds!). Hence the understanding of how water burns is very relevant for the understanding of photosynthesis and even workings of the immune system.

Living matter burns water routinely

Photosynthesis burns water by decomposing water to hydrogen and oxygen and liberating oxygen. Oxygen from CO_2 in atmosphere combines with the oxygen of H_2O to form O_2 molecules whereas H from H_2O combines with carbon to form hydrocarbons serving as energy sources for animals which in turn produce CO_2. This process is fundamental for aerobic life. There is also a simpler variant of photosynthesis in which oxygen is not produced and applied by an-aerobic life forms. The article "Living with Oxygen" by Mae-Wan Ho gives a nice overall view about the role of oxygen [D15] . As a matter fact, also animals burn water but they do this to produce hydrogen peroxide H_2O_2 which kills very effectively bacteria.

Burning of water has been studied as a potential solution for how to utilize the solar energy to produce hydrogen serving as a natural fuel [D16]. The reaction $O_2 + H_2 \rightarrow 2H_2O$ occurs spontaneously and liberates energy of about 1.23 eV. The reverse process $2H_2 \rightarrow H_2O_2 + H_2$ in the presence of sunlight means burning of water, and could provide the manner to store solar energy. The basic reaction $2H_2O + 4h\nu \leftrightarrow H_2O_2 + H_2$ stores the energy of four photons. What really

happens in this process is far from being completely understood. Quite generally, the mechanisms making possible extreme efficiency of bio-catalysis remain poorly understood. Here new physics might be involved. I have discussed models for photosynthesis and $ADP \leftrightarrow ATP$ process involved with the utilization of the biochemical energy already earlier [K39] .

How water could burn in TGD Universe?

The new results could help to develop a more detailed model about what happens in photosynthesis. The simplest TGD inspired sketch for what might happen in the burning of water goes as follows.

1. Assume that 1/4 of water molecules are partially dark (in sense of nonstandard value of Planck constant) or at least at larger space-time sheets in atto-second scale [D9, D8, D10, D12] . This would explain the $H_{1.5}O$ formula explaining the results of neutron diffraction and electron scattering.

2. The question is what this exotic fraction of water precisely is. The models for water electret, exclusion zones and chiral selection lead to concrete ideas about this. Electrons assignable to the H atoms of (partially) dark H_2O reside at space-time sheet $k_e = 151$ (this p-adic length scale corresponds to 10 nm, the thickness of cell membrane). At least the hydrogen atom for this fraction of water molecules is exotic and findings from neutron and electron scattering suggest that both proton and electron are at non-standard space-time sheets but not necessarily at the same space-time sheet. The model for the burning requires that electron and proton are at different space-time sheets in the initial situation.

3. Suppose all four electrons are kicked to the space-time sheet of protons of the exotic hydrogen atoms labeled by k_p. This requires the energy $E_\gamma = (1 - 2^{-n})E_0(k_p)$ (the formula involves idealizations). At this space-time sheet protons and electrons are assumed to combine spontaneously to form two H_2 atoms. Oxygen atoms in turn are assumed to combine spontaneously to form O_2.

4. For $k_f = 148$ and $n = 3$ minimum energy needed would be $4E_\gamma = 4 \times .4 = 1.6$ eV. For $k_p = 149$ (thickness of lipid layer) and $n = 2$ one would have $4E_\gamma = 4 \times .3462 = 1.385$ eV whereas $H_2O_2 + H_2 \rightarrow 2H_2O$ liberates energy 1.23 eV. Therefore the model in which electrons are at cell membrane space-time sheet and protons at the space-time sheet assignable to single lipid layer of cell membrane suggests itself. This would also mean that the basic length scales of cell are already present in the structure of water. Notice that there is no need to assume that Planck constant differs from its standard value.

There is no need to add, that the model is an unashamed oversimplification of the reality. It might however catch the core mechanism of photosynthesis.

Burning of salt water induced by RF radiation

Engineer John Kanzius has made a strange discovery [D1]: salt water in the test tube radiated by radio waves at harmonics of a frequency f=13.56 MHz burns. Temperatures about 1500 K, which correspond to .15 eV energy have been reported. One can irradiate also hand but nothing happens. The original discovery of Kanzius was the finding that radio waves could be used to cure cancer by destroying the cancer cells. The proposal is that this effect might provide new energy source by liberating chemical energy in an exceptionally effective manner. The power is about 200 W so that the power used could explain the effect if it is absorbed in resonance like manner by salt water.

Mae-Wan Ho's article "Can water Burn?" [D14] provides new information about burning salt water [D1], in particular reports that the experiments have been replicated. The water is irradiated using polarized radio frequency light at frequency 13.56 MHz. The energy of radio frequency quantum is $E_{rf} = .561 \times 10^{-7}$ eV and provides only a minor fraction $E_{rf}/E = .436 \times 10^{-7}$ of the needed energy which is $E = 1.23$ eV for single $2H_2O \rightarrow H_2O_2 + H_2$ event. The structure of water has been found to change, in particular something happens to O-H bonds. The Raman spectrum of the water has changed in the energy range $[0.37, 0.43]$ eV. Recall that the range of metabolic energy quanta $E(k, n) = (1 - 2^{-n})E_0(k)$ varies for electron in the range $[.35, .46]$ eV in the model

for the formation of exclusion zone induced by light. Therefore the photons assigned to changes in Raman spectrum might be associated with the transfer of electrons between space-time sheets.

The energies of photons involved are very small, multiples of 5.6×10^{-8} eV and their effect should be very small since it is difficult to imagine what resonant molecular transition could cause the effect. This leads to the question whether the radio wave beam could contain a considerable fraction of dark photons for which Planck constant is larger so that the energy of photons is much larger. The underlying mechanism would be phase transition of dark photons with large Planck constant to ordinary photons with shorter wavelength coupling resonantly to some molecular degrees of freedom and inducing the heating. Microwave oven of course comes in mind immediately.

As I made this proposal, I did not realize the connection with photosynthesis and actual burning of water. The recent experimental findings suggest that dark radio frequency photons transform to photons inducing splitting of water as in photosynthesis so that that one should have $r = \hbar/\hbar_0 = E_{rf}/4E$. One could say that large number of radio wave photons combine to form a single bundle of photons forming a structure analogous to what mathematician calls covering space. In the burning event the dark photon would transform to ordinary photon with the same energy. This process would thus transform low energy photons to high energy protons with the ratio $r = \hbar/\hbar_0$.

Therefore the mechanism for the burning of water in the experiment of Kanzius could be a simple modification of the mechanism behind burning of water in photosynthesis.

1. Some fraction of dark radio frequency photons are dark or are transformed to dark photons in water and have energies around the energy needed to kick electrons to smaller space-time sheets .4 eV. After this they are transformed to ordinary photons and induce the above process. Their in-elastic scattering from molecules (that is Raman scattering) explains the observation of Raman scattered photons. For a fixed value of $\hbar$ the process would occur in resonant manner since only few metabolic quanta are allowed.

2. How dark radio frequency photons could be present or could be produced in water? Cyclotron radiation assignable to say electrons in magnetic field comes in mind. If the cyclotron radiation is associated with electrons it requires a magnetic field of 4.8 Gauss the cyclotron frequency is 13.56 MHz. This is roughly ten times the nominal value $B_E = .5$ Gauss of the Earth's magnetic field and 24 times the value of dark magnetic field $B_d = .4B_E = .2$ Gauss needed to explain the effects of ELF em fields on vertebrate brain. Maybe dark matter at flux tubes of Earth's magnetic field with Planck constant equal to $\hbar/\hbar_0 = \frac{1}{4}\frac{E}{E_{rf}}$ transforms radio frequency photons to dark photons or induces resonantly the generation of cyclotron photons, which in turn leak out from magnetic flux tubes and form ordinary photons inducing the burning of water. $E_\gamma = .4$ eV would give $\hbar/\hbar_0 == 1.063 \times 2^{21}$ and $E_\gamma = .36$ eV would give $\hbar/\hbar_0 = .920 \times 2^{21}$.

3. Magnetic fields of magnitude .2 Gauss are in central role in TGD based model of living matter and there are excellent reasons to expect that this mechanism could be involved also with processes involved with living matter. There is indeed evidence for this. The experiments of Gariaev demonstrated that the irradiation of DNA with 2 eV laser photons (which correspond to one particular metabolic energy quantum) induced generation of radio wave photons having unexpected effects on living matter (enhanced metabolic activity) [I52] , and that even a realization of genetic code in terms of the time variation of polarization direction could be involved. TGD based model [K10, K90] identifies radio-wave photons as dark photons with same energy as possessed by incoming visible photons so that a transformation of ordinary photons to dark photons would have been in question. The model assumed hierarchy of values of magnetic fields in accordance with the idea about onion like structure of the magnetic body.

There are several questions to be answered.

1. Is there some trivial explanation for why salt must be present or is new physics involved also here. What comes in mind are Cooper pairs dark Na^+ ions (or their exotic counterparts which are bosons) carrying Josephson currents through the cell membrane in the model of the cell membrane as a Josephson junction which is almost vacuum extremal of Kähler action. In the experimental arrangement leading to the generation of exclusion zones the pH of water was important control factor, and it might be that the presence of salt has an analogous role to that of protons.

2. Does this effect occur also for solutions of other molecules and other solutes than water? This can be tested since the rotational spectra are readily calculable from data which can be found at net.

3. Are the radio wave photons dark or does water - which is very special kind of liquid - induce the transformation of ordinary radio wave photons to dark photons by fusing $r = \hbar/\hbar_0$ radio wave massless extremals (MEs) to single ME. Does this transformation occur for all frequencies? This kind of transformation might play a key role in transforming ordinary EEG photons to dark photons and partially explain the special role of water in living systems.

4. Why the radiation does not induce spontaneous combustion of living matter which contains salt. And why cancer cells seem to burn: is salt concentration higher inside them? As a matter fact, there are reports about [D6] . One might hope that there is a mechanism inhibiting this since otherwise military would be soon developing new horror weapons unless it is doing this already now. Is it that most of salt is ionized to Na^+ and Cl^- ions so that spontaneous combustion can be avoided? And how this relates to the sensation of spontaneous burning [D5] - a very painful sensation that some part of body is burning?

5. Is the energy heating solely due to rotational excitations? It might be that also a "dropping" of ions to larger space-time sheets is induced by the process and liberates zero point kinetic energy. The dropping of proton from k=137 (k=139) atomic space-time sheet liberates about .5 eV (0.125 eV). The measured temperature corresponds to the energy .15 eV. This dropping is an essential element in the ealier of remote metabolism and provides universal metabolic energy quanta. It is also involved with TGD based models of "free energy" phenomena. No perpetuum mobile is predicted since there must be a mechanism driving the dropped ions back to the original space-time sheets.

   In many-sheeted space-time particles topologically condense at all space-time sheets having projection to given region of space-time so that this option makes sense only near the boundaries of space-time sheet of a given system. Also p-adic phase transition increasing the size of the space-time sheet could take place and the liberated energy would correspond to the reduction of zero point kinetic energy. Particles could be transferred from a portion of magnetic flux tube portion to another one with different value of magnetic field and possibly also of Planck constant h_{eff} so that cyclotron energy would be liberated.

6. The electrolysis of water and also cavitation produces what is known as Brown's gas which should consist of water vapour and there might be a connection to the burning of salt water. The properties of Brown's gas [H5] however do not support this interpretation: for instance, Brown's gas has temperature of about 130 C but is able to melt metals so that some un-known mechanism liberating energy must be involved explaining also the claims about over-unity energy production in water splitting using electrolysis. TGD inspired model for Brown's gas [K40] suggests that activated water and Brown's gas correspond to same phase involving polymer sequences formed from exotic water molecules for which one hydrogen nucleus is dark and defining the analogs of basic biopolymers. The bond binding protons to a polymer like sequence would serve as the counterpart of covalent bond.

   One also ends up with a more detailed TGD inspired view about basic mechanism of metabolism in living matter predicting a tight correlation between p-adic length scale hypothesis and hierarchy of Planck constants. The model differs in some aspects from the rough models considered hitherto assuming that metabolic energy is liberated as zero point kinetic energy when particle drops to a larger space-time sheet or as cyclotron energy when cyclotron quantum number decreases. Now a phase transition increasing the p-adic length scale of the space-time surface would liberate either kinetic energy of cyclotron energy. Quantum numbers would not change: rather, t the scale appearing as a parameter in the expression of kinetic or cyclotron energy would change adiabatically and in this manner guarantee coherence. Also a phase transition in which the changes of scale due to a reduction of Planck constant and increase of the p-adic length scale compensate each other liberate metabolic energy.

Recall that one of the empirical motivations for the hierarchy of Planck constants came from the observed quantum like effects of ELF em fields at EEG frequencies on vertebrate brain and also from the correlation of EEG with brain function and contents of consciousness difficult to understand since the energies of EEG photons are ridiculously small and should be masked by thermal noise.

5.6.6 Morphogenesis, morphostasis, and learning in TGD framework

Michael Levin and his collaborators have been working with fascinating topics including fundamentals of long term memory and morphogenesis and morphostasis [I70, I71, I101]. I am grateful for Lian Sidorov for bringing these articles to my attention.

There are two articles about morphogenesis and morphostasis. The first article [I70] (`http://www.futuremedicine.com/doi/pdf/10.2217/rme.11.69`) seems to be directed to general audience and has the title "The wisdom of the body: future techniques and approaches to morphogenetic fields in regenerative medicine, developmental biology and cancer". Second article [I71] titled "Morphogenetic fields in embryogenesis, regeneration, and cancer: Non-local control of complex patterning" (`http://www.ncbi.nlm.nih.gov/pubmed/22542702`) is more technical. The basic notion is morphogenetic field, an old notion, which has not captured the attention of main stream biologists who have worked mainly with the attempt to reduce biology to genetic code. Sheldrake's work [I96] with the notion has drawn special attention but there are many other workers in the field.

The third article [I101] by Levin and Shomrat has title "An Automated Training Paradigm Reveals Long-term Memory in Planaria and Its Persistence Through Head Regeneration" (`http://mechanism.ucsd.edu/teaching/f13/cs200/Levin_longterm_learning_planaria_2013.pdf`) challenging the belief that brain is the only seat of memories.

According to Levin, the basic challenge of morphogenetics and morphostasis is to understand how the shape of the organism is generated and how it is preserved [I71]. The standard local approach based on belief on genetic determinism does not allow answer these questions satisfactorily. There is paradigm based on self-organization in which the local dynamics of cells leads to large scale structures as self-organization patterns. The game of life is an elegant example about how simple cellular automaton can lead to surprisingly complex behaviors: actually the game of life is universal Turing computer. The problem of this approach is that it is very difficult to deduce the local rules governing the behavior of basic units (whatever they are) in practice- especially so if they are also dynamical.

Second approach could be seen as computational with basic idea being that the process is guided by a template of the target state. Morphogenetic fields would define this template. The assumption about final goal can be argued to be too strong: much weaker principle defining a local direction of dynamics and leading automatically to the final state as something analogous to free energy minimum in thermodynamics might be enough. Unfortunately, second law is the only principle that standard physics can offer.

These problems are very relevant also for medicine [I70] since morphogenesis, morphostasis, and cancer all involve actively replicating cells: the difference is that in cancer the control and long scale coordination of the process fails and it becomes purely local process. Levin refers to cancer as geometric disease and it seems that this correction contains seed of truth.

These topics are also interesting from the point of view of TGD inspired quantum biology and consciousness. There are several new notions to be tested.

1. The new view about time and quantum implied by zero energy ontology (ZEO). In TGD framework the notion of preferred extremals as 4-D space-time sheet analogous to Bohr orbit, for which strict determinism of dynamics fails, replaces 3-space as basic unit. One can understand self-organizaton process in 4-D sense rather than 3-D sense: geometric time evolution would be replaced by subjective time evolution by quantum jumps. This could resolve the basic difficulty of the ordinary self-organization paradigm. Geometro-temporal pattern approaches to asymptotic quatum jump by quantum jump one rather than 3-D pattern.

2. The new view about information relying on the notion of negentropic entanglement and Negentropy Maximization Principle (NMP). NMP could be the principle guaranteeing local

positive goal making healing and evolution basic processes of Nature. In particular, the development of shape and shape preservation of organisms could involve NMP in essential manner. Also the approach of WCW spinor field to the maximum of vacuum functional (or equivalently that of Kähler function) gives a goal for the dynamics after the perturbation of the organism causing "trauma". If Kähler function is classical space-time correlate for entanglement negentropy, these two views are equivalent.

3. The notion of magnetic body (MB) carrying dark matter as phases with large value h_{eff} of Planck constant making living matter a macroscopic quantum system and providing a tool kit of quantum mechanisms (phase transitions changing the value of h_{eff} and thus the length of flux tube, reconnections changing the topology of magnetic Indra's net, and 1-braiding of flux tubes 3-space and 2-braiding of their orbits in 4-D space-time). Magnetic body defining a kind of coordinate grid is a good candidate for the TGD counterpart of morphogenetic field serving as a template for the developing organism. It would also give rise to topological quantum computation (TQC) type activities.

    The coordinate grid formed by flux tubes defines 3-D topological quantum computer program and the natural assumption is that learned behaviors are coded by the magnetic body as TQC programs. If replication of magnetic body accompanies the replication of DNA, cell, and even planaria (say), the learned behaviors are also replicated.

4. There are additional mechanisms: super-conductivity made possible by large values of h_{eff}, Josephson radiation from Josephson junctions transforming voltages to frequencies inducing resonant transitions, and radiation consisting of dark photons and inducing cyclotron transitions serving as a basic control and coordination tools. The radiation could be generated as analog of cyclotron radiation by quantum phase transitions at magnetic flux tubes, by Josephson junctions, and by microtubules serving as quantum antennas. Frequency modulation is an excellent candidate for the representation of information: kind of whale song would be in question.

All these new notions seem to be highly relevant for the understanding the findings challenging the standard intuition discussed in the articles. It would seem that both computational aspects (TQC), self-organization but in 4-D sense, the idea about template identified in terms of flux quanta of topologically quantized classical em fields, and the local direction of quantum dynamics defined by NMP are involved rather than single principle.

The notion of time in TGD framework

The TGD based notion of time is very relevant in attempts to understand the findings about the memory of planaria and metamorphosis and metastasis challenging the standard thinking.

1. The general picture based on zero energy ontology

1. In TGD framework one must make a distinction between subjective time and geometric time: usually these times are identified. Subjective time has state function reduction/quantum jump as chronon. Geometric time is the time of physicists and corresponds to one coordinate for space-time surface or imbedding space. General Coordinate Invariance implies that it is not unique but that there are very natural choices of it dictated by symmetries.

2. In zero energy ontology (ZEO) physical state is replaced with a pair of positive and negative energy states at opposite boundaries of $CD \times CP_2$, where CD is causal diamond identified as the intersection of future and past directed light-cones. I will talk about CD in the sequel without bothering to write "$\times CP_2$". In ordinary positive energy ontology zero energy states correspond to initial and final states of physical events. The space-time surfaces having their ends at the boundaries of $CD \times CP_2$ are space-time correlate for the physical time evolution between the initial and final states. CD:s form a fractal hierarchy since the distance between the tips of CD is assumed to be integer multiple of CP_2 time. Also Lorentz transforms and translates of CD are allowed so that it makes sense to speak about moduli space of CD:s and also have "wave functions" in this moduli space. This is very relevant for understanding what the flow of time corresponds physically.

One can say, that due to the failure of strict determinism the 4-D space-time surface connecting boundaries of CD becomes the basic dynamical unit as far as subjective time development is considered. The superposition of space-time sheets is recreated again and again in quantum jump so that "quantum average" space-time - also its past - changes.

One can speak about 4-D body, brain, even society and there is continual 4-D interactions. For instance, the recall of long term memories could be communications with the geometric past using time reversed signals reflecting back from the brain of the geometric past: essentially seeing in time direction would be in question. One can even consider healing process in which the healthy state result also in the geometric past!

A new view about long term memories emerges: the brain of geometric past can serve as the seat of memories. This applies to genuine conscious memories such as episodal memories but not to learned behaviors.

3. Zero energy ontology (ZEO) implies a new view about state function reduction and about how the experience about flow of time and its arrow emerge. The state function reductions can occur at either boundary of CD but also repeatedly at same boundary. The wave function in the moduli space of CD:s with fixed "lower boundary" changes although in each repetition of state function reduction although the positive energy state at "lower" boundary remains unchanged. In ordinary quantum measurement theory nothing would change. This change gives rise to the experience about flow of time. The change is that the average temporal distance between the fixed tip of "lower" boundary and the tip of the "upper boundary" increases: essentially dispersion leading to the decay of wave packet is in question. It is analogous to diffusion in which distance of the diffusing particle from the initial position gradually increases. One can quantify this by introducing the average increase of average geometric time in single state function reduction highly relevant for understanding time experience.

4. Couplings between several widely different length and time scales - say molecular length scale and the scale of biological body - seems to be needed in order to understand morphogenesis - at least as something implied by cell level events. TGD assigns to each particle its CD. The scale of the smallest CD assignable with the particle characterized by given p-adic prime p corresponds to its secondary p-adic length/time scale. For electron this time scale is .1 seconds defining a fundamental biorhythm: as a length scale it corresponds to the circumference of Earth.

5. One of the basic predictions of TGD is the failure of strict determinism of the time evolution for space-time surfaces. The interpretation is as a space-time correlate of quantum non-determinism. The reason is the huge vacuum degeneracy of Kähler action. Any space-time surface with vanishing induced Kähler form which is essentially Maxwell field, is vacuum extremals. Mathematically this huge degeneracy is like gauge degeneracy but implies 4-D (very essential distinction from standard view) spin glass degeneracy: there is huge number of different preferred extremals obtained as deformations of the vacuum extremals. This means non-determinism.

So called vacuum functional tells the probability of one particular preferred extremal and one can imagine plotting it as a functional of the extremal. The graph would be a fractal analogous to free energy landscape of spin glass: there are minima inside minima inside.... - now only the minima are replaced with maxima.

2. What healing in 4-D sense could mean?

The TGD view about time allows to imagine what 4-D healing could mean.

1. Suppose that one performs a deformation of the space-time sheet representing healthy organism. The system suffers "traumatic injury" in 4-D sense but only inside the CD in question. Classical non-determinism makes also possible the that the localization of 4-D deformation to a finite region of space-time rather than extending to infinite future. State functions repeatedly replace the zero energy state with a new one and it can gradually end up back to the maximum of Kähler function unless the deformation was not too large or unless it stucks

to a different local maximum. If it ends up with a original maximum, one can say that 4-D healing took place. Also the biological body of geometric past is healthy! In geometric sense the system was never sick! This mechanism requires no knowledge about healthy state and no algorithm for getting back into healthy state. Nature takes care of healing.

2. The sticking to a local maximum of vacuum functional can prevent getting to the ideal healthy state. This can be avoided by the same mechanism as in annealing, which serves as a metaphor in numerics for a process in which one finds deep minimum of function by "kicking" the system now and then to get out of local minimum. Now the "kicking" would be stimulus deforming the system but not too much.

3. One expects that also Negentropy Maximization Principle (NMP) is closely involved with healing since healing should involve regain of the lost information. NMP states that the total negentropy increases in state function reductions and is apparently the opposite of second law: the negentropies in question are however not the same thing and NMP implies second law for ordinary entanglement. The implication is that the potentially conscious information associated with the negentropic entanglement (with identical entanglement probabilities for entangled states) tends to increase and negentropic entanglement (see fig. `http://www.tgdtheory.fi/appfigures/cat.jpg` or fig. 21 in the appendix of this book) can be only transferred to another system or transformed to a new form, but cannot disappear. Negentropically entangled systems would define kind of Akashic records storing potentially conscious information transformed to conscious information in interaction of free quantum measurement. The approach towards maximum of negentropic and maximum of vacuum functional should closely to each other. Quite concretely, NMP could help to understand why the pieces of planaria split into two parts develop head and tail.

4. Clearly, NMP and the approach to the maximum of Kähler function both define candidates for the principles giving rise to same outcome as morphogenetic field is hoped to give. A possible interpretation is that the approach to the maximum of Kähler function is the space-time correlate for NMP: Kähler function defined as Kähler action for preferred extremal could be regarded as classical negentropy.

3. The flow and arrow of time in ZEO

The TGD based vision about how the arrow of geometric time has developed slowly and I do not dare claim it be fully developed and final [K6].

1. What seems clear now is the decisive role of ZEO and hierarchy of CDs, and the fact that the quantum arrow of geometric time is coded into the structure of zero energy states to a high extent. The still questionable but attractively simple hypothesis is that U matrix relates two zero energy state basis with opposite quantum arrows of geometric time: is this assumption really consistent with what we know about the arrow of time? The second basis is always state function reduced.

   If this is the case, the question is how the relatively well-defined quantum arrow of geometric time implies the experienced arrow of geometric time. Should one assume the arrow of geometric time separately as a basic property of the state function reduction cascade or more economically- does it follow from the arrow of time for zero energy states?

2. The state function reductions occurs at either of the two boundaries of CD. If the reduction occurs at given boundary is immediately followed by a reduction at the opposite boundary, the arrow of time alternates: this does not conform with intuitive expectations: for instance, this would imply that there are two selves assignable to the opposite boundaries!

   It took time to realize that zero energy states must be de-localized in the moduli space CDs (the size of CD plus discrete subgroup of Lorentz group defining boosts of CD leaving second tip invariant). One has quantum superposition of CDs with difference scales but with fixed upper or lower boundary belonging to the same light-cone boundary after state function reduction. In standard quantum measurement theory the repetition of state function reduction does not change the state but now it would give rise to the experienced flow of time. Zeno effect indeed requires that state function reductions can occur repeatedly at the

same boundary. In these reductions the wave function in moduli degrees of freedom of CD changes. This implies "dispersion" in the moduli space of CDs experienced as flow of time with definite arrow.

3. This approach codes also the arrow of time at the space-time level: the average space-time sheet in quantum superposition increases in size as the average position of the "upper boundary" of CDs drifts towards future state function reduction by state function reduction.

4. In principle the arrow of time can temporarily change but it would seem that this can occur in very special circumstances and probably takes place in living matter. Phase conjugate laser beam is a non-biological example in this respect. Memory recall [K70] would involve the change of arrow of geometric time for a subsystem corresponding to the signal propagating to the geometric past and reflecting back.

This vision involves minimal number of assumptions and is the most convincing one found hitherto and the challenge is to invent objections in order to develop it in more detail.

The notions of magnetic body and dark matter hierarchy

The notion of magnetic body is central in TGD. The TGD inspired model trying to explain the findings about microtubules by Indian research group led by Anirban Bandyopadhyay lead to rather interesting speculations about the role of magnetic flux tubes and a more precise speculative view about how living system could act as topological quantum computer [K107] [L37].

Remark: Magnetic body is somewhat misleading term since a simple deformation implies that magnetic flux quanta carry helical magnetic and electric fields along the flux tube axis.

1. Could magnetic body define coordinate grids making possible topological quantum computation?

If the claims of Indian research group led by Anirban Bandyopadhyay are true, one can say that microtubules are macroscopically quantum coherent systems at physiological temperatures. In his Youtube talk Anirban Bandyopadhyay (`https://www.youtube.com/watch?v=VQngptkPYE8`) [J39] discussed an identification of conduction pathways different from that of Penrose and Hameroff. In [J105] Gosh, Sahu, and Bandyopadhyay argue for evidence for massive global synchronization in brain and claim that experimental findings support the Penrose-Hameroff theory. In the article "Atomic water channel controlling remarkable properties of a single brain microtubule: correlating single protein to its supramolecular assembly" [J97] it is reported that ordered water inside microtubule is necessary for the conduction inside microtubule.

According to the same article the tubulins inside microtubule has same energy levels in chemical energy range as isolated tubulins, which suggests that the mechanism binding tubulins to form MT is not chemical. In the article "Multi-level memory-switching properties of a single brain microtubule" [J98] it is reported that the hysteresis curve for current along MT as function of voltage is ideal square curve meaning that there is no dissipation involved with the change of the current direction. This would make MT as an ideal memory device. Whether Penrose/Hameroff have in mind the use of current direction as qubit remains unclear. In video talk Bandyopadhyay refers also to these results.

I have considered the general proposal discussed in video lecture in the article [K107] [L37]. The findings reported in the talk give support for the general TGD inspired view about TQC and allow rather detailed model in the case of microtubules. The idea is that flux tubes form a 2-D coordinate grid consisting of parallel flux tubes in two different directions: the guess that they could consist of helical Fibonacci flux tubes and their mirror images is not however convincing. Crossing points would be associated with tubulins and the conformational state of tubulin could define a bit coding whether the braid strands defining coordinate lines are braided or not (swap or not). In this manner any bit pattern at microtubule defines a particular TQC program. If also conformations are quantum superposed, one has "quantum-quantum computation". It however seems that conformation change is irreversible chemical reaction [J81] so that this option is not feasible.

The TGD inspired modification of the proposal in terms of flux tube coordinate grids making possible TQC architectures with tubulin dimers defining bits defining in turn TQC program looks

more plausible to me. Coordinate grids can be fixed on the basis of the experimental findings and there are 8 of them. The interpretation is in terms of different resolutions. The grids for A and B type lattices are related by 2π twist for the second end of the basic 13-unit for microtubule. An attractive interpretation for the resonance frequencies is in terms of phase transitions between A and B type lattices. If A type lattices can be generated only in phase transitions induced by AC stimulus at resonance frequencies, one could understand their experimental absence, which is strong objection against the Penrose-Hameroff model.

This would fit very nicely with the general vision about frequencies as passwords inducing not only directed attention but activities in target - also TQCs! The increase of Planck constant could be associated with the phase transition to A-phase making possible high T_c dark super-conductivity for which evidence is observed! One can even deduce estimates for $h_{eff}/h = n$ if one requires that AC photons have energy above thermal threshold: $n = h_{e}ff/h = f_{visible}/f_AC$ would be the estimate. For bio-photon energies one would obtain something like $n \simeq 10^8 - 10^9$, which pops up in different contexts in TGD framework.

This picture generalizes in the fractal universe of TGD. One can form layers of 2-D coordinate grids and connect them by vertical flux tubes to obtain 3-D grid defining TQC. The brain is known to have grid-like architecture and neurons could by quantum computation produce bit/qubit defining swap or not/superposition of swap and not-swap for a larger scale TQC. One would have fractal of TQCs.

A further idea is that the TQC based on 1-braids generalizes in a natural manner to 2-braid TQC in TGD framework (for 2-braids in 4-D space-time see [K38]. The knotting occurs for string world sheets defining the orbits of braid strands - say magnetic flux tubes idealized to strings. In the case of microtubules this option suggests itself: the emergence of MTs could have meant emergence of 2-braid TQC and the increase of abstraction level in the information processing.

In the node of 3-D coordinate grid either reconnection of two flux tubes can occur or not: this is coded by one bit. Second bit tells which tube goes over which tube in the plane defined by two tubes. There are three planes of this kind corresponding to xy,xz, and yz planes, and therefore 6 bits altogether. Could genetic codon containing 6 bits of information code for what happens in the node of the grid. Note that 2-braiding is possible only if string worlds sheets "live" in 4-D space-time: for super strings living in higher-D space-time this is not possible.

This kind of 3-D TQC could be responsible for the those aspects which are nearest to computation. One must be however very cautious with the word "computation". Space-like braiding seems to be very natural for storing memories [K23] in braiding patterns ad bit patterns would characterize the 2-braiding associated with the coordinate grid but from this it is long way to computation in the usual sense of the word.

2. Flux tube grids and coding of position information

In metamorphosis and metastasis the basic problem is how the information about position is coded. How cell does know its position in organism? This is necessary for the cell to express its genome in appropriate manner: for instance, gene expression of neuron is quite different from that of muscle cell? According to the article of Levin [I71] organisms seem to have developed kind of coordinate grids to realize this purpose. For instance, simple coordinate transformations seem to related the grids of nearby species to each other. Magnetic flux tubes could be basic building bricks of these grids and at the same time the realization of morphogenetic fields. The coordinate value could be coded by the value of local magnetic field strength varying along the flux tube. By flux conservation this would correspond to the thickness of the flux tube or equivalently to cyclotron frequency. Radiation at cyclotron frequencies would act resonantly only at points at which the resonance condition is satisfied.

Voltages associated with Josephson junctions define Josephson frequencies which could be essential for bio-control and coordination via the resonance mechanism allowing selective activation of biological programs. According to [I71], the values of transmembrane potentials in frog embryo correlate with the formation of the face of Zenopus laevis embryos. The lipid layers of cell membrane are proposed to form Josephson junction (at microscopic leve the ionic channels and pumps associated with them).

Fractality suggests that nearby cell membranes - say those associated with epithelial sheets - could also form Josephson functions as fractal considerations. Gap junctions could provide a microscopic realization of these Josephson junctions. If so, then the large h_{eff} Josephson photons

with frequencies determined by transmembrane potential ($f = ZeV/h_{eff}$) could induce in resonant manner activities in precisely defined positions of the magnetic coordinate grid. The radiation at correct frequency would serve as kind of password allowing to initiate a biological program. For instance, in the case considered above they could initiate the generation of the face. The errors in development could be due to various birth defects could be due to external electric perturbations. Maybe, some day even the correction of these errors might be possible by using properly tuned electric voltages.

3. What happens to the magnetic body of planaria cut into two pieces?

When planaria is cut to two pieces, second pieces regenerates head and second regenerates tail. Also when one takes second cell away from 2-cell embryo, the remaining cell becomes a full organism rather than only half of it. If there is a template for the formation of organism, then also this template must split in two. As a matter of fact, I have proposed that the magnetic body of the cell decomposes to two in cell division and that this splitting actually guides the cell division.

The fractality of TGD Universe suggests similar splitting in all scales. The vertex of Feynman diagram representing the decay of photon to electron-positron pairs provides an ultra-simplified version of the replication. In TGD framework the lines of Feynman diagrams are replaced with 4-D orbits of 3-D surfaces (or by holography 3-D orbits of 2-D partonic surfaces) and this is true in all scales. Therefore the idea that magnetic body replicates would reduce one of the most mysterious processes of living matter to generalization of fundamental physics. Note that string models do not allow analogs for the vertices of Feynman diagrams, they are possible only in TGD framework.

The idea about magnetic body defining a coordinate grid serving as a counterpart of morphogenetic field or as template able to guide the development of the organism becomes central. It seems that even individual cell - perhaps even DNA - should contain microscopic representation of some topological aspects of the adult organism. This conforms with the notion of holography and is consistent with the central role of genes. Magnetic body with large h_{eff} being very multi-sheeted structure analogous to covering space could provide this representation. With inspiration coming from Hox genes and from deep ignorance about genetics I proposed that the magnetic body of DNA and even DNA in some rough sense could be homologous to the biological body [K44].

Can one test this hypothesis? It is also possible to isolate the cells of planaria during the development of new head by closing gap junction connections between them for about 48 hours [I71]. The outcome is planaria with two heads. As if the isolation of two cells which should have belong to the head of planaria had induced splitting of the magnetic body assignable to the head to two so that the outcome was too separate heads. One can however split the two-headed planaria again and the headless part develops now two heads! If the two headed magnetic body replicates, the outcome follows as a prediction.

Is brain really the seat of memories?

Levin and Shomrat tell about experiments demonstrating that brain is not necessarily the seat of memories as usually assumed. Planaria have brains and they are able to learn and remember. When planaria is split, the pieces develop head and tail. In the experiments planaria are taught some skill and after that split into two pieces. According to [I101], there is evidence that the part of planaria with new head remembers the skill. From this one can conclude that brain is not the only possible seat of memories.

Before continuing, it should be emphasized that memories are now defined as learned behaviors - assumed to reduce basically to conditionings of neurons at the motor areas of brain so that they generate certain motor response to sensory input. In TGD framework memories are understood as genuine conscious memories about events of past and involve communication with the geometric past.

One can imagine several explanations for the findings about the memory preservation. The computationalist possibility is that memories are transferred at least temporarily to the body of planaria and then back to the new head. This does not look biologically feasible.

Three TGD inspired explanations - corresponding to the identification of the brain of the geometric past, biological body, or magnetic body as the seat of memories - are considered.

1. Memories - identified as conscious experiences analogous to episodal memories rather than learned skills - could reside in the old brain or biological body or even magnetic body of the

planaria with new head in the geometric past and accessed by negative energy signals which are time reflected from it. This explanation is not natural when memories are identified as learned skills, which in the ideal case are un-conscious behaviors.

2. In TGD Universe entire body and brains could form a hologram like structure [K10] and the information about body is transferred to the new brain. This would be like hologram completion. TGD indeed suggests strongly that entire body is conscious. For instance, the sensory organs carry the primary sensory qualia, one could circumvent the problem caused by the fact that neural circuits seem the same in all sensory areas. Cortex - maybe entire brain - would build standardized cognitive mental images, give them names, and entangle them with sensory qualia at sensory organs.

   Phantom leg is the basic objection against this view but new view about time allows to circumvent it: the seat for the experience about pain in phantom leg is in geometric past when the leg still existed. Note that here memories are not learned skills but memories about genuine events in geometric past.

   Second TGD inspired explanation for phantom leg would be it is that phantom leg corresponds to the magnetic body part: it is however not clear whether the sensation of pain even other bodily sensations can be located at magnetic body.

3. The long term memories of planaria restricted to learned behaviors could be represented also at the magnetic rather than biological body. Quantum computationalist would agree with this idea since learned skills would be very naturally TQC programs realized at the coordinate grid formed by the magnetic flux tubes. If magnetic body is replicated as planaria is cut to two pieces, also the TQC programs are replicated. DNA as TQC proposal [K23] assigns these programs to the braids defined by flux tubes assumed to connect DNA nucleotides or codons with the lipids of the lipid layers of the nuclear or cell membranes.

4. Could the state function reduction sequence implying 4-D self-organization driven by NMP lead to and asymptotic state in which also the skills learned in possession of old brain are possessed. As a matter fact, this aspect is certainly present since the replica of the magnetic body of planaria brain must give rise to original biological brain. TQC programs for the skills would be however present from the beginning.

5. In Zero Energy Ontology the space-time surface connecting 3-surfaces at the opposite light-like boundaries of causal diamond are the basic objects. The maxima of Kähler function correspond to very special pairs of 3-surfaces connected by space-time surfaces. One can say that 4-D dynamical patterns, "behaviors" are fundamental objects. In ordinary ontology they would 3-D patters perhaps interpreted as asymptotic states resulting in self-organization.

The second option looks like the most plausible explanation since allows to understand the replication of not only organism but also the TQC programs defining behavior repertoire.

5.7 Connections to the work of other researchers in the forefront

Many connections with the workers in the field have emerged. In the following I list some articles in chronological order. Some of the people included have not worked with remote mental interactions but in TGD world order their work relates rather closely to this field so that I have included them.

5.7.1 Mae Wan-Ho

Mae Wan-Ho is one of the pioneers of the new biology. She emphasizes the fact that genetic code is not enough to understand inheritance (see article *Mystery of Missing Heritability Solved* [I63]), that genes alone do not determine body patterns (see article it Genes don't Generate Body Patterns [I62]), that there are no genes for intelligence (see article *No Genes for Intelligence in the Human Genome* [I64]). In TGD framework the notion of magnetic body could provide the umbrella

concept suggesting braiding as a universal mechanism to encode interactions with environment to braiding.

Ho realizes the importance of water-protein interaction (see article *Proteins secret water music in nanospace*) [I65]. Ho dares also to speak about homeopathy and water memory (see it Quantum Coherent Water Homeopathy [I65]). The TGD counterpart is the vision about cellular and molecular "seasons". External energy feed melts the "ice" formed by ordered water around globular proteins. This leads to new conformations and protein aggregation. This process also updates topological quantum programs by inducing time-like braiding changing space-like braidings of the perturbed part of the system with its complement.

Ho also emphasizes the importance of liquid crystal phases in biology. Liquid crystals are associated with cell membranes, cytoskeletal and muscle proteins, collagen and other connective tissue macromolecules, and also DNA in chromosomes [**?**] Ho assigns morphogenic fields with them (see *Liquid Crystalline Morphogenetic Field* [I66]). Ho has introduced "Quantum Jazz" as a wonderful metaphor for what Bohm would have called active information and I call negentropic entanglement making possible highly correlated states in which particles are effectively free. Ho has proposed that these liquid crystals act as a holographic medium and based the proposal on the effects of polarized light [**?**] In TGD framework also magnetic flux tubes would be involved. Flux tubes would connect the basic units of liquid crystals to those of other liquid crystals. DNA nucleotides to lipids of nuclear or cell membrane (see chapter it DNA as Topological Quantum Computer of [**?**].

Space-like braiding is modified by liquid chrystal fluid flows defining time-like braidings (dance metaphor). Liquid crystals plus magnetic flux tubes could serve as the holographic medium storing dynamical patterns to spatial patterns and therefore defining also fundamental memory representations. The sensitivity of liquid crystal state and therefore of braiding to various parameters such as em fields, temperature and pressures changes, hydration, pH, concentrations of various ions makes braiding an ideal mechanism for making living matter a hologram substrate.

Also topological quantum computation like processes would become possible. The fractality crucial for holography would correspond to the possibility of having flux tubes within flux tubes within.... In other words, one would have hierarchical braiding. Braids would decompose to braids which are braided in turn. As a matter fact, this braiding is central element of the dynamics of TGD Universe, not only of TGD inspired biology.

I have commented some of the articles of Mae Wan-Ho in the chapter *TGD inspired model for nerve pulse* of [**?**]see article *Can Water Burn?* [D14]).

5.7.2 Peter Gariaev

Peter Gariaev and his group have done a lot of pioneering work in bio-electromagnetism and the notion of wave DNA is due to him. The findings of Gariaev's group include the rotation of polarization plane of laser light by DNA [I50], phantom DNA effect [I51] , the transformation of laser light to radio wave photons having biological effects [I52] , the coding of DNA sequences to the modulated polarization plane of laser light and the ability of this kind of light to induce gene expression in another organisms provided the modulated polarization pattern corresponds to an "address" characterizing the organism [I50] , and the formation of images of what is believed to be DNA sample itself and of the objects of environment by DNA sample in a cell irradiated by ordinary light in UV-IR range [I84] . The chapter Model for the findings about hologram generatg properties of DNA [K1] of book "Genes and Memes" represent an article written in collaboration with Peter Gariaev and published in DNADJ (DNA Decipher Journal) in January 2011. If the interpretation of the experimental data is correspond then dark matter at magnetic flux body assignable to DNA sample has been photographed. What would happen that incoming photons leak to the dark flux tubes in a phase transition changing the value of Planck constant, are reflected from the dark matter and transform back to ordinary photons generating the picture in the film.

Quantum Model for remote replication [K120] is second article written together with Peter Gariaev. There are three experimental guidelines: the phantom DNA [I51] identified as dark nucleon sequences in TGD framework and the evidence for remote activation of DNA transcription [I50] - both discovered by Gariaev's group - are assumed as the first two key elements of the model. The remote replication of DNA suggested by the experimental findings of Montagnier's group serves as a further guideline in the development of the model. Also the results of the latest experiment

of Gariaev's group in many respects similar to that of Montagnier's experiment but differing in certain crucial aspects from it are used as input.

Polymerase chain reaction (PCR) is the technique used in the experiments of Montagnier's group [I14] and later in somewhat modified experiment by Gariaev's group involving irradiation of the second test tube by laser light. DNA polymerase catalyzes the formation of DNA from existing DNA sequences serving as a template. Since the catalytic interaction of DNA polymerase takes place with already existing DNA sequence, the only possibility is that first some conjugate DNA sequences are generated by remote replication after which DNA polymerase uses these sequences as templates to amplify them to original DNA sequences. Whether the product consists of original DNA or its conjugate can be tested.

In TGD inspired quantum biology the representations of genes in terms of temporal patterns of em radiation could be in central role. TGD suggest concrete model for water memory in terms of the magnetic body of biomolecule whose cyclotron frequency pattern codes for the biological effects of the molecule. Water memory would mean that water can build magnetic bodies mimicking those of biomolecules or perhaps steal them in the process of dilution which involves the shaking of the solution. The basic problem of the model is how to the gene coded as a temporal field pattern could activate corresponding gene. It seems that the solution of this problem requires that also linear spatial pattern matters. A possible realization would be as planar sheets of magnetic flux tubes emerging from sender DNA and attaching to the target DNA and carrying the radiation. Remote replication would take place only if resonance condition for the frequencies depending on nucleotides is satisfied for each flux tube. Note that DNA as topological quantum computer relies on similar flux tube structure.

TGD suggest also another representation of the genetic code in terms of dark nucleons [L10] , [L10] , which could be highly relevant for the realization of water memory in terms of a dark portion of water for which there exist empirical evidence [K21]. This dark portion would also explain the numerous anomalies of water. It became as a total surprise that the states of dark nucleons correspond in natural manner to DNA, RNA, tRNA, and amino-acids. DNA would define only one particular representation of the genetic code, which in the primary form would be realized at elementary particle level and that there could exists many representations of DNA. Also the model for DNA as topological quantum computer [K23] proposes a non-standard representation of the code.

The model inspires the proposal that the magnetic body of a polar molecule codes for it using dark nucleon sequences assignable to the hydrogen bonds between the molecule and surrounding ordered water layer. Quantum antenna mechanism would allow the immune system to modify itself by developing ordinary DNA coding for amino-acids attaching to and thus "catching" the polar molecule. The mechanism could be behind water memory and homeopathic healing. Every polar molecule in living matter would have dark nucleon sequence or several of them (as in the case of amino-acids) serving as its name. This would also associate unique dark nucleon sequence also with the magnetic body of DNA so that "DNA-dark DNA" association would be automatic. Same applies to mRNA and tRNA and amino-acids. The general idea is therefore that symbolic dynamics emerges already at the molecular level: the dark DNA sequence serving as a "name" of the molecule to high extent determines the dynamics just as in human society.

The existence of a multitude of representations of the code would not be too surprising when one realizes that the information processing performed by computers involves endless variety of different representations of various codes. The problem is about attitudes: the dogma that biology is nothing but chemistry is what is being challenged and we love dogmas because they liberate us from the burden of using our own brains.

5.7.3   Luc Montagnier

The article "DNA waves and water" by L. Montagnier, J. Aissa, E. Del Giudice, C. Lavallee, A. Tedeschi, and G. Vitiello [I45] has created quite a furor even before its publication. The article was preceded by article [I44] , whose results led to my own proposal about the existence of new kind of representation of DNA in water [L19] and the recent article indeed suggests the existence of a new kind nano-scale represention of DNA besides electromagnetic representation of the code, which was also suggested for years ago by the group of Peter Gariaev [I50] and also in TGD framework [K36]. The article DNA waves and water discussed TGD based explanation of the findings.

The claim of Montagnier's team is that the radiation generated by DNA affects water in such a manner that it behaves as if it contained the actual DNA. A brief summary of experiment of Montagnier and collaborators is in order.

1. Two test tubes containing 100 bases long DNA fragments were studied. Both tubes were subjected to 7 Hz electromagnetic radiation. Earth's magnetic field was eliminated to prevent its possible interference (the cyclotron frequencies of Earth's magnetic field are in EEG range and one of the family secrets of biology and neuroscience since seventies is that cyclotron frequencies in magnetic fields have biological effects on vertebrate brain). The frequencies around 7 Hz correspond to cyclotron frequencies of some biologically important ions in the endogenous magnetic field of .2 Tesla explaining the findings. This field is 2/5 of the nominal value of the Earth's magnetic field.

2. What makes the situation so irritating for skeptics who have been laughing for decades for homeopathy and water memory is that the repeated dilution process used for the homeopathic remedies was applied to DNA in the recent case. The dilution containing no detectable amounts DNA (dilution factor was 10^{-12}) was placed in second test tube whereas the first test tube contained 100 bases long DNA in the original concentration.

3. After 16 to 18 hours both tubes were subjected to polymerase chain reaction (PCR), which builds DNA from its basic building bricks using DNA polymerase enzyme. What is so irritating that DNA was generated also in the test tube containing the highly diluted water. Water seems to be able to cheat the polymerase by mimicking the presence of the actual DNA serving in the usual situation as a template for building copies of DNA. One could also speak about the analog quantum teleportation.

The model explaining remote replication would apply also to the findings of Montagnier. The essential elements would be sheets formed by flux tubes emerging from DNA crucial also in the model of DNA as quantum computer and nucleotide dependent resonance condition satisfied for each flux tube allowing DNA portion to active only similar DNA portion.

5.7.4   Rupert Sheldrake

Rupert Sheldrake is very interesting thinker whose basic idea is that even genetic expression is more like a habit. Even the manner how crystallization takes place could be a habit. In TGD framework the 4-dimensional character of geometric existence and zero energy ontology in which quantum states are pairs of positive energy states assignable to the two light-like boundaries of causal diamonds conforms with Sheldrakes views (See the article Sheldrakes Morphic Fields and TGD View about Quantum Biology).

The basic idea of Sheldrake that Nature would have habits just as we do is probably one of those aspects which generate most irritation in physicalists believing that Nature is governed by deterministic laws with classical determinism replaced with quantum statistical determinism. Sheldrake is one of those very few scientists able to see the reality rather than only the model of reality. Morphic resonance would make possible to establish the habits of Nature and the past would determine to high extent the present but on organic manner and in totally different sense as in the world of physicalist.

5.7.5   Seth Lloyd on quantum life

The notion of quantum biology is becoming accepted notion although Wikipedia contains still nothing about its most important application (photosynthesis). I can be proud that I have been a pioneer of quantum biology for about two decades. TGD remains still one of the very few theories leaving the realm of standard quantum theory and suggesting besides the new view about space-time a generalization of quantum theory involving in an essential manner quantum theory of consciousness based on the identification of quantum jump as moment of consciousness. The new view about quantum theory involves a refined view about quantum measurement based on Negentropy Maximization Principle (NMP) [K49] identified as the basic variational principle and zero energy ontology (ZEO) replacing ordinary standard energy ontology. The new view providing

new vision about the relationship between subjective time and geometric time, about the arrow of time, and about second law.

The hierarchy of Planck constants having as space-time correlate effective (or real -depending on interpretation) n-sheeted coverings of 8-D imbedding space (or space-time) with $h_{eff} = nh$ defining the value of (effective) Planck constant. p-Adic physics as physics of cognition is essential part of theory and together with the hierarchy of Planck constants closely related to the notion of negentropic entanglement characterizing living matter. Negentropic entanglement is maximal involving two-particle case tge entanglement of n states characterized by $n \times n$ unit matrix with n identified in terms of h_{eff}. Also maximal m-particle entanglement with $1 < m \leq n$ is possible and one can write explicit formulas for the entangled states relating closely to the notion of exotic atom introduced earlier. The hierarchy of Planck constants as associated with dark matter so that dark matter is what makes living matter living in TGD Universe.

The concepts of many-sheeted space-time and topological field quantization imply that the concept of field body (magnetic body) becomes a crucial ew element in the understanding of living matter. Non-locality in even astrophysical scales becomes an essential piece of the description of living matter. Remote mental interactions making possible communication between biological and magnetic bodies become standard phenomena in living matter. The reconnection of magnetic flux tubes and phase transitions changing the value of h_{eff} and thus changing the length of magnetic flux tubes become a basic piece of biochemistry. Various macroscopic quantum phases such as dark electronic Cooper pairs and of protons and even ions as well as Bose-Einstein condensate of various dark bosonic objects with large value of h_{eff} are also central. They are associated with magnetic flux bodies (magnetic flux tubes) .

TGD implies a new, still developing, view about metabolism. Magnetic body as a carrier of metabolic energy and negentropic entanglement (see fig. `http://www.tgdtheory.fi/appfigures/cat.jpg` or fig. 21 in the appendix of this book) allows to understand the deeper role of metabolism in a unified manner. The notion of high energy phosphate bond assigned to ATP is one of the poorly understood notions of biochemistry. As a matter fact, all basic biomolecules are carriers of metabolic energy liberated as they are broken down in catabolism. It is usually thought that the covalent bonds containing shared valence electron pair between atoms involved carries this energy and that covalent bond reduces to standard quantum theory. TGD challenges this belief: covalent bond could in TGD framework correspond to magnetic flux tube associated with the bond having considerably larger size than the distance between atoms: similar picture has already earlier emerged in the model of nuclei as strings with colored flux tubes connecting nucleons and having length scale much longer than nuclei [L10]: this model also explains [K50] the puzzling observation that protonic charge radius seems to be somewhat larger than predicted [?].

The metabolic energy quantum would be associated with large h_{eff} valence electron pair being identifiable as cyclotron energy in endogenous magnetic field for which the pioneering experiments of Blackman [J46] suggests value $B_{end} = .2$ Gauss as the first guess.Of course, entire spectrum of values coming as power of two multiples of this field strength can be considered. This would require rather high value of h_{eff}/h of order 10^8. Reconnection of flux tubes would make possible to transfer these electron pairs between molecules: actually a piece of flux tube containing the electron pair would be transferred in the process. This view allows to unify the model of metabolism with the view of DNA-cell membrane system as topological quantum computer with DNA nucleotides and lipids (or molecules assigned with them) by flux tubes.

Seth Lloyd represents three examples about situations in which quantum biology seems to be a "must": photosynthesis, navigation of birds, and odour perception. Photosynthesis represents the strongest and most quantitative support for quantum biology. Navigation and odour perception suggest strongly quantum theory model but leave the details of the model open.

I have applied TGD to numerous situations during years and also discussed simple TGD inspired models for all these three phenomena . The following represents briefly the core of Lloyd's talk and comparison with TGD based views. I do not of course have access to the data basis and can represent only a general vision rather than detailed numerical models. I share Lloyd's belief that quantum models provide the only manner to understand the data although models as such are not final. The authors of course want to publish their work and therefore cannot introduce explicitly notions like high temperature super-conductivity, which I believe are crucial besides purely TGD based concepts. What is however good that the models start from data and just look how to explain the data in quantum approach. Data lead to assumptions, which are not easy to defend

in the framework of standard quantum theory. For instance, the presence of long-lived entangled pairs of electrons and electron and hole with wave functions possessing rather long coherence length and somehow isolated from entanglement destroying interactions with the external world emerge from the data. In TGD large value of h_{eff}/h and associated negentropic entangleement justifies these assumptions.

Photosynthesis

The incredible effectiveness of the first step of the photosynthesis after photon absorption [**?**] is one of the key points of Lloyd in this talk (`http://www.kurzweilai.net/seth-lloyd-on-quantum-life`). The organisms living deep under the surface of ocean are able to gather their metabolic energy using only the visible photons of black body radiation, whose typical photon energy is much lower than that of metabolic energy. In human eyes there is even mechanism preventing the detection of less than five photons at time.

The first step of photosynthesis after the capture of photon by harvesting antenna proteins has been a long standing mystery and here only quantum mechanical approach seems to provide the needed understanding. The light harvesting antenna proteins can be visualized as small disk like objects and are associated with a membrane like structure - so called thylakoid membrane similar to cell membrane. The absorption creates what is known as exciton - electron-hole pair, which is most naturally singlet. Photon has spin so that the exciton must have unit angular momentum. After its creation the electron of the exciton reaches by a random walk like process the reaction centre. From the reaction centre the process continues as a stepwise electron transfer process leading eventually to the chemical storage of the photon energy.

The capture of photon occurs with some probability and also the process continues from reaction centre only with probability of about 5 per cent. The process with which the electrons reaches the reaction centre is however amazingly effective: effectives is above 95 per cent. This is mysterious since fort the classical random walk for exciton between the chromophores the time is proportional to the square root of distance measured as number of neighboring chromophores along the path.

The quantum proposal is that exciton is spin singlet state - this minimizes the interactions with photons - and performs quantum (random) walk to the reaction centre. The model assumes only experimental data as input and all parameters are fixed. Temperature remains the variable parameter. One can consider two extreme situations. At low energy limit the random walks tends to be stuck since external perturbations (mostly thermal photons) inducing the random walk process are not effective enough and quantum walk becomes so slow so that the exciton decays before it reaches the reaction centre. At high energy limit the thermal perturbations destroy quantum coherence and classical random walk results so that the efficiency becomes essentially zero. There is a temperature range where the transfer efficiency is near unity and time for reaching the reaction centre relatively short. This range has as midpoint room temperature.

If I have understood correctly, the model accepts as experimental facts the rather long lifetime of the exciton - few nanoseconds. In quantum-computerish this assumption translates to the statement that exciton belongs to a de-coherence-free subspace so that external perturbations are not able to destroy the exciton too fast. Second assumption is that the exciton is de-localized over a ring ling like structure of size scale of 7 Angstroms (actually there are two rings of this kind, inner and outer and the wave function is assumed to be rotationally symmetric for the inner ring). This de-localization increases the probability of transfer to neighboring chromophore so that it is proportional to the square N^2 of the number N of chromophores rather than N. The technical term expressing this is concatenated quantum code.

Skeptic would probably claim that coherence and stability of coherence are the weak points of the model. In TGD framework the assumption that electron-hole pair is negentropically entangled would guarantee its long life time. The reason is that NMP [K49] favors negentropic entanglement. Negentropic entanglement corresponds to entanglement associated with n-sheeted effective covering of imbedding space and n has interpretation in terms of effective Planck constant $h_{eff} = nh$. The naive guess is that coherence scale for the wave function of exciton scales up by factor n or $\sqrt{n}$. This entanlgement need not have anything to do with spin but could relate to large $\hbar$.

I have earlier considered a slightly different proposal [K40]. Instead of exciton the negentropically entangled system would be Cooper pair of dark electrons. Note that the negentropic entanglement need not relate to the spin but to the n-fold covering although it could be assigned

with spin too in which case the state would be spin singlet. The motivation came from the fact that the transfer of electrons to the reaction centre takes as pairs (http://upload.wikimedia.org/wikipedia/commons/thumb/c/c7/Z-scheme.png/675px-Z-scheme.png). The TGD inspired interpretation of electron pair would be as dark Cooper pair. Two electron pairs would come from the splitting of two water molecules to O_2, 4 protons and two electron pairs, and they would end up to P680 part of photosystem II (680 refers to maximally absorbed wavelength in nanometers) and from here to P680* as two pairs. This mechanism would require that the Cooper pairs absorbs the photon as single particle. In the case of dark Cooper pairs this might be naturally true. If this requires exchange of photon between the members of the pair, the rate for this process is of the order α^2 lower.

Avian navigation

Second topic discussed by Seth Lloyd is avian navigation (http://en.wikipedia.org/wiki/Bird_migration). The challenge is to understand how birds (and also fishes) are able to utilize Earth's magnetic field in order to find their way during migration. In some cases the magnetite in the beak of the bird guides the way along magnetic field lines by inducing magnetic force, and the process can be understood at least partially. Consciousness theorist could of course wonder why these animals find year after year their exact birth place.

Robins however represent an example not so easy to understand. There are three input facts:

1. Robins are able to detect the orientation of B_E but not its direction. They can also detect the angle between orientation and vertical to the Earth's surface and from this to deduce also the direction of B_E.

2. Blue or green light is necessary for the successful detection of the orientation.

3. Oscillating em field with frequency of order MHz makes the robins totally disoriented.

The only model that seems to be able to explain the findings is that long-lived entangled pairs of electrons are created by the photon provided their energy is high enough. For red light the energy is 2 eV and is not yet quite enough. This suggests that the electrons originate from a pair of molecules or atoms of single molecule. It is not known what the molecules in question could be. The electrons of the pair are spinning in the magnetic field and this is suggested to cause the decay of the pair and second member (why not both?) of the pair would contribute to a current giving eventually rise to nerve pulse pattern.

Entangled long-lived electron pair should be created. Long lifetime is the problem. The proposed mechanism brings in mind the TGD based variant for the light harvesting mechanism of photosynthesis. Universality suggests that long lived dark negentropically entangled Cooper pairs are generated in both cases so that light harvesting is in question in both cases. These pairs assignable to membrane structures in both cases in turn would generate a supra current giving eventually rise to a generation of nerve pulses in the case of navigation and to electron transfer process in the case of photosynthesis. If the same mechanism is involved in both cases, the extreme effectiveness of this light harvesting process could make it possible for the birds to navigate even in dark. Electron has cyclotron frequency of about 1.5 MHz in the Earth's magnetic field and this makes easy to understand why oscillation with this frequency (resonance) induces disorientation by forcing the spinning of the dark Cooper pairs.

Why the energy of photon creating the dark electron Cooper pair should correspond to visible light? Cyclotron energy scale for the ordinary value of Planck constant is extremely small and corresponds to frequency in MHz range. For visible photons the frequency by order of magnitude 10^8 higher. Does this correspond to the value of h_{eff}? Similar order of magnitude estimate follows from several premises. If the scaling of h by n corresponds roughly to the scaling of p-adic scale by $\sqrt{n}$, one would have roughly 10^{15}-fold (effective) covering of imbedding space which looks rather science-fictive! For electrons this would imply size of order cell size if dark scale corresponds to the p-adic scale. If the electrons are originally in bound states with binding energy of order eV, the value of h_{eff} could be much lower.

I smell the quantum

Quantum detection of odours was the third topic in Lloyd's talk. For decades it was believed that odor perception is based on lock and key mechanism. Human has 387 odour receptors and this would be the number of smells too. It has however turned out that humans can discriminate between about 10^4 smells and Luca Turin and his wife have written a book giving a catalogue of all these smells. It is clear that lock key mechanism is correct but something else is needed in order to understand the spectrum of odors.

The key observation of Turin is that the smells seems to be not purely chemically determined but is different for molecules consisting of atoms differing only by the weight of nucleus and thus being chemically identical. Therefore the vibrational spectrum of the molecule, which is typically in infrared, seems to be important. The proposal of Turin is that the process of odour perception involves the tunnelling of the vibrating electron from odour molecule. This tunnelling can be assisted by absorption of phonon coming from the receptor with frequency which corresponds to fundamental vibrational frequency or its multiple. The model has been tested in several cases. The latest test described by Lloyd is the one in which hydrogen in some molecule is replaced with deuteron, which is twice as heavy so that the vibrational frequency is reduced by a factor $1/\sqrt{2}$. Fruit flies took the role of odour perceivers and it turned out that they easily discriminate between the molecules.

I have considered earlier a somewhat different quantum model for odour perception by starting from the pioneering experimental work of Callahan [I32], which led him to conclude that in the case of insects odour perception is "seeing" at infrared wavelengths. Infrared wavelengths correspond to vibrational energies for molecules so that this brings in the dependence on the square root of the inverse of the mass of the odorant and predicts that chemically identical molecules containing only different isotopes of atoms smell differently.Frequencies are same as in the model of Turin. Instead of phonons IR photons would play the key role serving as passwords exciting particular cyclotron state at particular magnetic tube. Similar mechanism could be at work in the case of ordinary vision.

5.7.6 Orch-OR theory of Penrose and Hameroff and new experimental findings about microtubules

The latest news in quantum biology is the claim about corroboration of the the Orch OR theory of Penrose Hameroff (`http://www.kurzweilai.net/discovery-of-quantum-vibrations-in-microtubules-insi`) [J6]. To my humble opinion the news suffer from rather heavy hyping. If the observation of the group lead by Anirban Bandyopadhyay about detection of quantum vibration in microtubule scale (their lengths vary up to 50 μm) can be replicated, one can speak about breakthrough in quantum consciousness. The results do not however prove Orch OR, which involves poorly defined vision about quantum gravitational description of state function reduction so that most predictions are just order of magnitude estimates relying on Uncertainty Principle.

The biological half of the theory relies on microtubules and for this side of the theory the claimed finding would of course be a victory. Indeed, there is a meeting in Amsterdam devoted to Orch OR theory of consciousness motivated by this finding (`http://www.brakkegrond.nl/programma/ 1253/Penrose_Bandyopadhyay_Hameroff/Lezing_Microtubuli_het_grote_debat_over_het_bewustzijn/ #eng`). Unfortunately, I could not find any article about the findings of Bandyopadhyay in web. I managed however to find two years old Youtube talk of Bandyopahdyay summarizing earlier experimental results supporting the vision about microtubules as macroscopic quantum systems (`https://www.youtube.com/watch?v=VQngptkPYE8`) [J39] to be discussed below.

The findings reported in the talk give support for the general TGD inspired view about TQC and allow rather detailed model in the case of microtubules. The idea is that flux tubes form a 2-D coordinate grid consisting of parallel flux tubes in two different directions: the guess that they could consist of helical Fibonacci flux tubes and their mirror images is not however convincing. Crossing points would be associated with tubulins and the conformational state of tubulin could define a bit coding whether the braid strands defining coordinate lines are braided or not (swap or not). In this manner any bit pattern at microtubule defines a particular TQC program. If also conformations are quantum superposed, one has "quantum-quantum computation". It however seems that conformation change is irreversible chemical reaction [J81] so that this option is not

feasible.

The TGD inspired modification of the proposal in terms of flux tube coordinate grids making possible TQC architectures with tubulin dimers defining bits defining in turn TQC program looks more plausible to me. Coordinate grids can be fixed on the basis of the experimental findings and there are 8 of them. The interpretation is in terms of different resolutions. The grids for A and B type lattices are related by 2π twist for the second end of the basic 13-unit for microtubule. An attractive interpretation for the resonance frequencies is in terms of phase transitions between A and B type lattices. If A type lattices can be generated only in phase transitions induced by AC stimulus at resonance frequencies, one could understand their experimental absence, which is strong objection against the Penrose-Hameroff model.

This would fit very nicely with the general vision about frequencies as passwords inducing not only directed attention but activities in target - also TQCs! The increase of Planck constant could be associated with the phase transition to A-phase making possible high T_c dark super-conductivity for which evidence is observed! One can even deduce estimates for $h_{eff}/h = n$ if one requires that AC photons have energy above thermal threshold: $n = h_{eff}f/h = f_{visible}/f_AC$ would be the estimate. For bio-photon energies one would obtain something like $n \simeq 10^8 - 10^9$, which pops up in different contexts in TGD framework.

This picture generalizes in the fractal universe of TGD. One can form layers of 2-D coordinate grids and connect them by vertical flux tubes to obtain 3-D grid defining TQC. The brain is known to have grid-like architecture and neurons could by quantum computation produce bit/qubit defining swap or not/superposition of swap and not-swap for a larger scale TQC. One would have fractal of TQCs. One can even think 4-D grids in Euclidian space-time regions with 6 bits defining the swaps at each crossing point: could this have something to do with the genetic code?

A further idea is that 1-braid TQC generalize in a natural manner to 2-braid TQC in TGD framework (for 2-braids see [K38]. The knotting occurs for string world sheets defining the orbits of braid strands - say magnetic flux tubes idealized to strings. In the case of microtubules this option suggests itself: the emergence of MTs could have meant emergence of 2-braid TQC and the increase of abstraction level in the information processing. Note that 2-braiding is possible only if string worlds sheets "live" in 4-D space-time: for super strings living in higher-D space-time this is not possible.

Penrose-Hameroff theory

Approximately two decades ago Penrose and Hameroff proposed a model that they called Orchestrated Objective Reduction (Orch OR) [J114]. Besides the highly speculative quantum gravity related ideas, the model assumes that microtubules are quantum coherent systems essential for consciousness. For the importance of microtubules one can find a lot of qualitative support. A I believe that microtubules are important for consciousness and I have developed ideas about the role of microtubules [K56]. Personally, however, I find it difficult to believe in the reduction of consciousness to microtubular level, but see microtubules as one particular layer in the hierarchy of conscious entities. Personally, I would prefer fractality over the naive length scale reductionism.

Many objections [J81] against the biological feasibility of Orch OR (`http://en.wikipedia.org/wiki/Orchestrated_objective_reduction`) [J114] have been raised. For the latest response of the authors to the criticism see [J112]. There are two basic challenges: one should formulate precisely what Orch OR really means and be able to identify the qubit.

1. The basic vision about quantum superposition of space-time geometries gives rise to consciousness as something analogous to quantum computation. State function reduction would thus reduce to a mechanism rather than being something irreducible. Most quantum physicists would disagree about this. The quantum superposed geometries would be protein conformations. Since there is no theory of quantum gravity, the proposal boils down to the ad hoc estimate for the time τ for Orch OR to take place claimed to be $\tau = \hbar/E_G$, where E_G is the difference of gravitational energies for the superposed geometries. The estimates favor nuclear scale 5 fm and one needs a coupling between nano-scale physics of electrons and physics nuclei and London forces are suggested to be responsible for this coupling. It deserved to be mentioned that the gravitational energy for a blog of water with radius around 10^{-4} meters - the size scale of large neuron - is about Planck mass so that gravitation and

biology might relate. In my own proposal involving large gravitational Planck constant assigned to space-time sheets mediating gravitational interaction, Planck mass might serve as a threshold above which large values of Planck constant would emerge [K79, K57].

2. Concerning the identification of qubit there is a long list of suggestions. The superposition of tubulin conformations was one of the first proposals. Reimers [J81], who has criticized heavily Orch-OR proposal, reports that irreversible chemical reaction is responsible for selecting conformation so that quantum superpositions would not make sense. Conformational switching could however be involved with classical computational aspects of biological information processing and Hameroff has proposed before Orch OR that microtubules could act as classical cellular automatons.

   Also other proposals for qubit have been made. Quantum fluctuations generating London force between electric dipoles could somehow give rise to qubits. Also magnetic dipoles, nuclear spin, AC current flow, and synergistic modes have been mentioned. Also the identification of qubit as a helical conduction pathway has been proposed ("Oscillating London force dipoles in resonance rings in helical pathways through microtubule lattices"). It is difficult to imagine what the two superposed states defining qubit would be. For instance, could qubit correspond to electron current running in two different directions and is quantum superposition possible at criticality for a phase transition inducing the change of the current direction? For this option the information storage capacity of microtubule would be rather modest. In also difficult to see the claimed connection with topological quantum computation since braiding gives rise to entanglement between states at the ends of the braids.

 Orch OR proposal involves several interesting ideas probably relevant for quantum consciousness.

1. Aromatic rings have probably some deep role in quantum consciousness. For instance, most psychoactive biomolecules and also DNA and three amino-acids contain them. Hameroff and Penrose trace this role to London force between aromatic rings and quantum fluctuations making them qubits. I am unable to imagine what the exact proposal is. In any case, what is known is that electrons at aromatic rings are de-localized.

   Comment: My own humble proposal is that electrons could be further de-localised at magnetic flux tubes in longer scales and make cyclotron BE condensates of dark electrons or their Cooper pairs possible. They would make possible the coupling between receptor-information molecule complex and magnetic bodies at various levels of hierarchy. Hierarchy of Planck constants and negentropic entanglement suggests the existence of a new kind of state consisting of electrons (that is fermions) but analogous to Bose-Einstein condensate.

2. The idea about insulation provided by hydrophobic pockets of proteins against fluctuations destroying quantum coherence is nice and it would be natural to put aromatic rings into these pockets.

3. The needed long value of Orch OR de-coherence time τ (originally assumed to correspond to 40 Hz thalamocortical resonance frequency) is one of the problems of Orc OR and the recent discovery of EEG like oscillations in kHz range [J90] is claimed to make the situation more tolerable.

   Comment: Fractal hierarchy of EEGs mediating communications between parts of biological body and corresponding magnetic body is basic prediction of TGD and the observation seems to provide evidence for this prediction.

4. Reimers et al challenges [J82] also Fröhlic Bose-Einstein condensation [J104] and claims that according to his own simulations the resulting state is extremely incoherent [J82]. There are however models which give Bose-Einstein condensation [J28] and the in [J39] the experimental findings about assembly of microtubules are interpreted as Fröhlic condensation. The frequency inducing the condensation would be however 3 orders of magnitude lower than predicted by Fröhlich.

There is a further puzzling result (`http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2114131/pdf/jc10231067.pdf`) [J74] in conflict with the assumption of Orch OR that brain microtubules are dominantly so-called A-type tubules. Brain microtubules re-assembled in vitro form lattices of type B and for them the lattice must have surface discontinuities. This makes sense for microtubules which are partially fused together as in the structures consisting of cylinder whose surface is formed by 9 units consisting of 3 microtubules glued together along their sides. This would not allow Fibonacci helices proposed by Penrose and Hameroff to serve as conducting pathways defining the analogs of braid strands in their model for microtubule as topological quantum computer (TQC) unless one is ready to give up helical symmetry. One way out of the difficulty would be that vitro results do not hold in vivo but Kikkawa et al has shown that all in vivo microtubules have lattice of type B (`http://jcb.rupress.org/content/127/6/1965.abstract`) [J83].

The above mentioned article concludes that only the lattice B is realized in nature. This lattice does not possess helical symmetry. After each full turn along sequence α or β tubulin sequence there is a shift as the figure 2 of the article demonstrates: this discontinuity is called seam in the article. Furthermore, these helices can be said to have periodicity 5. The helix-like curve satisfies the condition $z = 4a\phi/2\pi$ and the nth tubulins along vertical is located at $z(n) = na$, a the size of the tubulin. For $\phi = 2\pi$ one has $\Delta z = a$ rather $\Delta z = 0$ as figure 2 of the article shows. This discontinuity could have some important biological meaning.

Hameroff, Nip, Porter, and Tuszynski have an article about microtubules as topological quantum computation written in 2002 [J94]. They do not give any justification for why the conduction pathways should correspond to Fibonacci numbers but the article by Hameroff represents evidence that the important certain amino-acids crucial for consciousness inside tubulin molecules are located along the Fibonacci conduction pathways (`http://www.quantumconsciousness.org/biosystemselsevier.htm`) [J94].

2011 Hameroff and Penrose considered the possibility that microtubules could perform topological quantum computation. The proposal of Penrose and Hameroff (`http://www.quantumconsciousness.org/biosystemselsevier.htm`) [J94] assumes realization of braiding in terms of helical braids strands assignable to A-type microtubules (which according to experimenters do not exist in brain and - as it seems - in living matter in general). In the simplest realization the strands are parallel to each other and have horizontal periodicity characterized by 13 tubules. Also Fibonacci pathways with horizontal periodicity of 3, 5, and 8 are Fibonacci pathways. The strands with different periodicities can intersect and can therefore be braided. One can also construct left- and right handed variants of the strands and left- and right-handed strands intersect periodically with a period of 13. The experiments discussed in [?] however suggest a different kind of braidings.

In the intersection points braiding (swap) operation could be realized meaning that first strand goes either over or below the second one. Gupta and Hameroff suggests that MAPs are responsible for this kind of swap and thus define the fundamental quantum gates for TQC (`https://sbs.arizona.edu/project/consciousness/report_poster_detail.php?abs=1435`) [J111]. Of course, also more complex gates can be imagined but swap is enough to build universal TQC. Official biology assigns to MAP many other functions associated with MAPs but also this function can be imagined. Penrose and Hameroff have also consider the possibility that topological qubits are represented in terms of quantum superpositions of helical pathways with 13-periodicity characterized by the gap between neighboring pathways.

The identification of Bandyopadhyay for conduction pathways

In his Youtube talk Anirban Bandyopadhyay (`https://www.youtube.com/watch?v=VQngptkPYE8`) [J39] discussed an identification of conduction pathways different from that of Penrose and Hameroff. In [J105] Gosh, Sahu, and Bandyopadhyay argue for evidence for massive global synchronization in brain and claim that experimental findings support the Penrose-Hameroff theory. In the article "Atomic water channel controlling remarkable properties of a single brain microtubule: correlating single protein to its supramolecular assembly" [J97] it is reported that ordered water inside microtubule is necessary for the conduction inside microtubule. According to the same article the tubulins inside microtubule has same energy levels in chemical energy range as isolated tubulins which suggests that the mechanism binding tubulins to form MT is not chemical. In the article "Multi-level memory-switching properties of a single brain microtubule" [J98] it is reported that the hysteresis curve for current along MT as function of voltage is ideal square curve meaning that

there is no dissipation involved with the change of the current direction. This would make MT as an ideal memory device. Whether Penrose/Hameroff have in mind the use of current direction as qubit remains unclear. In video talk Bandyopadhyay refers also to these results.

I consider only the general proposal discussed in video lecture here: the Youtube representation gives concrete illustrations of conduction pathways.

1. It is assumed that there are two kinds of hexagonal tubulin lattices labelled as A and B. As found there is strong evidence that A-type tubules do not exist stably. For both types the tubulin dimers defining dipoles are nearly axial and define candidates for conduction paths with winding periodicity of 13 tubulin dimers. For B type one has rows made of α or β type tubulins along with α and β have effective periodicity of five if one accepts discontinuity at after 2π rotation. One might think that this dictates the choice of the candidates for the conduction paths to consist of sequences of $\alpha-\beta$ dimers: for these sequences are along the microtubule. If hops occur between α and β this assumption is natural. The proposed pathways are however more general and - as it seems to me - based on rather ad hoc mathematical rule.

2. The notion of helical conduction pathway is the starting point. For B-type tubules this notion must be modified. Presumably the criterion for what it is to be a helical pathway is that they are straight-lines connecting nearest neighbors to each other- this is natural if conduction is identified as hopping between neighboring tubulin molecules. The position of each pathway represented by a value of discrete dynamical variable replacing spin as representation of qubit -essentially the angle $\phi = n \times 2\pi/13$ is in question. There are 13 different values for ϕ. For A-type conducting pathways the condition that one has $\alpha - \beta$ sequence very probably gives the the claimed pathways with periodicity 13. One can ask whether the pathways of type A are obtained by twisting the pathways of type B at the second end by 2π and whether living systems could be able to perform this twist to achieve phase transition between two states of the microtubule.

3. Instead of single pathway one considers groups of parallel pathways consisting of translates of a fixed pathway with a fixed gap $\Delta\Phi_{gap} = n_{gap}2\pi/13$ along the circumference of microtubule. I failed to understand the motivation for this: maybe the idea is that the additional degree of freedom makes possible the analog of spin degree of freedom as angular position of the pathway. One could also consider the possibility that the translates of a pathway define a braid: this braid would be however trivial since the pathways are parallel. If I have understood correctly, topological qubits would be represented as quantum superpositions of helical conduction pathways with same gap $\Delta\phi = n_{gap} \times 2\pi/13$ between neighboring pathways. This is not what TGD suggests.

4. By $n = 13$ modulo arithmetics it can that the series of pathways with $n = kn_{gap}\ mod\ 13$, $k = 1, 2, ...$ generates additional gaps. One says that the decomposition occurs. The addition of translated parallel pathways can also lead to a pair of pathways with $n_{gap} = 0$ or $n_{gap} = 1$ in which case pathways overlap or touch. This is not allowed. What this means physically is unclear to me. One could also avoid touching simply by allowing only the translates to be such that $kn_{gap} \leq 13$ holds true: even weaker condition can guarantee this.

Consider first what one obtains for A-type microtubules.

1. The construction rule gives for $n_{gap} \in 1, 2, 3, 4, 6, 12$ many secondary gaps, in particular $n_{gap,new} = 1$ so that "don't touch" rule is violated. For $n_{gap}in\{5, 7, 8, 9, 10, 11, 13\}$ only 1 or one secondary gap or no secondary gap is obtained. The decompositions of primary gaps are

$$5 \to (5, 3)\ ,\quad 7 \to (7, 6)\ ,\quad 8 \to (8, 5)\ ,\quad 9 \to (9, 4)\ ,\quad 10 \to (10, 3)\ ,\quad 11 \to (11, 2)\ ,\quad 13 \to 13\ .$$

2. One can form from these collections of parallel pathways more complex collections as unions. Only unions for which "don't touch" rule is satisfied. This leaves for A-type microtubules 4 groups of pathways characterized by four values of n_{gap} each. The 4 groups of 4 of n_{gap} values which can co-exist without breaking teh basic rule are

$$
\begin{array}{cccc}
(8, & 5, & 10, & 13) \\
(7, & 9, & 11, & 13) \\
(5, & 7, & 10, & 13) \\
(5, & 7, & 9, & 13)
\end{array}
\qquad\qquad (5.7.1)
$$

Here only the generating gaps are listed. For instance, the $(8, 5, 10, 13)$ decomposes to $(8, 5, 3, 10, 13)$.

3. There is a problem: these parallel pathways do not have intersections and therefore cannot form braids unless also their mirror images are allowed or one introduces additional group of pathways, which could be called transversal.

4. One does not obtain Fibonacci conduction pathways with periodicities 3, 5, 8 for A-types microtubules suggested by Penrose and Hameroff. One could argue that since the periodicity as winding number is a topological characteristics, the correct identification should give all winding numbers or at least those which are Fibonacci numbers in case A-type microtubules.

What about B-type microtubules?

1. For B-type microtubules one obtains 4 pathways, one of them parallel to the microtubule and the remaining three with periodicity 7. Only the gaps 2,3,4 are allowed by the "don't touch" rule. 2 and 3 do not decompose and 4 decomposes to (4,2) so that 2 and 4 can co-exist.

2. For the axial pathway X there is no restriction to the values of n_{gap} unless one just assumes $n_{gap} = 2$ as in the illustration of slides. It is argued that together A and B-type pathways cover the entire series. I failed to understand what this means: in any case, the primary gap number $n_{gap} = 12$ is missing and I find difficult to understand what complementarity could mean.

3. The 3 pathways 2,3,4 are parallel and cannot intersect each other but they can intersect the axial pathways called X so that braiding is possible. For X type pathways conduction would take place along sequence of $\alpha - \beta$ pairs.

4. For A-option one obtains only periodicity 13 and for B option periodicity 7 for primary gaps 2,3,4 and periodicity 1 for the line parallel to microtubule with periodicity 1.

Bandyopahyay emphasizes that A-type pathways are ideal for TQC whereas B-type pathways are ideal for communications. I did not understand the argument. Certainly this requires that a phase transition from B to A can take place.

The transitions reported to occur as the microtubule is excited at certain resonance frequencies, would in this picture correspond to transitions between different groups rather than excitation of single pathway. The number of resonance frequencies is reported to be 8. If there are n pathways all possible transitions would give $n(n+1)/2$ resonance frequencies: this number cannot be equal to 8 unless some frequencies are degenerate. It would seem that more plausible interpretation is in terms of excitation of a physical state assignable to given pathway or group of its parallel translates rather than between groups of them.

Microtubules from TGD point of view

In TGD framework microtubules are especially interesting from the point of view of TQC - both for 1- and 2-braids and MTs might represent an evolutionary step in which 1-braid TQCs were extended to 2-braid TQCs.

1. What does one mean with TQC?

I ended up with my own proposal about TGD Universe as topological quantum computer (TQC) around 2002 [**?**] with inspiration coming from New Scientist article [C3] - at the same time Hameroff has proposed the idea about conducting pathways as braids. By looking at old blog articles I learned that I have developed the vision about DNA as TQC during 2007 [K23, K93].

The proposal is that the braiding of magnetic flux tubes associated with the magnetic bodies of biomolecules - and probably also much larger structures - makes possible TQC like activities basic aspect of living systems. For instance, braids connecting DNA and nuclear and cellular membranes could make possible automatic construction of memories as space-like braidings of magnetic flux tubes induced by time like braiding generated by the liquid flow around cell and nuclear membrane [K23]. Also microtubules could be connected to axons by flux tubes and similar mechanism could be at work. A universal representation of memories could be in question and couple microtubules directly to the neural activities.

It is essential that the second of each braid is free to move so that temporal braiding patterns are generated and induce spatial braiding patterns (dance metaphor helps to visualize this [K23]). Second essential point is that the qubits reside at the ends of braid strands. This is why the statement of Penrose and Hameroff that conduction pathway defines a qubit in some manner - say in terms of current direction - does not make sense in standard TQC paradigm. In the following I shall propose that the statement can be made to make sense if one considers generalization of TQC involving 2-braids instead of 1-braids so that 2-D objects get "knotted" instead of 1-D objects [K38].

The braiding induced by say 2-D flow of lipids would still be passive generation of memories but one could consider also genuine quantum computation like activities in which the braiding defining the TQC program is constructed in a controlled manner. For instance, one could associate to microtubular surface highly regular "pre-braidings" involving crossings of magnetic flux tubes for which basic braiding operation (swap) between neighboring braid strands could be controlled by the tubulin molecule associated with the crossing. Swap could be determined by the tubulin conformation in the crossing defining a classical bit so that classical computer program expressible as cylindrical surface decorated with bits would code TQC program. In this manner coupling of the events at cell membrane to microtubular quantum cognition would be achieved.

What one exactly means with topological quantum computation (TQC) is not at all obvious and one can consider several variants of it in TGD framework.

1. Zero energy ontology (ZEO) leads to the notion of unitary U-matrix having as its rows M-matrices which are "square roots" of density matrices which are products of hermitian matrix and unitary S-matrix. These matrices define time-like entanglement coefficients between the positive and negative energy states at the opposite boundaries of causal diamond (CD). For braid strands along light-like 3-surfaces defining string ends one obtains entanglement between fermions at the ends of strands. Since the entanglement matrix is unitary it defines density matrix which is sum over projection operator acting as identity matrices and state function reduction yields a negentropically entangled state carrying information. One can pose additional conditions on space-time like negentropic entanglement (see fig. `http://www.tgdtheory.fi/appfigures/cat.jpg` or fig. 21 in the appendix of this book) and ends up with a highly unique form of entanglement coefficients from the condition that any splitting of the system to two parts defines negentropic entanglement [K49].

2. In absence of degeneracy giving rise to negentropic entanglement one would have ordinary entanglement and ordinary quantum measurement theory applies. The outcome of TQC would be statistically determined from state function reductions for large enough number of sub-CDs of given CD. It would be coded by quantum classical correspondence (QCC) to the parameters characterizing classical fields inside CD (frequencies, wave numbers,...). EEG patterns would be one particular representation of this kind.

3. Interaction free quantum measurement in principle allows to measure the quantum state without changing it (in the ideal situation, see Elitzur-Weizman bomb testing proposal [B2]). One could therefore imagine a non-halting TQC and extraction of the information without halting it at all. Negentropic entanglement is stable under state function reduction by NMP [K49]: it can increase or it can be transferred but it cannot be reduced. Interaction free quantum measurement could make possible the reading the outcome of TQC without halting TQC. TQC would represent "Akashic records" and by NMP Universe would be building increasing library of Akashic records. This might provide a general mechanism of term memory.

4. Also a generalization of ordinary 1-braid TQC to 2-braid TQC is suggestive. 1-D braid strands define braiding of orbits of point like particles in 3-D space space-time - say light-like 3-surface. In TGD framework the 1-D braid strands correspond to the boundaries of 2-D string world sheets and the evolution of string world sheets corresponds to 2-braid in space-time. One obtains a generalization of 1-braid TQC to 2-braid TQC in which knotting occurs for 2-D string world sheets of 4-D space-time rather than 1-D strings of 3-D space.

Qubits at the ends of time-like braid strand are replaced with quantum states at space-like braid strands defining ends of string world sheet and TQC corresponds to a time evolution in which the 2-knotting of braid strands changes. The first basic operation is what Alexander the Great did for the knot - the breaking of 1-knot temporarily. What happens is following: if braid strand A goes over B before the moment of breaking, it goes below B after it. This is however not the only possible operation: also reconnection - basic operation for magnetic flux tubes - can take place: the braids strands AB and CD are replaced with AD and CB. These operations define standard vertices in closed string model. The sequence of these operations defines 2-braiding and one can assign to it a generalization of 1-braid TQC to 2-braid TQC. 2-braid TQC is not possible in super string models since strings are imbedding in space-time having dimension higher than $D = 4$.

The quantum states of braids strand would define qudits. In TGD qupits representable as superposition of p^N states, p prime, are of special interest in TGD framework.

2. Could MTs lead from 1-braid TQCs to 2-braid TQCs?

What can one say about the situation concerning microtubules in TGD framework? Since I am not a professional biologist, I can imagine rather freely.

Consider first TQC in the standard sense, that is for 1-braids.

1. The obvious question concerns the nature of the braid strands (conduction pathways in the terminology of Penrose and Hameroff) and here standard physics cannot provide much insight. A natural TGD based identification would be in terms of magnetic flux tubes carrying dark electrons or even better, their Cooper pairs forming currents running along the microtubule. This would predict that microtubules act as super-conductor like systems. The basic aspect of this kind of system is resistance which does not depend on the length of the wire since the resistance is determined by what happens at the ends of the wire where electron current enters or leaves the wire - now flux tube. For ordinary superconductors the resistance involves term which does not depend on temperature. Also now one might expect that the resistance has similar behavior.

The states of Bose-Einstein condensate at the braid strand cannot defined the qubits in ordinary 1-braid TQC for which the states reside at the ends of braid matter. The flux tubes should have ends - at least effectively. The ends should carry quantum numbers defining the qubits. The effective end would correspond to wormhole throat of a wormhole contact at which the magnetic flux flows to another space-time sheet. Quite generally, the flux tubes would be closed structures: for instance, elementary particles correspond to two-sheeted flux tubes having two wormhole contacts as "ends".

2. Maybe the tubulin at the crossing point could induce swap or not depending on its state. Tubulin dimers possess two different configurations and the original proposal of Hameroff was that these configurations correspond to two values of bit. The bit represented as a tubulin conformation would tell whether the left-handed strand runs above or below the right-handed strand at the crossing. The braiding would have representation as a 2-dimensional cylinder with points representing classical bits determining the TQC program. Classical computing and quantum computing would couple together. If tubulin conformations could form quantum superpositions, one would have "quantum-quantum-computation". According to [J81], the process inducing the change of tubulin conformation is chemical irreversible process so that this option does not seem to be possible.

3. The swap at the crossing point for certain value of time would be determined by the state of the tubulin at the crossing at particular moment. At each moment the braiding pattern for

braids connecting microtubule ends would determine the TQC program in terms of unitary entanglement matrices. What is important is that unitary matrix between the states at the ends of braid gives rise to negentropic entanglement with entanglement probabilities forming a matrix proportional to unit matrix. The negentropic entanglement alone could be in principle source of conscious information obtained by interaction free quantum measurement. These states would define what I have called "Akashic records" responsible for memory storage as quantum invariants.

What is new that a generalization of TQC based on 2-braids defined by string world sheets can be imagined. The idealization of time evolutions of magnetic flux tubes can be idealized as string world sheets so that magnetic flux tubes would become key players also in 2-braid TQC. The transition from DNA as TQC to MT as TQC could correspond to the replacement of 1-braids with 2-braids. The quantum states of 2-braid TQC would corresponding unhalting 1-braid TQCs. This would represent a step leading to a higher abstraction level and could play a fundamental role in evolution in accordance with the role of emergence of microtubules in ontogeny.

1. The states of braid strands could define qubits for TQC based on 2-braids defined by string world sheets assignable to time evolutions of flux tubes idealized as strings.

   The spin direction of cyclotron Bose-Einstein condensate defines one candidate for qubit. The direction of DC current along braid strand could also define qubit. If the system is ideal Josephson junction then a constant voltage should however gives rise to an oscillating current. The presence of resistances at the ends of the flux tubes is expected to give rise to the standard form of Ohm's law in average sense.

2. The hysteresis curve for the micro tubular current I as function of voltage V between the ends of microtubule is reported to be square [J98] so that the phase transition changing the current direction could be quantum phase transition at criticality and make possible qubits as superpositions of both current directions near criticality for the current flip. TQC would halt when the voltage is changed so that it is not in the critical region anymore.

3. For magnetic flux tubes the vertex changing swap for 1-braid corresponds to reconnection, which would therefore find a new application in TGD inspired biology. I have earlier proposed that the ATP-ADP transformation generates reconnection but failed to realize that the interpretation could be in terms of 2-braid TQC. Energy metabolism as a continual occurrence ADP→ATP and its reversal could be also a direct signature of 2-braid TQC. The spatio-temporal pattern of ADP↔ ATP transformations would reveal the TQC program code.

4. The change of the conformation of tubulin molecule would induce a swap. The reconnection of flux tubes -perhaps also induced by a change in the conformation of tubulin molecule - is also possible. The TQC program for 2-braids would be coded by the temporal history of changes of tubulin conformations represented in terms of bits. Chemistry would be used to write TQC programs. 2-braid TQC could be seen as sequence of 1-braid TQCs, which need not halt.

Admittedly, the model involves several new physics elements, which skeptic with Occam's razor could use to debunk the approach: dark matter hierarchy represented as hierarchy of effective Planck constants, the motion of magnetic body implied by the TGD based geometrization of classical fields and new view about space-time, and the notion of negentropic entanglement and Negentropy Maximization Principle [K49] defining the variational principle of TGD inspired theory of consciousness. These new elements are not however ad hoc assumptions but basic pillars of quantum TGD.

3. Identification of conduction pathways

Consider next the detailed identification of the conduction pathways assumed to correspond to a grid formed by flux tubes.

The interpretation of Bandyopadhyay has some problematic aspects. The proposed parallel strands do not intersect and cannot therefore define braid. The transitions to which the resonance

frequencies are assigned, are not identified. No comment is represented concerning the problem that A-type microtubules have not been observed experimentally. From these problematic aspects it takes some time to end up with TGD based vision about the situation.

1. In TGD framework it is natural to regard the pathways of A-type microtubules as obtained by 2π twist for the "upper" end of B-type pathways which are of type X and possess the primary gap numbers allowed for A-type groups: recall that this gives 4 groups of four primary gaps. The pathways obtained from the transversal pathways of B-type microtubules by 2π twist define an excellent candidate for the complementary pathways needed to obtain crossings and braiding.

   What looks like a problem is that the twist for the 3 groups of 7-periodic pathways would produce two 7-periodic pathways per 13-unit, which corresponds to 14 rather than 13 tubulins rather per basic unit. The only explanation is that the discontinuity disappears and implies that there one has 13 tubulins per single structural unit of Q-type tubule.

2. If one excludes the decomposable pathways with $n_{gap} = 4$, the twists of 2 and 3 groups would define transverse pathways for A-type microtubules. Altogether 8 different coordinate grids formed by the pathways - now magnetic flux tubes - would be obtained. The 8 resonance frequencies would correspond to the phase transitions $A \leftrightarrow B$ induced by $\pm 2\pi$ twist for the "upper" end of the basic unit.

3. In TGD framework the most natural explanation for why A type tubules are ideal for TQC is that they correspond to a large value of h_{eff}, and the phase transition increases the value of h_{eff} and makes superconductivity and TQC possible for A type tubules. Unitary S-matrix characterizing TQC defines entanglement probabilities which are identical so that negentropic entanglement is in question. Negentropic entanglement is very closely related to large value of $h_{eff}/b = n$: n corresponds to the number of entangled states in the simplest situation.

4. One can estimate the value of h_{eff} if the AC radiation inducing the phase transition corresponds to dark photons with energy which is above thermal energy. For the energy $E \simeq 2$ eV of visible photons this would give for 8 MHz frequency $n = h_{eff}/h \simeq 6 \times 10^7$. For IR frequencies above thermal threshold which corresponds to the energy $E \simeq .05eV$ assignable to resting potential, one would have $n = h_{eff}/h = 10^5 - 10^6$.

   Corresponding p-adic length scales giving estimates for the length scales of flux tubes would scale like $n^{1/2}$. For B-type microtubules the p-adic length scale would be naturally 5×4 nm corresponding to 5-periodicity and 4 nm length diameter for single tubulin. For A-type microtubules corresponding scale would be by factor 10^3 longer for IR frequencies: upper bound would give 20 μm. The length of microtubules obtained in experiments ranges from 2μ to 25 μm so that the estimate seems to make sense.

4. Could frequency hierarchy correspond to a p-adic hierarchy of magnetic flux tubes?

The hierarchy of frequency scales kHz, MHz, and GHz could correspond to cyclotron frequencies for electron and perhaps also proton. In particular, the crucial role of water in making conductivity possible suggests that protonic cyclotron B-E condensate is important in the water core of MT at least but possibly also in longer length scales.

1. TGD allows magnetic monopole fluxes for flux tubes: in this case the cross section of the flux tube would be closed 2-D surface (sphere) rather than disk, and no current rotating around the tube would be needed to create the magnetic flux. This kind of flux tubes could explain the presence of magnetic fields in cosmic scales: in Maxwellian cosmology they are impossible in early cosmology because the needed currents are to possible. This kind of fluxes might be associated with super-conductors and even permanent magnets. The unit of magnetic flux $\Phi = \int eBdS$ is $h/2$ for a disk cross section. For spherical cross section of monopole flux tube the flux is $\Phi = \oint eBdS$ and unit is $2h$ that is 4 times larger. This could serve as a test for whether one has monopole flux or standard flux.

2. I have proposed that constant endogenous magnetic field $B_{end} = .2$ Gauss$= .2 \times 10^{-4}$ Tesla could explain the effects of ELF radiation to vertebrate brain as resulting from cyclotron transitions of large h_{eff} B-E condensate. The recently updated model replaces cyclotron transitions with phase transitions scaling the value of p-adic prime and thus the value of the magnetic field. The model yields essentially the same predictions as the earlier model. The phase transition scales down the radius of the flux tube characterized by p-adic length scale $L(k) \simeq 2^{(k-151)/2} \times L(151)$, $L(151) \simeq 10$ nm by a power of two: the increase in cyclotron energy due to the reduction of flux tube radius is in good approximation $ne(B_f - B_i)/m = neB_f(1 - 2^k) \simeq neB_f$, where B_f is the field strength for the compressed magnetic flux tube.

3. For electron in endogenous magnetic field of .2 Gauss cyclotron frequency is $f_e \simeq .5$ MHz: for proton one has $f_p \simeq 300$ Hz (note that the ratio of cyclotron frequencies of electron and proton is given by the mass ratio $m_p/me \simeq 1843 \sim 2^{11}$) . The reported resonance frequency is $f \simeq 8$ MHz, which is 2^4 times higher than f_e. This suggests that the irradiation induces p-adic phase transition of flux tubes contracting them by a factor $1/2$ and increasing field strength by a factor 4. This would mean that the p-adic length scale is reduced from $L(k)$ to $L(k-4)$. The possibility of this interpretation yields support for the p-adic length scale hypothesis.

4. Purely number theoretic considerations predict that in biologically interesting length scale range ranging from 10 nm to 2.5 μm there are four p-adic length scales which correspond to Gaussian Mersenne primes $M_{G,n} = (1+i)^n - 1$, $n = 151, 157, 163, 167$. One could speak of a number theoretic miracle. It is easy to see that the transition induced by 8 MHz radiation could correspond to the transition $k = 167 \to 163$ for electron. This gives strong support for the fundamental role of these Mersenne scales.

   First, B_{end} corresponds to magnetic length of $L_B = \sqrt{\hbar/eB} = 5.7$ μm not far from the p-adic length scale $L(169)$ is $L(169) \simeq 5.1$ μm. L_B would give flux quantum $h/2$. The problem is that this scale is by a factor 2 longer than the Mersenne scale $L(167)$. Situation changes if the flux is monopole flux for flux tube with spherical rather than disk-like cross section. By previous argument the flux quantization would be obtained for a sphere with radius given by the p-adic length scale $L(167)$. One would obtain Mersenne scale and the transition $L(k) \to L(k-4)$ would correspond to $k = 167 \to k = 163$. Proton cyclotron frequency would be scaled up in this transition to 4.8 kHz and it would be natural to identify frequencies in kHz frequencies as harmonics of f_p.

5. The scaling $k \to k-11$ would transform $f_e = .5$ MHz to $f_e = 1$ GHz. The p-adic scale would become $k = 156$. $k = 157$ would have been more attractive outcome. $L(156) \simeq 57.6$ nm looks too large to be radius for a magnetic flux tube assignable to the MT strand of thickness of order 4 nm. I would more naturally correspond to the length scale defined by a strand of 13 tubulins.

6. Microtubule strand corresponds to length scale 4 nm which suggests that p-adic length scale $L(149)$ assignable to lipid layer of cell membrane characterizes the flux tubes defining the coordinate grid at MT surface. GHz frequency is assigned with the order water in the interior of MT $L(145) \simeq 1.25$ nm seems to be a good candidate for the corresponding p-adic length scale. $f_p = 1.35$ GHz frequency is obtained if flux the transition is $k = 167 \to 145$.

7. An attractive possibility is that the flux tubes in the interior of MT contain dark proton sequences defining the dark nuclei with single dark proton with large value of Planck constant h_{eff} with size scale of single DNA codon. The amazing prediction of the model of dark nucleon is that the counterparts for the DNA, RNA, amino-acids and even tRNA are obtained and vertebrate genetic code can be realized as a natural correspondence between these states [K37, L10]. One can imagine the possibility that the dark genetic codes inside MT and connected by radial magnetic flux tubes to the codons at the braid strands at the surface of MT.

5. About B-type lattice

Some TGD- and computer science inspired comments on B-type lattice are in order.

1. B-type lattice is discontinuous along vertical line. There is a horizontal pair of α and β tubulin monomers at discontinuity and here α (β) tubulins have 3 instead of 2 nearest neighbour β (α) tubulins. Could the possible flux tubes connecting microtubule to the axonal membrane and making possible to receive sensory input begin here? The flux tube pair parallel to this line brings in mind DNA double strand. The α- or β-sequences with vertical 5-periodicity would be discontinuous after full turn: the shift in vertical direction would be 5 tubulin units but single turn of the helical path would correspond to a vertical shift of 4 tubulin units only.

2. The discontinuity suggests that the tubulin consists of pieces of 13-units maybe defining a sequences of 13 binary digits as code words - kind of bytes - in turn defining the classical computer code giving rise to TQC code.

3. A second interesting aspect is the 7-periodicity of transversal pathways in axial direction. One of the TGD inspired models for genetic code [K36] interprets 64 genetic codons as a subset of 127 element space consisting of $2^7 - 1$ elements identified as a subset set of mutually consistent logical statements of 7-bit algebra so that the negation of the statement cannot belong to the set.

Statements would be analogous to axioms of mathematical system being identically true. One statement is non-realizable: in case of set theoretic realization it would be naturally empty set. If statements are realized as spin excitations of ferromagnet then absence of spin excitations would correspond to the non-realizable statement. One could also argue that only communicable statements are possible. Communication of the state could be defined as radiation generated by the transition from the ground state to a multiply excited state. If there is no change (ground state goes to ground state), the statement is not communicable. Could 7-bit sequences be restricted by the condition that they represent identically true statements? This condition would make possible error correction mechanism analogous to parity bit.

6. Could DNA sequences code for TQC programs?

One also ends up with a rather crazy idea about possible interpretation of genetic code.

1. If one piles up 2-D TQC:s one obtains 3-D 1-braid TQC. In crossings one must have 3 bits to specify whether to swap or not since there are three planes for TQC and 3 pairs of crossing strands (12,13,23).

2. For 2-braid TQC one obtains 6 bits at each crossing of 3-D grid. The first bit tells whether reconnection occurs and second tells which of the resulting crossing strands goes over the other. One can imagine even a concrete realization. DNA strand which is a coil with radius of 10 nm could be accompanied by a flux tube and there would be for each codon to flux tubes crossing this flux tubes so that 6 bits would be needed to characterized the 2-braid locally. DNA as TQC model suggests that second flux tube connects DNA codons to a helical flux tube at lipid layer of nuclear or cell membrane. Second strand could connect it to similar tube at cell membrane.

3. Just for fun one can imagine also a second, even more science fictive realization. If one further piles 3D TQC:s in 4-D one obtains 4-D one making sense in zero energy ontology because failure of strict non-determinism is basic element of TGD. Single crossing would in 4-D would involve crossings of four lines in orthogonal dimensions. TGD predicts also space-time regions with Euclidian signature in all scales (lines of generalised Feynman diagrams). I have proposed that any system corresponds to an Euclidian space-time sheet having its size and shape and behaving like quantum system. In these regions the fourth piling might really make sense!

This would make 6 crossing pairs corresponding to 6 planes in which particular TQC takes place - for which one must tell whether to swap or not (12,13,14,23,24,34). This makes 6 bits. DNA codons correspond to 6 bits! Could codons define crossing points of magnetic flux tubes arriving from 4 coordinate directions- perhaps at Euclidian space-time sheets? Could the planes correspond to 3 components of magnetic field and 3 components electric field. Magnetic flux tubes and electric flux tubes in 3 directions? In Euclidian regions magnetic and electric do not differ intrinsically. It is however difficult to concretize this proposal.

In the following I try to understand the observations reported by Anirban Bandyopadhyay (`https://www.youtube.com/watch?v=VQngptkPYE8`) in TGD framework.

The observations of the group of Anirban Bandyopadhyay from TGD point of view

The observations of Anirban Bandyopadhyay are briefly summarized by Massimon Pregnolato at `http://www.quantumbionet.org/admin/files/MassimoPregnolato-RitaPizzi2011.pdf`. At this stage one can of course several models for the findings and in the following one option is selected.

1. The most plausible model is based on the notion of coordinate grid formed by longitudinal and transversal magnetic flux tubes whose crossing points are the points at which swap occurs or does not occur depending on the state of tubulin dimer. The grids associated with A and B tubules are obtained by a 2π twist for the upper end of the tubulin.

2. There is a large number of options for grids and they are identified on basis of the experimental findings. Transversal coordinate lines would correspond to the 7-periodic parallel lines with either gap 2 or 3 (gap 4 lines decompose to gap 4 and gap 2 lines) and longitudinal coordinate lines to one of 4 line groups involving four gaps so that 8 coordinate grids are obtained and related by a 2π twist for A and B tubules respectively. Gaps could characterize measurement resolution.

3. For A-type microtubule one can consider also Fibonacci grids constructed from helical curves and their mirror images with periodicities 3,5,8,13 and arbitrary gaps but it is difficult to interpret the resonance frequencies and understand their number for this option.

1. Fröhlich B-E condensation or something else?

Excitation at the resonance frequencies cause microtubules to assemble extremely rapidly. This is proposed to be due to Fröhlich condensation. The resonance frequency of AC stimulation leading to a rapid generation of microtubules in the length scale range $[.2 - 22.5]$ μm is around 8 MHz. There is correlation between resonance frequencies and lengths of microtubules and qubit sets that are possible.

Comment: The identification as formation of Fröhlich B-E condensate can be criticized. The frequency at which this would take place was predicted by Fröhlich to be around GHz rather than in MHz range.

In TGD framework AC stimulation could generate flux tube grid or activate existing magnetic flux tube grid forming a braid like structure serving as a template for the formation of microtubule around it. If the formation of grid corresponds to quantum criticality, the resonance frequencies could also generate phase transitions between A and B type states of the microtubuli. AC signal could also generate contacts to these flux tubes making possible supra currents. The formation of microtubules is known to proceed by the formation of vertical nucleotide polymers which are then glued together horizontally: flux tube could serve as a template for the formation of the nucleotide polymer. The magnetic fields at flux tubes can be accompanied by helical electric fields (in this case both magnetic and electric fields are helical) and these fields could be responsible for the polarization of microtubule and induce the growth of microtubules in such a manner that the polarized alpha-beta tubulin always attaches in the same manner to the growing polymer. Fröhlich condensation would be a consequence of generation of flux tube coordinate grids defining microtubule skeleton- growth of the magnetic body would precede that of biological body.

The length of the tubule increases with resonance frequency which suggests that single tubulin dimer is added to the polymer during each cycle. MHz range and formation time around few seconds. This would mean something like 10^6 giving MT with length of order 10^{-4} meters. The order of magnitude is correct.

2. 8 resonance frequencies in AC stimulation and 8 distinct interference patterns

Microtubules are reported to have 8 resonance peaks for AC stimulation (kilohertz to 10 megahertz), which appear to correlate with various helical conductance pathways around the geometric microtubule lattice. The explanation is proposed in terms of current pathways which are identified topological qubits.

Comment: To me this terminology looks strange and confusing. Why not to speak about braid strands or specify what topological qubit means if one is speaking about TQC? I am unable to understand why groups of parallel pathways are considered as topological qubits (TQs). The idea about parallel translates might however make sense.

As already explained, the notion of coordinate grid in the sense discussed is consistent with the findings. The resonance frequencies could correspond to phase transitions changing A-type coordinate grids to B-type or vice versa. Coordinate grid would define the basic architecture of TQC.

The second claim is that there are altogether eight distinct quantum interference patterns from a single microtubule, each correlating with one of the 8 resonance frequencies and pathways. According to the interpretation discussed in the talk 4 sets of four pathways representing quantum TQ each can exist simultaneously for type A microtubules claimed to be ideal for quantum computation. Lattices of type B exhibit 4 different pathways and are claimed to be ideal for communications. The lattices A and B are complementary in the sense that together they allow all possible pathways (this is not quite true: $n_{gap} = 12$ is lacking). The set of possible pathways depends on the length of MT.

Comment: Also this would conform with the TGD inspired model in which one has 8 coordinate grids for tubules of B and their deformations by twist to A type tubules. The 8 interference patterns would correspond to different coordinate grids. What coordinate grids are physically allowed coordinate grids are depends the length of the microtubule.

3. Observations about conductivity

There are also several observations about conductivity suggesting quantum coherence.

1. In assembled microtubules AC excitation at the resonant frequencies causes electronic conductance to become lossless, or 'ballistic', essentially quantum conductance, presumably along these helical quantum channels. Resonance in the range of kilohertz demonstrates microtubule de-coherence times of at least 0.1 millisecond. Does this mean that AC signals at resonance frequencies are able to create these channels or groups of them?

   Or does this mean, that the resonance signal transforms the microtubule to A (or B) type lattice which is highly conducting or even super-conducting (via magnetic flux tubes). The claim that A type lattice does not exist in vivo reduces to the statement that it does not exist stably in vivo. The AC signal at resonance frequency induces the twist taking lattice B into lattice A in which TQC is possible.

2. There are three frequency scales corresponding to kHz Hz, MHz and GHz ranges. The natural identification for these rather low frequency scales is in terms of cyclotron frequencies of dark electrons and possibly also various ions at magnetic flux tubes. The simplest identification would be in terms of three ranges for the strengths of magnetic field. I have proposed that .2 Gauss magnetic field define endogenous magnetic field explaining the effects of ELF em radiation on brain in terms of cyclotron transitions of biologically important ions, in particular Calcium ions for which cyclotron frequency would be 15 Hz (later an alternative explanation making essentially the same predictions has emerged). For electron the cyclotron frequency would .5 MHz so that for 16 times strong field would correspond to cyclotron frequency of 8 MHz appearing as resonance frequency. GHz frequency would require a magnetic field of .04 Tesla.

3. It is stated that the system cannot be classified as insulator, semiconductor, or conductor. The reason would be that the two bands involved do not overlap as in conductors, are not completely separate with large gap as in insulators, nor separate with a small gap. Instead the bands touch each other in pointwise manner.

   Comment: Stimulus with the resonance frequency could regenerate the flux tubes or bridges to the flux tubes allowing the transfer of electrons to them. The ballistic resistance temperature independent resistance would be due to a very long free path or due to super-conductivity at the magnetic flux tubes - the latter is the TGD inspired hypothesis. This kind of behavior could result if the electrons can leak to the flux tube only if they have same momentum as the Cooper Bose-Einstein condensate at the flux tube. Resonance condition would mean

that the magnitude of the wave vector of electron is quantized in magnitude: this would also support the proposed interpretation.

4. It is claimed that conductance does not depend on microtubule length, is temperature independent, and has discrete values. Also ohmic dissipation is claimed to be negligible.

   Comment: The interpretation could be in terms of superconducting current pathways defined by magnetic flux tubes looks natural as already found.

The observation that water is necessary for MT conductivity [J97] suggests that the presence of water is essential for large h_{eff}. One of the many possibilities is that the flux tubes (which are closed) return through the interior of MT containing the ordered water. Also dark variants of genes realized as dark proton sequences dark nuclei could be involved.

4. Ferroelectric hysteresis

What is interpreted as ferroelectric hysteresis is claimed to demonstrate memory capacity in microtubules [J98]. Current viz. voltage over the microtubule exhibits square hysteresis. Suddenly all-in one jump changing the direction of current at critical voltage. This is analog of ferromagnetic or ferroelectric behavior but in completely quantal manner.

One can ask whether the quantum superpositions of two current directions might represent qubit. If so, the information processing capacity of microtubule would be rather modest unless one consideres seriously 2-braid TQC. (recall however that in neuroscience single neuron is assumed to represent bit).

It is not at all obvious that ferroelectric hysteresis is in question and TGD suggests different interpretation for the hysteresis curve. The current as function of voltage could reflect quantum coherent current in Bose-Einstein condensate of electronic Cooper pairs with all Cooper pairs having the same momentum. Macroscopic quantum coherence would make the state stable against perturbations defined by the external voltage and only when the voltage exceeds critical magnitude the state would change its momentum to opposite values instantaneously. If the interpretation as cyclotron BE-condensate is correct one would have Cooper pairs with spin 1 in same state and effectively only single particle representing memory.

The assumption of Bose-Einstein condensate might be unnecessary strong: negentropic entanglement might be enough. Dark electrons are negentropically entangled and the entanglement stores potentially conscious information. The degeneracy of the ground state essential for achieving stable enough entanglement also in standard approach to TQC. The negentropic entanglement would not be in spin degrees of freedom but in those labeling sheets of the covering of M^4 and CP_2 defined by the space-time sheet of electron. Anti-symmetry in these exotic degrees of freedom would make electrons bosons if seen from the perspective of standard physics and allow them to effectively B-E condense to the same state with respect to standard quantum numbers. Note that this proposal resembles somewhat the proposal of Hameroff and Penrose for topological qubits in terms of parallel current pathways with same gap. In this case the negentropic entanglement could perhaps stabilize the state in the sense that NMP [K49] would not allow the quantum jump leading to opposite direction of electron current to take place.

5. Dynamical instability of MTs

MTs are dynamic instable and the length of MT changes in jumps. The conjecture is that some kind of language is involved. On basis of few second time scales one can wonder whether the correspondence with language production could be rather direct. Could regions of type A contain the information communicated in speech, say the information needed to form words or sentences? If microtubules of type B are indeed responsible for communications, one can ask whether $A \to B$ phase transitions generate the signal in turn inducing the nerve pulse patterns correlating with internal speech. The connection with language could be realized also at gene level [K36].

I have proposed that microtubule acts as quantum antenna emitting radiation with frequencies $f_n = nc/L$, where L is the length of MT. The variation of the length of microtubule would predict frequency modulation of the radiation coding for potentially conscious information. The model for nerve pulse and EEG makes similar prediction [K66, K20]. Josephson frequency for cell membrane as Josephson junction is proportional to membrane voltage and the variations of membrane voltages due to oscillations and nerve pulse activity are coded to EEG via frequency

modulation. Even ordinary speech involves frequency modulation as is clear by listening recorded speech with abnormally slow speed. If microtubules talk, the most natural language would be based on frequency modulation.

The system seems to be critical, maybe it is quantum critical in TGD sense. At quantum criticality the dynamics involves a large number of length scales. In TGD framework quantum criticality would mean that the hierarchy of Planck constants is involved such that given length scales is proportional to the effective value of Planck constant. Maybe different lengths for flux tubes correspond to values of effective Planck constant $h_{eff} = nh$.

Conclusion

The important conclusion suggested by the experiments is that microtubules - in particular, brain microtubules - are macroscopic quantum systems. Already this would be enormously important conclusion. To my personal opinion, the interpretation in the talk is not convincing at the level of details and TGD inspired modification of the proposal in terms of flux tube coordinate grids making possible TQC architectures with tubulin dimers defining bits defining in turn TQC program looks more plausible to me. A natural generalization of of 1-braid TQC to 2-braid TQC is also highly suggestive in TGD framework and could be seen as evolutionary step assignable to the emergence of microtubules. The interpretation based in Fibonacci conduction paths fails to predict correctly the number of resonances. An attractive interpretation for the resonance frequencies is in terms of phase transitions between A and B type lattices. If A type lattices can be generated only in h_{eff} increasing phase transitions induced by AC stimulus at resonance frequencies, one could understand their experimental absence and why super-conductivity like state is generated.

5.7.7   Morphogenesis, morphostasis, and learning in TGD framework

Michael Levin and his collaborators have been working with fascinating topics including fundamentals of long term memory and morphogenesis and morphostasis [I70, I71, I101]. I am grateful for Lian Sidorov for bringing these articles to my attention.

There are two articles about morphogenesis and morphostasis. The first article [I70] (`http://www.futuremedicine.com/doi/pdf/10.2217/rme.11.69`) seems to be directed to general audience and has the title "The wisdom of the body: future techniques and approaches to morphogenetic fields in regenerative medicine, developmental biology and cancer". Second article [I71] titled "Morphogenetic fields in embryogenesis, regeneration, and cancer: Non-local control of complex patterning" (`http://www.ncbi.nlm.nih.gov/pubmed/22542702`) is more technical. The basic notion is morphogenetic field, an old notion, which has not captured the attention of main stream biologists who have worked mainly with the attempt to reduce biology to genetic code. Sheldrake's work [I96] with the notion has drawn special attention but there are many other workers in the field.

The third article [I101] by Levin and Shomrat has title "An Automated Training Paradigm Reveals Long-term Memory in Planaria and Its Persistence Through Head Regeneration" (`http://mechanism.ucsd.edu/teaching/f13/cs200/Levin_longterm_learning_planaria_2013.pdf`) challenging the belief that brain is the only seat of memories.

According to Levin, the basic challenge of morphogenetics and morphostasis is to understand how the shape of the organism is generated and how it is preserved [I71]. The standard local approach based on belief on genetic determinism does not allow answer these questions satisfactorily. There is paradigm based on self-organization in which the local dynamics of cells leads to large scale structures as self-organization patterns. The game of life is an elegant example about how simple cellular automaton can lead to surprisingly complex behaviors: actually the game of life is universal Turing computer. The problem of this approach is that it is very difficult to deduce the local rules governing the behavior of basic units (whatever they are) in practice- especially so if they are also dynamical.

Second approach could be seen as computational with basic idea being that the process is guided by a template of the target state. Morphogenetic fields would define this template. The assumption about final goal can be argued to be too strong: much weaker principle defining a local direction of dynamics and leading automatically to the final state as something analogous to

free energy minimum in thermodynamics might be enough. Unfortunately, second law is the only principle that standard physics can offer.

These problems are very relevant also for medicine [I70] since morphogenesis, morphostasis, and cancer all involve actively replicating cells: the difference is that in cancer the control and long scale coordination of the process fails and it becomes purely local process. Levin refers to cancer as geometric disease and it seems that this correction contains seed of truth.

These topics are also interesting from the point of view of TGD inspired quantum biology and consciousness. There are several new notions to be tested.

1. The new view about time and quantum implied by zero energy ontology (ZEO). In TGD framework the notion of preferred extremals as 4-D space-time sheet analogous to Bohr orbit, for which strict determinism of dynamics fails, replaces 3-space as basic unit. One can understand self-organizaton process in 4-D sense rather than 3-D sense: geometric time evolution would be replaced by subjective time evolution by quantum jumps. This could resolve the basic difficulty of the ordinary self-organization paradigm. Geometro-temporal pattern approaches to asymptotic quatum jump by quantum jump one rather than 3-D pattern.

2. The new view about information relying on the notion of negentropic entanglement and Negentropy Maximization Principle (NMP). NMP could be the principle guaranteeing local positive goal making healing and evolution basic processes of Nature. In particular, the development of shape and shape preservation of organisms could involve NMP in essential manner. Also the approach of WCW spinor field to the maximum of vacuum functional (or equivalently that of Kähler function) gives a goal for the dynamics after the perturbation of the organism causing "trauma". If Kähler function is classical space-time correlate for entanglement negentropy, these two views are equivalent.

3. The notion of magnetic body (MB) carrying dark matter as phases with large value h_{eff} of Planck constant making living matter a macroscopic quantum system and providing a tool kit of quantum mechanisms (phase transitions changing the value of h_{eff} and thus the length of flux tube, reconnections changing the topology of magnetic Indra's net, and 1-braiding of flux tubes 3-space and 2-braiding of their orbits in 4-D space-time). Magnetic body defining a kind of coordinate grid is a good candidate for the TGD counterpart of morphogenetic field serving as a template for the developing organism. It would also give rise to topological quantum computation (TQC) type activities.

   The coordinate grid formed by flux tubes defines 3-D topological quantum computer program and the natural assumption is that learned behaviors are coded by the magnetic body as TQC programs. If replication of magnetic body accompanies the replication of DNA, cell, and even planaria (say), the learned behaviors are also replicated.

4. There are additional mechanisms: super-conductivity made possible by large values of h_{eff}, Josephson radiation from Josephson junctions transforming voltages to frequencies inducing resonant transitions, and radiation consisting of dark photons and inducing cyclotron transitions serving as a basic control and coordination tools. The radiation could be generated as analog of cyclotron radiation by quantum phase transitions at magnetic flux tubes, by Josephson junctions, and by microtubules serving as quantum antennas. Frequency modulation is an excellent candidate for the representation of information: kind of whale song would be in question.

All these new notions seem to be highly relevant for the understanding the findings challenging the standard intuition discussed in the articles. It would seem that both computational aspects (TQC), self-organization but in 4-D sense, the idea about template identified in terms of flux quanta of topologically quantized classical em fields, and the local direction of quantum dynamics defined by NMP are involved rather than single principle.

The notion of time in TGD framework

The TGD based notion of time is very relevant in attempts to understand the findings about the memory of planaria and metamorphosis and metastasis challenging the standard thinking.

1. The general picture based on zero energy ontology

1. In TGD framework one must make a distinction between subjective time and geometric time: usually these times are identified. Subjective time has state function reduction/quantum jump as chronon. Geometric time is the time of physicists and corresponds to one coordinate for space-time surface or imbedding space. General Coordinate Invariance implies that it is not unique but that there are very natural choices of it dictated by symmetries.

2. In zero energy ontology (ZEO) physical state is replaced with a pair of positive and negative energy states at opposite boundaries of $CD \times CP_2$, where CD is causal diamond identified as the intersection of future and past directed light-cones. I will talk about CD in the sequel without bothering to write "$\times CP_2$". In ordinary positive energy ontology zero energy states correspond to initial and final states of physical events. The space-time surfaces having their ends at the boundaries of $CD \times CP_2$ are space-time correlate for the physical time evolution between the initial and final states. CD:s form a fractal hierarchy since the distance between the tips of CD is assumed to be integer multiple of CP_2 time. Also Lorentz transforms and translates of CD are allowed so that it makes sense to speak about moduli space of CD:s and also have "wave functions" in this moduli space. This is very relevant for understanding what the flow of time corresponds physically.

   One can say, that due to the failure of strict determinism the 4-D space-time surface connecting boundaries of CD becomes the basic dynamical unit as far as subjective time development is considered. The superposition of space-time sheets is recreated again and again in quantum jump so that "quantum average" space-time - also its past - changes.

   One can speak about 4-D body, brain, even society and there is continual 4-D interactions. For instance, the recall of long term memories could be communications with the geometric past using time reversed signals reflecting back from the brain of the geometric past: essentially seeing in time direction would be in question. One can even consider healing process in which the healthy state result also in the geometric past!

   A new view about long term memories emerges: the brain of geometric past can serve as the seat of memories. This applies to genuine conscious memories such as episodal memories but not to learned behaviors.

3. Zero energy ontology (ZEO) implies a new view about state function reduction and about how the experience about flow of time and its arrow emerge. The state function reductions can occur at either boundary of CD but also repeatedly at same boundary. The wave function in the moduli space of CD:s with fixed "lower boundary" changes although in each repetition of state function reduction although the positive energy state at "lower" boundary remains unchanged. In ordinary quantum measurement theory nothing would change. This change gives rise to the experience about flow of time. The change is that the average temporal distance between the fixed tip of "lower" boundary and the tip of the "upper boundary" increases: essentially dispersion leading to the decay of wave packet is in question. It is analogous to diffusion in which distance of the diffusing particle from the initial position gradually increases. One can quantify this by introducing the average increase of average geometric time in single state function reduction highly relevant for understanding time experience.

4. Couplings between several widely different length and time scales - say molecular length scale and the scale of biological body - seems to be needed in order to understand morphogenesis - at least as something implied by cell level events. TGD assigns to each particle its CD. The scale of the smallest CD assignable with the particle characterized by given p-adic prime p corresponds to its secondary p-adic length/time scale. For electron this time scale is .1 seconds defining a fundamental biorhythm: as a length scale it corresponds to the circumference of Earth.

5. One of the basic predictions of TGD is the failure of strict determinism of the time evolution for space-time surfaces. The interpretation is as a space-time correlate of quantum non-determinism. The reason is the huge vacuum degeneracy of Kähler action. Any space-time

surface with vanishing induced Kähler form which is essentially Maxwell field, is vacuum extremals. Mathematically this huge degeneracy is like gauge degeneracy but implies 4-D (very essential distinction from standard view) spin glass degeneracy: there is huge number of different preferred extremals obtained as deformations of the vacuum extremals. This means non-determinism.

So called vacuum functional tells the probability of one particular preferred extremal and one can imagine plotting it as a functional of the extremal. The graph would be a fractal analogous to free energy landscape of spin glass: there are minima inside minima inside.... - now only the minima are replaced with maxima.

2. What healing in 4-D sense could mean?
The TGD view about time allows to imagine what 4-D healing could mean.

1. Suppose that one performs a deformation of the space-time sheet representing healthy organism. The system suffers "traumatic injury" in 4-D sense but only inside the CD in question. Classical non-determinism makes also possible the that the localization of 4-D deformation to a finite region of space-time rather than extending to infinite future. State functions repeatedly replace the zero energy state with a new one and it can gradually end up back to the maximum of Kähler function unless the deformation was not too large or unless it stucks to a different local maximum. If it ends up with a original maximum, one can say that 4-D healing took place. Also the biological body of geometric past is healthy! In geometric sense the system was never sick! This mechanism requires no knowledge about healthy state and no algorithm for getting back into healthy state. Nature takes care of healing.

2. The sticking to a local maximum of vacuum functional can prevent getting to the ideal healthy state. This can be avoided by the same mechanism as in annealing, which serves as a metaphor in numerics for a process in which one finds deep minimum of function by "kicking" the system now and then to get out of local minimum. Now the "kicking" would be stimulus deforming the system but not too much.

3. One expects that also Negentropy Maximization Principle (NMP) is closely involved with healing since healing should involve regain of the lost information. NMP states that the total negentropy increases in state function reductions and is apparently the opposite of second law: the negentropies in question are however not the same thing and NMP implies second law for ordinary entanglement. The implication is that the potentially conscious information associated with the negentropic entanglement (with identical entanglement probabilities for entangled states) tends to increase and negentropic entanglement (see fig. `http://www.tgdtheory.fi/appfigures/cat.jpg` or fig. 21 in the appendix of this book) can be only transferred to another system or transformed to a new form, but cannot disappear. Negentropically entangled systems would define kind of Akashic records storing potentially conscious information transformed to conscious information in interaction of free quantum measurement. The approach towards maximum of negentropic and maximum of vacuum functional should closely to each other. Quite concretely, NMP could help to understand why the pieces of planaria split into two parts develop head and tail.

4. Clearly, NMP and the approach to the maximum of Kähler function both define candidates for the principles giving rise to same outcome as morphogenetic field is hoped to give. A possible interpretation is that the approach to the maximum of Kähler function is the space-time correlate for NMP: Kähler function defined as Kähler action for preferred extremal could be regarded as classical negentropy.

3. The flow and arrow of time in ZEO
The TGD based vision about how the arrow of geometric time has developed slowly and I do not dare claim it be fully developed and final [K6].

1. What seems clear now is the decisive role of ZEO and hierarchy of CDs, and the fact that the quantum arrow of geometric time is coded into the structure of zero energy states to a high

extent. The still questionable but attractively simple hypothesis is that U matrix relates two zero energy state basis with opposite quantum arrows of geometric time: is this assumption really consistent with what we know about the arrow of time? The second basis is always state function reduced.

If this is the case, the question is how the relatively well-defined quantum arrow of geometric time implies the experienced arrow of geometric time. Should one assume the arrow of geometric time separately as a basic property of the state function reduction cascade or more economically- does it follow from the arrow of time for zero energy states?

2. The state function reductions occurs at either of the two boundaries of CD. If the reduction occurs at given boundary is immediately followed by a reduction at the opposite boundary, the arrow of time alternates: this does not conform with intuitive expectations: for instance, this would imply that there are two selves assignable to the opposite boundaries!

   It took time to realize that zero energy states must be de-localized in the moduli space CDs (the size of CD plus discrete subgroup of Lorentz group defining boosts of CD leaving second tip invariant). One has quantum superposition of CDs with difference scales but with fixed upper or lower boundary belonging to the same light-cone boundary after state function reduction. In standard quantum measurement theory the repetition of state function reduction does not change the state but now it would give rise to the experienced flow of time. Zeno effect indeed requires that state function reductions can occur repeatedly at the same boundary. In these reductions the wave function in moduli degrees of freedom of CD changes. This implies "dispersion" in the moduli space of CDs experienced as flow of time with definite arrow.

3. This approach codes also the arrow of time at the space-time level: the average space-time sheet in quantum superposition increases in size as the average position of the "upper boundary" of CDs drifts towards future state function reduction by state function reduction.

4. In principle the arrow of time can temporarily change but it would seem that this can occur in very special circumstances and probably takes place in living matter. Phase conjugate laser beam is a non-biological example in this respect. Memory recall [K70] would involve the change of arrow of geometric time for a subsystem corresponding to the signal propagating to the geometric past and reflecting back.

This vision involves minimal number of assumptions and is the most convincing one found hitherto and the challenge is to invent objections in order to develop it in more detail.

The notions of magnetic body and dark matter hierarchy

The notion of magnetic body is central in TGD. The TGD inspired model trying to explain the findings about microtubules by Indian research group led by Anirban Bandyopadhyay lead to rather interesting speculations about the role of magnetic flux tubes and a more precise speculative view about how living system could act as topological quantum computer [K107] [L37].

Remark: Magnetic body is somewhat misleading term since a simple deformation implies that magnetic flux quanta carry helical magnetic and electric fields along the flux tube axis.

   1. Could magnetic body define coordinate grids making possible topological quantum computation?

If the claims of Indian research group led by Anirban Bandyopadhyay are true, one can say that microtubules are macroscopically quantum coherent systems at physiological temperatures. In his Youtube talk Anirban Bandyopadhyay (`https://www.youtube.com/watch?v=VQngptkPYE8`) [J39] discussed an identification of conduction pathways different from that of Penrose and Hameroff. In [J105] Gosh, Sahu, and Bandyopadhyay argue for evidence for massive global synchronization in brain and claim that experimental findings support the Penrose-Hameroff theory. In the article "Atomic water channel controlling remarkable properties of a single brain microtubule: correlating single protein to its supramolecular assembly" [J97] it is reported that ordered water inside microtubule is necessary for the conduction inside microtubule.

According to the same article the tubulins inside microtubule has same energy levels in chemical energy range as isolated tubulins, which suggests that the mechanism binding tubulins to form MT is not chemical. In the article "Multi-level memory-switching properties of a single brain microtubule" [J98] it is reported that the hysteresis curve for current along MT as function of voltage is ideal square curve meaning that there is no dissipation involved with the change of the current direction. This would make MT as an ideal memory device. Whether Penrose/Hameroff have in mind the use of current direction as qubit remains unclear. In video talk Bandyopadhyay refers also to these results.

I have considered the general proposal discussed in video lecture in the article [K107] [L37]. The findings reported in the talk give support for the general TGD inspired view about TQC and allow rather detailed model in the case of microtubules. The idea is that flux tubes form a 2-D coordinate grid consisting of parallel flux tubes in two different directions: the guess that they could consist of helical Fibonacci flux tubes and their mirror images is not however convincing. Crossing points would be associated with tubulins and the conformational state of tubulin could define a bit coding whether the braid strands defining coordinate lines are braided or not (swap or not). In this manner any bit pattern at microtubule defines a particular TQC program. If also conformations are quantum superposed, one has "quantum-quantum computation". It however seems that conformation change is irreversible chemical reaction [J81] so that this option is not feasible.

The TGD inspired modification of the proposal in terms of flux tube coordinate grids making possible TQC architectures with tubulin dimers defining bits defining in turn TQC program looks more plausible to me. Coordinate grids can be fixed on the basis of the experimental findings and there are 8 of them. The interpretation is in terms of different resolutions. The grids for A and B type lattices are related by 2π twist for the second end of the basic 13-unit for microtubule. An attractive interpretation for the resonance frequencies is in terms of phase transitions between A and B type lattices. If A type lattices can be generated only in phase transitions induced by AC stimulus at resonance frequencies, one could understand their experimental absence, which is strong objection against the Penrose-Hameroff model.

This would fit very nicely with the general vision about frequencies as passwords inducing not only directed attention but activities in target - also TQCs! The increase of Planck constant could be associated with the phase transition to A-phase making possible high T_c dark super-conductivity for which evidence is observed! One can even deduce estimates for $h_{eff}/h = n$ if one requires that AC photons have energy above thermal threshold: $n = h_eff/h = f_{visible}/f_AC$ would be the estimate. For bio-photon energies one would obtain something like $n \simeq 10^8 - 10^9$, which pops up in different contexts in TGD framework.

This picture generalizes in the fractal universe of TGD. One can form layers of 2-D coordinate grids and connect them by vertical flux tubes to obtain 3-D grid defining TQC. The brain is known to have grid-like architecture and neurons could by quantum computation produce bit/qubit defining swap or not/superposition of swap and not-swap for a larger scale TQC. One would have fractal of TQCs.

A further idea is that the TQC based on 1-braids generalizes in a natural manner to 2-braid TQC in TGD framework (for 2-braids in 4-D space-time see [K38]. The knotting occurs for string world sheets defining the orbits of braid strands - say magnetic flux tubes idealized to strings. In the case of microtubules this option suggests itself: the emergence of MTs could have meant emergence of 2-braid TQC and the increase of abstraction level in the information processing.

In the node of 3-D coordinate grid either reconnection of two flux tubes can occur or not: this is coded by one bit. Second bit tells which tube goes over which tube in the plane defined by two tubes. There are three planes of this kind corresponding to xy,xz, and yz planes, and therefore 6 bits altogether. Could genetic codon containing 6 bits of information code for what happens in the node of the grid. Note that 2-braiding is possible only if string worlds sheets "live" in 4-D space-time: for super strings living in higher-D space-time this is not possible.

This kind of 3-D TQC could be responsible for the those aspects which are nearest to computation. One must be however very cautious with the word "computation". Space-like braiding seems to be very natural for storing memories [K23] in braiding patterns ad bit patterns would characterize the 2-braiding associated with the coordinate grid but from this it is long way to computation in the usual sense of the word.

2. Flux tube grids and coding of position information

In metamorphosis and metastasis the basic problem is how the information about position is coded. How cell does know its position in organism? This is necessary for the cell to express its genome in appropriate manner: for instance, gene expression of neuron is quite different from that of muscle cell? According to the article of Levin [I71] organisms seem to have developed kind of coordinate grids to realize this purpose. For instance, simple coordinate transformations seem to related the grids of nearby species to each other. Magnetic flux tubes could be basic building bricks of these grids and at the same time the realization of morphogenetic fields. The coordinate value could be coded by the value of local magnetic field strength varying along the flux tube. By flux conservation this would correspond to the thickness of the flux tube or equivalently to cyclotron frequency. Radiation at cyclotron frequencies would act resonantly only at points at which the resonance condition is satisfied.

Voltages associated with Josephson junctions define Josephson frequencies which could be essential for bio-control and coordination via the resonance mechanism allowing selective activation of biological programs. According to [I71], the values of transmembrane potentials in frog embryo correlate with the formation of the face of Zenopus laevis embryos. The lipid layers of cell membrane are proposed to form Josephson junction (at microscopic leve the ionic channels and pumps associated with them).

Fractality suggests that nearby cell membranes - say those associated with epithelial sheets - could also form Josephson functions as fractal considerations. Gap junctions could provide a microscopic realization of these Josephson junctions. If so, then the large h_{eff} Josephson photons with frequencies determined by transmembrane potential ($f = ZeV/h_{eff}$) could induce in resonant manner activities in precisely defined positions of the magnetic coordinate grid. The radiation at correct frequency would serve as kind of password allowing to initiate a biological program. For instance, in the case considered above they could initiate the generation of the face. The errors in development could be due to various birth defects could be due to external electric perturbations. Maybe, some day even the correction of these errors might be possible by using properly tuned electric voltages.

3. What happens to the magnetic body of planaria cut into two pieces?

When planaria is cut to two pieces, second pieces regenerates head and second regenerates tail. Also when one takes second cell away from 2-cell embryo, the remaining cell becomes a full organism rather than only half of it. If there is a template for the formation of organism, then also this template must split in two. As a matter of fact, I have proposed that the magnetic body of the cell decomposes to two in cell division and that this splitting actually guides the cell division.

The fractality of TGD Universe suggests similar splitting in all scales. The vertex of Feynman diagram representing the decay of photon to electron-positron pairs provides an ultra-simplified version of the replication. In TGD framework the lines of Feynman diagrams are replaced with 4-D orbits of 3-D surfaces (or by holography 3-D orbits of 2-D partonic surfaces) and this is true in all scales. Therefore the idea that magnetic body replicates would reduce one of the most mysterious processes of living matter to generalization of fundamental physics. Note that string models do not allow analogs for the vertices of Feynman diagrams, they are possible only in TGD framework.

The idea about magnetic body defining a coordinate grid serving as a counterpart of morphogenetic field or as template able to guide the development of the organism becomes central. It seems that even individual cell - perhaps even DNA - should contain microscopic representation of some topological aspects of the adult organism. This conforms with the notion of holography and is consistent with the central role of genes. Magnetic body with large h_{eff} being very multi-sheeted structure analogous to covering space could provide this representation. With inspiration coming from Hox genes and from deep ignorance about genetics I proposed that the magnetic body of DNA and even DNA in some rough sense could be homologous to the biological body [K44].

Can one test this hypothesis? It is also possible to isolate the cells of planaria during the development of new head by closing gap junction connections between them for about 48 hours [I71]. The outcome is planaria with two heads. As if the isolation of two cells which should have belong to the head of planaria had induced splitting of the magnetic body assignable to the head to two so that the outcome was too separate heads. One can however split the two-headed planaria again and the headless part develops now two heads! If the two headed magnetic body replicates, the

outcome follows as a prediction.

Is brain really the seat of memories?

Levin and Shomrat tell about experiments demonstrating that brain is not necessarily the seat of memories as usually assumed. Planaria have brains and they are able to learn and remember. When planaria is split, the pieces develop head and tail. In the experiments planaria are taught some skill and after that split into two pieces. According to [I101], there is evidence that the part of planaria with new head remembers the skill. From this one can conclude that brain is not the only possible seat of memories.

Before continuing, it should be emphasized that memories are now defined as learned behaviors - assumed to reduce basically to conditionings of neurons at the motor areas of brain so that they generate certain motor response to sensory input. In TGD framework memories are understood as genuine conscious memories about events of past and involve communication with the geometric past.

One can imagine several explanations for the findings about the memory preservation. The computationalist possibility is that memories are transferred at least temporarily to the body of planaria and then back to the new head. This does not look biologically feasible.

Three TGD inspired explanations - corresponding to the identification of the brain of the geometric past, biological body, or magnetic body as the seat of memories - are considered.

1. Memories - identified as conscious experiences analogous to episodal memories rather than learned skills - could reside in the old brain or biological body or even magnetic body of the planaria with new head in the geometric past and accessed by negative energy signals which are time reflected from it. This explanation is not natural when memories are identified as learned skills, which in the ideal case are un-conscious behaviors.

2. In TGD Universe entire body and brains could form a hologram like structure [K10] and the information about body is transferred to the new brain. This would be like hologram completion. TGD indeed suggests strongly that entire body is conscious. For instance, the sensory organs carry the primary sensory qualia, one could circumvent the problem caused by the fact that neural circuits seem the same in all sensory areas. Cortex - maybe entire brain - would build standardized cognitive mental images, give them names, and entangle them with sensory qualia at sensory organs.

   Phantom leg is the basic objection against this view but new view about time allows to circumvent it: the seat for the experience about pain in phantom leg is in geometric past when the leg still existed. Note that here memories are not learned skills but memories about genuine events in geometric past.

   Second TGD inspired explanation for phantom leg would be it is that phantom leg corresponds to the magnetic body part: it is however not clear whether the sensation of pain even other bodily sensations can be located at magnetic body.

3. The long term memories of planaria restricted to learned behaviors could be represented also at the magnetic rather than biological body. Quantum computationalist would agree with this idea since learned skills would be very naturally TQC programs realized at the coordinate grid formed by the magnetic flux tubes. If magnetic body is replicated as planaria is cut to two pieces, also the TQC programs are replicated. DNA as TQC proposal [K23] assigns these programs to the braids defined by flux tubes assumed to connect DNA nucleotides or codons with the lipids of the lipid layers of the nuclear or cell membranes.

4. Could the state function reduction sequence implying 4-D self-organization driven by NMP lead to and asymptotic state in which also the skills learned in possession of old brain are possessed. As a matter fact, this aspect is certainly present since the replica of the magnetic body of planaria brain must give rise to original biological brain. TQC programs for the skills would be however present from the beginning.

5. In Zero Energy Ontology the space-time surface connecting 3-surfaces at the opposite light-like boundaries of causal diamond are the basic objects. The maxima of Kähler function

correspond to very special pairs of 3-surfaces connected by space-time surfaces. One can say that 4-D dynamical patterns, "behaviors" are fundamental objects. In ordinary ontology they would 3-D patters perhaps interpreted as asymptotic states resulting in self-organization.

The second option looks like the most plausible explanation since allows to understand the replication of not only organism but also the TQC programs defining behavior repertoire.

Chapter 6

Quantum Mind and Neuro Science

6.1 Introduction

Quantum biology-rather than only quantum brain- is an essential element of Quantum Mind in TGD Universe. Cells, biomolecules, and even elementary particles are conscious entities and the biological evolution is evolution of consciousness so that it would be very artificial to restrict the discussion to brain, neurons, or microtubules. The basic new physics inspired ideas behind TGD inspired quantum biology have been discussed already in the first article but deserve to be listed.

1. Many-sheeted space-time allows the interpretation of the structures of macroscopic world around us in terms of space-time topology. Magnetic/field body acts as intentional agent using biological body as a sensory receptor and motor instrument and controlling biological body and inheriting its hierarchical fractal structure. Fractal hierarchy of EEGs and its variants can be seen as communication and control tools of magnetic body. Also collective levels of consciousness have a natural interpretation in terms of magnetic body. Magnetic body makes also possible entanglement in macroscopic length scales. The braiding of magnetic flux tubes makes possible topological quantum computations and provides a universal mechanism of memory. One can also undersand the real function of various information molecules and corresponding receptors by interpreting the receptors as addresses in quantum computer memory and information molecules as ends of flux tubes which attach to these receptors to form a connection in quantum web.

2. Zero energy ontology (ZEO) makes possible the proposed p-adic description of intentions and cognitions and their transformations to action. Time mirror mechanism based on sending of negative energy signal to geometric past would apply to both long term memory recall, remote metabolism, and realization of intentional acting as an activity beginning in the geometric past in accordance with the findings of Libet. ZEO gives a precise content to the notion of negative energy signal in terms of zero energy state for which the arrow of geometric time is opposite to the standard one.

   The associated notion of causal diamond (CD) is essential element and assigns to elementary particles new fundamental time scales which are macroscopic: for electron the time scale is .1 seconds, the fundamental biorhythm. An essentially new element is time-like entanglement which allows to understand among other things the quantum counterparts of Boolean functions in terms of time-like entanglement in fermionic degrees of freedom.

3. The assignment of dark matter with a hierarchy of Planck constants gives rise to a hierarchy of macroscopic quantum phases making possible macroscopic and macrotemporal quantum coherence and allowing to understand evolution as a gradual increase of Planck constant. The model for dark nucleons leads to a surprising conclusion: the states of nucleons correspond to DNA, RNA, tRNA, and amino-acids in a natural manner and vertebrate genetic code as correspondence between DNA and amino-acids emerges naturally. This suggests that genetic code is realized at the level of dark hadron physics and living matter in the usual sense provides a secondary representation for it.

The hierarchy of Planck constants emerges from basic TGD under rather general assumptions. The key element is the huge vacuum degeneracy which implies that preferred non-vacuum extremals of Kähler action form a 4-D spin glass phase. The basic implications following from the extreme non-linearity of Kähler action is that normal derivatives of imbedding space coordinates at 3-D light-like orbits of partonic 2-surfaces and at space-like 3-surfaces at ends of CDs are many-valued functions of canonical momentum densities: this is one of the reasons that forced to develop physics as an infinite-D Kähler geometry vision instead of trying to develop path integral formalism or canonical quantization. A convenient manner to treat the situation is to introduce local many-sheeted covering of imbedding space such that the sheets are completely degenerate at partonic 2-surfaces. This leads in natural manner to the hierarchy of Planck constants as effective hierarchy hierarchy and integer multiples of Planck constants emerge naturally.

4. Living matter as conscious hologram is one of the basic ideas of TGD inspired biology and consciousness theory. The basic objection against TGD is that the interference of classical fields is impossible in the standard sense for the reason that that classical fields are not primary dynamical variables in TGD Universe. The resolution is based on the observation that only the interference of the effects caused by these fields can be observed experimentally and that many-sheeted space-time allows to realized the summation of effects in terms of multiple topological condensations of particles to several parallel space-time sheets. One concrete implication is fractality of qualia. Qualia appear in very wide range of scales: our qualia could in fact be those of magnetic body. The proposed mechanism for the generation of qualia realizes the fractality idea. The hologram idea has also rather abstract mathematical generalizations inspired by TGD. Infinite primes lead to the idea that each space-time point has a complex number theoretic anatomy and that one could see evolution also as evolution of this number theoretic anatomy. Quantum Mathematics replacing elements of number fields with Hilbert spaces characterizing their number theoretic anatomy is very similar idea and leads to holography also since one can replace the points of Hilbert spaces involved with Hilbert spaces repeatedly. In both cases this process is analogous to a repeated second quantization.

5. p-Adic physics can be identified as physics of cognition and intentionality. The hierarchy of p-adic length scales predicts a hierarchy of universal metabolic quanta as increments of zero point kinetic energies. Negentropic entanglement possible for number theoretic entanglement entropy makes sense for rational (and even algebraic) entanglement and leads to the identification of life as something residing in the intersection of real and p-adic worlds. NMP respects negentropic entanglement and the attractive idea is that the experience of understanding and positively colored emotions relate to negentropic entanglement. An attractive idea is that the negentropic entanglement can be assigned with magnetic flux tube and that ATP serves as a correlate for negentropic entanglement. This leads to a rather detailed ideas about the role of phosphate bond and provides interpretation for the fact that the number of valence bonds tend to be maximized in living matter. In a loose sense one could even call ATP a consciousness molecule.

6. The view about the function of brain differs from the standard view. The simplest option is that brain is builder of symbolic representations building percepts and giving them names rather than the seat of primary qualia relevant to our conscious experience. Sensory organs would carry our primary qualia and brain would build sensory percepts as standardized mental images by using virtual sensory input to the sensory organs. The new view about time is absolutely essential for circumventing the objections against this vision. The prediction is that also neuronal and even cell membranes define sensory maps with primary qualia assignable to the lipids serving as pixels of the sensory screen. These qualia would not however represent our qualia but lower level qualia. At this moment it is not possible to choose between thet two options. The role of EEG and its various counterparts at fractally scaled frequency ranges is to make possible communications to the various onion-like layers of the magnetic body and the control by magnetic body. Dark matter at these layers could be seen as the intentional agent and sensory perceiver.

In the following I briefly summarize some applications. I am of course forced to leave details to the books about TGD inspired theory of consciousness at my homepage [K88, K11, K62, K35, K10, K42, K46, K81].

The appendix of the book gives a summary about basic concepts of TGD with illustrations. There are concept maps about topics related to the contents of the chapter prepared using CMAP realized as html files. Links to all CMAP files can be found at `http://www.tgdtheory.fi/cmaphtml.html` [L35]. Pdf representation of same files serving as a kind of glossary can be found at `http://www.tgdtheory.fi/tgdglossary.pdf` [L36]. The topics relevant to this chapter are given by the following list.

- Magnetic body [L52]

- Basic Mechanisms associated with magnetic body [L39]

- Hierarchy of Planck constants [L50]

- Negentropy Maximization Principle [L54]

- Quantum model for nerve pulse [L62]

- Quantum model for sensory perception [L63]

- Quantum model for sensory receptor [L64]

- Quantum model of EEG [L65]

6.2 TGD based model for qualia and sensory receptors

The identification of quantum number increments in quantum jump for a subsystem representing sub-self and the capacitor model of sensory receptor are already more than decade old ideas.

The concrete realization of this vision is based on several ideas that I have developed during last five years.

1. The vision about dark matter as a hierarchy of phases partially labeled by the value of Planck constant led to the model of DNA as topological quantum computer [K23] . In this model magnetic flux tubes connecting DNA nucleotides with the lipids of the cell membrane define strands of the braids defining topological quantum computations. The braid strand corresponds to so called wormhole flux tube and has quark and antiquark at its ends. u and d quarks and their antiquarks code for four DNA nucleotides in this model.

2. Zero energy ontology assigns to elementary particles so called causal diamonds (CDs). For u and d quarks and electron these time scales are (6.5, .78, 100) ms respectively, and correspond to fundamental biorhythms. Electron time scale corresponds to 10 Hz fundamental biorhythm defining also the fundamental frequency of speech organs, .78 ms to kHz cortical synchrony [J69] , and 160 Hz to cerebellar synchrony [J75] . Elementary particles therefore seem to be directly associated with neural activity, language, and presumably also hearing. One outcome was the modification of the earlier model of memetic code involving the notion of cognitive neutrino pair by replacing the sequence of cognitive neutrino pairs with that of quark sub-CDs within electron CD. Nerve pulses could induce the magnetization direction of quark coding for bit but there are also other possibilities. The detailed implications for the model of nerve pulse [K66] remain to be disentangled.

3. The understanding of the Negentropy Maximization Principle [K49] and the role of negentropic entanglement in living matter together with the vision about life as something in the intersection of real and p-adic worlds was a dramatic step forward. In particular, space-like and time-like negentropic entanglement (see fig. `http://www.tgdtheory.fi/appfigures/cat.jpg` or fig. 21 in the appendix of this book) become basic aspects of conscious intelligence and are expected to be especially important for understanding the difference between speech and music.

4. One of the basic challenge has been to construct a quantitative model for cell membrane.

    (a) The first model was based on the assumption that long range weak forces however play a key role [K7]. They are made possible by the exotic ground state represented as almost vacuum extremal of Kähler action for which classical em and Z^0 fields are proportional to each other whereas for the standard ground state classical Z^0 fields are very weak. Neutrinos are present but it seems that they do not define cognitive or Boolean representations in the time scales characterizing neural activity. Electrons and quarks for which the time scales of causal diamonds correspond to fundamental biorhythms - one of the key observations during last years- take this role. The essential element is that the energies of the Josephson photons are in visible range. This would explain bio-photons and even why the frequencies assignable to visual receptors. The problem is that Weinberg angle must be assumed to be much smaller in the near vacuum extremal phase than in standard model.

    (b) Second model is based on Gerald Pollack's findings about fourth phase of water and exclusion zones [L38]. These zones inspire a model for pre-biotic cells. The outcome is a modification of the simplest model of Josephson junction. Besides resting potential also the difference between cyclotron energies between the two sides of the membrane plays a key role. This model allows to understand what happens in metabolism in terms of a quantum model replacing the thermodynamical model for cell membrane with its quantal "square root" inspired by Zero Energy Ontology. The model allows also to understand bio-photons as decay products of dark photons.

    (c) The success of the latter model does not of course mean that the weak forces could not be important in cell membrane scale and the realistic model could be a hybrid of these two models. The inclusion of Z^0 contribution to the effective magnetic field could also to the fact that the endogenous magnetic field deduced from Blackman's experiments is $B_{end} = 2B_E/5$ rather than B_E (Earth's magnetic field).

6.2.1 A general model of qualia and sensory receptor

The identification of sensory qualia in terms of quantum number increments and geometric qualia representing geometric and kinematic information in terms of moduli of CD, the assignment of sensory qualia with the membrane of sensory receptor, and capacitor model of qualia are basic ideas behind the model. The communication of sensory data to magnetic body using Josephson photons is also a key aspect of the model.

A general model of qualia

It is good to start by summarizing the general vision about sensory qualia and geometric qualia in TGD Universe.

1. The basic assumption is that sensory qualia correspond to increments of various quantum numbers in quantum jump. Standard model quantum numbers- color quantum numbers, electromagnetic charge and weak isospin, and spin are the most obvious candidates. Also cyclotron transitions changing the integer characterizing cyclotron state could corresponds to some kind of quale- perhaps 'a feeling of existence'. This could make sense for the qualia of the magnetic body.

2. Geometric qualia could correspond to the increments of zero modes characterizing the induced CP_2 Käjhler form of the partonic 2-surface and of the moduli characterizing the causal diamonds serving as geometric correlates of selves. This moduli space involves the position of CD and the relative position of tips as well as position in CP_2 and relative position of two CP_2 points assigned to the future and past boundaries of CD. There are good motivations for proposing that the relative positions are quantized. This gives as a special case the quantization of the scale of CD in powers of two. Position and orientation sense could would represent this kind of qualia. Also kinematical qualia like sensation of acceleration could

correspond to geometric qualia in generalized 4-D sense. For instance, the sensation about motion could be coded by Lorentz boots of sub-CD representing mental image about the object.

3. One can in principle distinguish between qualia assignable to the biological body (sensory receptors in particular) and magnetic body. The basic question is whether sensory qualia can be assigned only with the sensory receptors or with sensory pathways or with both. Geometric qualia might be assignable to the magnetic body and could provide third person perspective as a geometric and kinematical map of the body and its state of motion represented using the moduli space assignable to causal diamonds (CD). This map could be provided also by the body in which case the magnetic body would only share various mental images. The simplest starting assumption consistent with neuro-science is that sensory qualia are assigned with the cell membrane of sensory receptor and perhaps also with the neurons receiving data from it carried by Josephson radiation coding for the qualia and possibly partially regenerating them if the receiving neuron has same value of membrane potential as the sensory receptor when active. Note that during nerve pulse also this values of membrane potential is achieved for some time.

Could some sensory qualia correspond to the sensory qualia of the magnetic body?

Concerning the understanding of a detailed model for how sensory qualia are generated, the basic guideline comes from the notion of magnetic body and the idea that sensory data are communicated to the magnetic body as Josephson radiation associated with the cell membrane. This leaves two options: either the primary a sensory qualia are generated at the level of sensory receptor and the resulting mental images negentropically entangle with the "feeling of existence" type mental images at the magnetic body or they can be also generated at the level of the magnetic body by Josephson radiation -possibly as cyclotron transitions. The following arguments are to-be-or-not-to-be questions about whether the primary qualia must reside at the level of sensory receptors.

1. Cyclotron transitions for various cyclotron condensates of bosonic ions or Cooper pairs of fermionic ions or elementary particles are assigned with the motor actions of the magnetic body and Josephson frequencies with the communication of the sensory data. Therefore it would not be natural to assign qualia with cyclotron transitions. One the other hand, in zero energy ontology motor action can be regarded formally as a time reversed sensory perception, which suggests that cyclotron transitions correlated with the "feeling of existence" at magnetic body entangled with the sensory mental images. They could also code for the pitch of sound as will be found but this quale is strictly speaking also a geometric quale in the 4-D framework.

2. If Josephson radiation induces cyclotron transitions, the energy of Josephson radiation must correspond to that of cyclotron transition. This means very strong additional constraint not easy to satisfy except during nerve pulse when frequencies varying from about 10^{14} Hz down to kHz range are emitted the system remains Josephson contact. Cyclotron frequencies are also rather low in general, which requires that the value of $\hbar$ must be large in order to have cyclotron energy above the thermal threshold. This would however conform with the very beautiful dual interpretation of Josephson photons in terms of bio-photons and EEG. One expects that only high level qualia can correspond to a very large values of $\hbar$ needed.

   For the sake of completeness it should be noticed that one might do without large values of $\hbar$ if the carrier wave with frequency defined by the metabolic energy quantum assignable to the kicking and that the small modulation frequency corresponds to the cyclotron frequency. This would require that Josephson frequency corresponds to the frequency defined by the metabolic quantum. This is not consistent with the fact that very primitive organisms possess sensory systems.

3. If all primary qualia are assigned to the magnetic body, Josephson radiation must include also gluons and light counterparts of weak bosons are involved besides photons. This is quite a strong additional assumption and it will be found that the identification of sensory qualia in terms of quantum numbers of quark pair restricts them to the cell membrane. The coding of

qualia by Josephson frequencies is however possible and makes it possible to regenerate them in nervous system. The successful model explaining the peak frequencies of photoreceptors in terms of ionic cyclotron frequencies supports this view and provides a realization for an old idea about spectroscopy of consciousness which I had already been ready to give up.

Capacitor model of sensory qualia

In capacitor model of sensory receptor the increments of quantum numbers are amplified as particles with given quantum numbers flow between the plates of capacitor like system and the second plate defines the sub-self responsible for the mental image. The generation of complementary qualia assignable to the two plates and bringing in mind complementary colors is predicted. The capacitor is at the verge of di-electric breakdown. The interior and exterior of the receptor cell are the most plausible candidates for the capacitor plates with lipid layers defining the analog of di-electric able to changes its properties. Josephson currents generating Josephson radiation could communicate the sensory percept to the magnetic body but would not generate genuine sensory qualia there (the pitch of sound would be interpreted as a geometric quale). The coding is possible if the basic qualia correspond in one-one manner to ionic Josephson currents. There are sensory receptors which themselves do not fire (this is the case for hair cells for hearing and tactile receptor cells) and in this case the neuron next to the receptor in the sensory pathway would take the role of the quantum critical system.

The notion of sensory capacitor can be generalized. In zero energy ontology the plates could be effectively replaced with positive and negative energy parts of zero energy state or with cyclotron Bose-Einstein condensates corresponding to two different energies. Plates could also correspond to a pair of space-time sheets labeled by different p-adic primes and the generation of quale would correspond in this case to a flow of particles between the space-time sheets or magnetic flux tubes connected by contacts defining Josephson junctions.

The TGD inspired model for photoreceptors [K66] relies crucially on the assumption that sensory neurons at least and probably all cell membranes correspond to nearly vacuum extremals with the value of Weinberg angle equal to $sin^2(\theta_W) = .0295$ and weak bosons having Compton length of order cell size and ordinary value of Planck constant. This also explains the large parity breaking effects in living matter. The almost vacuum extremal property conforms with the vision about cell membrane as a quantum critical system ideal for acting as a sensory receptor.

6.2.2 Detailed model for the qualia

The proposed vision about qualia requires a lot of new physics provided by TGD. What leads to a highly unique proposal is the intriguing coincidence of fundamental elementary particle time scales with basic time scales of biology and neuro science and the model of DNA as topological quantum computer [K23] .

1. Zero energy ontology brings in the size scale of CD assignable to the field body of the elementary particle. Zero energy states with negentropic time-like entanglement between positive and negative energy parts of the state might provide a key piece of the puzzle. The negentropic entanglement (see fig. `http://www.tgdtheory.fi/appfigures/cat.jpg` or fig. 21 in the appendix of this book) beween positive energy parts of the states associated with the sub-CD assignable to the cell membrane and sub-CD at the magnetic body is expected to be an important factor.

2. For the standard value of $\hbar$ the basic prediction would be 1 ms second time scale of d quark, 6.5 ms time scale of u quark, and .1 second time scale of electron as basic characterizes of sensory experience if one accept the most recent estimates $m(u) = 2$ MeV and $m(d) = 5$ MeV for the quark masses [C1] . These time scales correspond to 10 Hz, 160 Hz, and 1280 Hz frequencies, which all characterize neural activity (for the identification of 160 Hz frequency as cerebellar resonance frequency see [J75]). Hence quarks could be the most interesting particles as far as qualia are considered and the first working hypothesis would be that the fundamental quantum number increments correspond to those for quark-anti-quark pair. The identification in terms of quantum numbers of single quark is inconsistent with the model of color qualia.

3. The model of DNA as topological quantum computer led to the proposal that DNA nucleotides are connected to the lipids of the cell membrane by magnetic flux tubes having quark and antiquark at its ends such that the u and d quarks and their antiquarks code for the four nucleotides. The outer lipid layer was also assumed to be connected by flux tubes to the nucleotide in some other cell or in cell itself.

4. The model for DNA as topological quantum computer did not completely specify whether the flux tubes are ordinary flux tubes or wormhole flux tubes with possibly opposite signs of energy assigned with the members of the flux tube pair. Although it is not necessary, one could assume that the quantum numbers of the two parallel flux tubes cancel each other so that wormhole flux tube would be characterized by quantum numbers of quark pairs at its ends. It is not even necessary to assume that the net quantum numbers of the flux tubes vanish. Color confinement however suggests that the color quantum at the opposite ends of the flux tube are of opposite sign.

    (a) The absence of a flux tube between lipid layers was interpreted as an isolation from external world during the topological quantum computation. The emergence of the flux tube connection means halting of topological quantum computation. The flux tube connection with the external world corresponds to sensory perception at the level of DNA nucleotide in consistency with the idea that DNA plays the role of the brain of cell [K75] . The total color quantum numbers at the ends of the flux tubes were assumed to sum up to zero. This means that the fusion of the flux tubes ending to the interior and exterior cell membrane to single one creates a flux tube state not localized inside cell and that the interior of cell carries net quantum numbers. The attractive interpretation is that this process represents the generation of quale of single nucleotide.

    (b) The formation of the flux tube connection between lipid layers would involve the transformation of both quark-antiquark pairs to an intermediate state. There would be no kinematic constraints on the process nor to the mass scales of quarks. A possible mechanism for the separation of the two quark-antiquark pairs associated with the lipids from the system is double reconnection of flux tubes which leads to a situation in which the quark-antiquark pairs associated with the lipid layers are connected by short flux loops and separated to a disjoint state and there is a long wormhole flux tube connecting the nucleotides possibly belonging to different cells.

    (c) The state of two quark pairs need not have vanishing quantum numbers and one possibility is that the quantum numbers of this state code for qualia. If the total numbers of flux tubes are vanishing also the net quantum numbers of the resulting long flux tube connecting two different cells provide equivalent coding. A stronger condition is that this state has vanishing net quantum numbers and in this case the ends of the long flux tube would carry opposite quantum numbers. The end of flux tube at DNA nucleotide would characterize the quale.

5. Two identification of primary qualia are therefore possible.

    (a) If the flux tubes have vanishing net quantum numbers, the primary sensory quale can be assigned to single receptor cell and the flow of the quantum numbers corresponds to the extension of the system with vanishing net quantum numbers in two-cell system.

    (b) If the net quantum numbers of the flux tube need not vanish, the resulting two cell system carries non-vanishing quantum numbers as the pair of quark-antiquark pairs removes net quantum numbers out of the system.

6. If the net quantum numbers for the flux tubes vanish always, the specialization of the sensory receptor membrane to produce a specific quale would correspond to an assignment of specific quantum numbers at the DNA ends of the wormhole flux tubes attached to the lipid layers of the cell membrane. The simplest possibility that one can imagine is that the outer lipid layer is connected to the conjugate DNA nucleotide inside same cell nucleus. This option would however assign vanishing net quantum number increments to the cell as whole and is therefore unacceptable.

7. The formation of a temporary flux tube connection with another cell is necessary during the generation of quale and the question is what kind of cell is in question. The connection of the receptor to cells along the sensory pathway are expected to be present along the entire sensory pathway from DNA nucleotide to a nucleotide in the conjugate strand of second neuron to DNA nucleotide of the third neutron.... If Josephson photons are able to regenerate the quale in second neuron this would make it possible to replicate the quale along entire sensory pathway. The problem is that Josephson radiation has polarization orthogonal to axons and must propagate along the axon whereas the flux tube connection must be orthogonal to axon. Hence the temporary flux tube connection is most naturally between receptor cells and would mean horizontal integration of receptor cells to a larger structure. A holistic process in directions parallel and orthogonal to the sensory pathway would be in question. Of course, the flux tube could be also curved and connect the receptor to the next neuron along the sensory pathway.

8. The specialization of the neuron to sensory receptor would require in the framework of positive energy ontology that -as far as qualia assignable to the electro-weak quantum numbers are considered - all DNA nucleotides are identical by the corresponds of nucleotides with quarks and antiquarks. This cannot be the case. In zero energy ontology and for wormhole flux tubes it is however enough to assume that the net electroweak quantum numbers for the quark antiquark pairs assignable to the DNA wormhole contact are same for all nucleotides. This condition is easy to satisfy. It must be however emphasized that there is no reason to require that all nucleotides involved generate same quale and at the level of neurons sensory maps assigning different qualia to different nucleotides and lipids allowing DNA to sensorily perceive the external world are possible.

The model should be consistent with the assignment of the fundamental bio-rhythms with the CDs of electron and quarks.

1. Quark color should be free in long enough scales and cellular length scales are required at least. The QCD in question should therefore have long enough confinement length scales. The first possibility is provided by almost vacuum extremals with a long confinement scale also at the flux tubes. Large $\hbar$ for the cell membrane space-time sheet seems to be unavoidable and suggests that color is free in much longer length scale than cell length scale.

2. Since the length of the flux tubes connecting DNA and cell membrane is roughly 1 micrometer and by a factor of order 10^7 longer than the d quark Compton length, it seems that the value of Planck constant must be of this order for the flux tubes. This however scales up the time scale of d quark CD by a factor of 10^{14} to about 10^4 years! The millisecond and 160 ms time scales are much more attractive. This forces to ask what happens to the quark-anti-quark pairs at the ends of the tubes.

3. The only possibility seems to be that the reconnection process involves a phase transition in which the closed flux tube structure containing the two quark pairs assignable to the wormhole contacts at lipid layers is formed and leaks to the page of the Big Book with pages partially labeled by the values of Planck constant. This page would correspond to the standard value of Planck constant so that the corresponding d quark CDs would have a duration of millisecond. The reconnection leading to the ordinary situation would take place after millisecond time scale. The standard physics interpretation would be as a quantum fluctuation having this duration. This sequence of quark sub-CDs could define what might be called memetic codon representation of the nerve pulse sequence.

4. One can also consider the possibility is that near vacuum extremals give rise to a copy of hadron physics for which the quarks associated with the flux tubes are light. The Gaussian Mersennes corresponding to $k = 151, 157, 163, 167$ define excellent p-adic time scales for quarks and light variants of weak gauge bosons. Quark mass 5 MeV would with $k = 120$ would be replaced with $k = 163$ (167) one would have mass 1.77 eV (.44 eV). Small scaling of both masses gives 2 eV and .5 eV which correspond to basic metabolic quanta in TGD framework. For quark mass of 2 MeV with $k = 123$ $k = 163$ (167) one would give masses .8

eV (.05 eV). The latter scale correspond to Josephson energy assignable with the membrane potential in the ordinary phase.

In this case a phase transition transforming almost vacuum extremal to ordinary one takes place. What this would mean that the vacuum extremal property would hold true below much shorter p-adic length scale. In zero energy ontology the scaling up of quark masses is in principle possible. This option looks however too artificial.

6.2.3 Overall view about qualia

This picture leads to the following overall view about qualia. There are two options depending on whether single quark-antiquark pair or two of them labels the qualia. In the following only the simpler option with single quark-antiquark pair is discussed.

1. All possible pairings of spin and electroweak isospin (or em charge) define 16 basic combinations if one assumes color singletness. If arbitrary color is allowed, there is a nine-fold increase of quantum numbers decomposable to color singlet and octet qualia and further into 3×15 qualia with vanishing increments of color quantum numbers and 6×16 qualia with non-vanishing increments of color quantum numbers. The qualia with vanishing increments for electroweak quantum numbers could correspond to visual colors. If electroweak quantum numbers of the quark-anti-quark pair vanish, one has 3×7 *resp.* 6×8 combinations of colorless *resp.* colored qualia.

2. There is a huge number of various combinations of these fundamental qualia if one assumes that each nucleotide defines its own quale and fundamental qualia would be analogous to constant functions and more general qualia to general functions having values in the space with $9 \times 16 - 1$ points. Only a very small fraction of all possible qualia could be realized in living matter unless the neurons in brain provide representations of body parts or of external world in terms of qualia assignable to lipid-nucleotide pairs. The passive DNA strand would be ideal in this respect.

3. The basic classification of qualia is as color qualia, electro-weak quale, and spin quale and products of these qualia. Also combinations of color qualia and and electroweak and spin quale are possible and could define exotic sensory qualia perhaps not yet realized in the evolution. Synesthesia is usually explained in terms of sensory leakage between sensory pathways and this explanation makes sense also in TGD framework if there exists a feedback from the brain to the sensory organ. Synesthesia cannot however correspond to the product qualia: for "quantum synesthesia" cross association works in both directions and this distinguishes it from the ordinary synesthesia.

4. The idea about brain and genome as holograms encourages to ask whether neurons or equivalently DNA could correspond to sensory maps with individual lipids representing qualia combinations assignable to the points of the perceptive field. In this framework quantum synesthesia would correspond to the binding of qualia of single nucleotide (or lipid) of neuron cell membrane as a sensory representation of the external world. DNA is indeed a holographic representation of the body (gene expression of course restricts the representation to a part of organism). Perhaps it is this kind of representation also at the level of sensory experience so that all neurons could be little sensory copies of body parts as holographic quantum homunculi. In particular, in the associative areas of the cortex neurons would be quantum synesthetes experiencing the world in terms of composite qualia.

5. The number of flux tube connections generated by sensory input would code for the intensity of the quale. Josephson radiation would do the same at the level of communications to the magnetic body. Also the temporal pattern of the sequence of quale mental images matters. In the case of hearing this would code for the rhythmic aspects and pitch of the sound.

6.2.4 About detailed identification of the qualia

One can make also guesses about detailed correspondence between qualia and quantum number increments.

1. Visual colors would correspond to the increments of only color quantum numbers. Each biologically important ion would correspond to its own color increment in one-one correspondence with the three pairs of color-charged gluons and these would correspond to blue-yellow, red-green, and black white [K66] . Black-white vision would mean a restriction to the $SU(2)$ subgroup of color group. The model for the cell membrane as a nearly vacuum extremal assigns the peak frequencies corresponding to fundamental colors with biologically important ions. Josephson radiation could induce artificially the same color qualia in other neurons and this might provide an manner to communicate the qualia to the brain where they could be re-experienced at neuronal level. Some organisms are able to perceive also the polarization of light. This requires receptors sensitive to polarization. The spin of quark pair would naturally code for polarization quale.

2. Also tastes and odours define qualia with "colors". Certainly the increments of electroweak numbers are involved but since these qualia do not have any directional flavor, spin is probably not involved. This would give c 3×4 basic combinations are possible and can certainly explain the 5 or 6 basic tastes (counted as the number of different receptors). Whether there is a finite number of odours or not has been a subject of a continual debate and it might be that odours already correspond to a distribution of primary qualia for the receptor cell. That odours are coded by nerve pulse patterns for a group of neurons [J127] would conform with this picture.

3. Hearing seems to represent a rather colorless quale so that electroweak isospin suggests again itself. If we had a need to hear transversely polarized sound also spin would be involved. Cilia are involved also with hair cells acting as sensory receptors in the auditory system and vestibular system. In the case of hearing the receptor itself does not fire but induces a firing of the higher level neuron. The temporal pattern of qualia mental images could define the pitch of the sound whereas the intensity would correspond to the number of flux tube connections generated.

   The modulation of Josephson frequencies -rather than Josephson frequencies as such- would code for the pitch and the total intensity of the Josephson radiation for the intensity of the sound and in fact any quale. Pitch represents non-local information and the qualia sub-selves should be negentropically entangled in time direction. If not, the experience corresponds to a sequence of sound pulses with no well-defined pitch and responsible for the rhythmic aspects of music. Right brain sings-left brain talks metaphor would suggests that right and left brain have different kind of specializations already at the level of sensory receptors.

4. Somato-sensory system gives rise to tactile qualia like pain, touch, temperature, proprioception (body position). There are several kinds of receptors: nocireceptors, mechanoreceptors, thermoreceptors, etc... Many of these qualia have also emotional coloring and it might be that the character of entanglement involved (negentropic/entropic defines the emotional color of the quale. If this is the case, one might consider a pure quale of touch as something analogous to hearing quale. One can argue that directionality is basic aspect of some of these qualia -say sense of touch- so that spin could be involved besides electroweak quantum numbers. The distribution of these qualia for the receptor neuron might distinguish between different tactile qualia.

6.3   Could cell membrane correspond to almost vacuum extremal?

The question whether cell membrane or even cell could correspond almost vacuum extremal of Kähler action (in some cases) was the question which led to the realization that the frequencies of peak sensitivity for photoreceptors correspond to the Josephson frequencies of biologically important ions if one accepts that the value of the Weinberg angle equals to $sin^2(\theta_W) = .0295$ instead of the value .23 in the normal phase, in which the classical electromagnetic field is proportional to the induced Kähler form of CP_2 in a good approximation. Another implication made possible by the large value of Planck constant is the identification of Josephson photons as the counterparts

of bio-photons one one hand and those of EEG photons on the other hand. These observation in turn led to a detailed model of sensory qualia and of sensory receptor. Therefore the core of this argument deserves to be represented also here although it has been discussed in [K66] .

6.3.1 Cell membrane as almost vacuum extremal

Although the fundamental role of vacuum extremals for quantum criticality and life has been obvious from the beginning, it took a long time to realize how one could model living cell as this kind of system.

1. Classical electric fields are in a fundamental role in biochemistry and living biosystems are typically electrets containing regions of spontaneous electric polarization. Fröhlich [J104] proposed that oriented electric dipoles form macroscopic quantum systems with polarization density serving as a macroscopic order parameter. Several theories of consciousness share this hypothesis. Experimentally this hypothesis has not been verified.

2. TGD suggests much more profound role for the unique di-electric properties of the biosystems. The presence of strong electric dipole fields is a necessary prerequisite for cognition and life and could even force the emergence of life. Strong electric fields imply also the presence of the charged wormhole BE condensates: the surface density of the charged wormholes on the boundary is essentially equal to the normal component of the electric field so that wormholes are in some sense 'square root' of the dipole condensate of Fröhlich! Wormholes make also possible pure vacuum polarization type dipole fields: in this case the magnitudes of the em field at the two space-time sheets involved are same whereas the directions of the fields are opposite. The splitting of wormhole contacts creates fermion pairs which might be interpreted as cognitive fermion pairs. Also microtubules carry strong longitudinal electric fields. This formulation emerged much before the identification of ordinary gauge bosons and their superpartners as wormhole contacts.

Cell membrane is the basic example about electret and one of the basic mysteries of cell biology is the resting potential of the living cell. Living cell membranes carry huge electric fields: something like 10^7 Volts per meter. For neuron resting potential corresponds to about .07 eV energy gained when unit charge travels through the membrane potential. In TGD framework it is not at all clear whether the presence of strong electromagnetic field necessitates the presence of strong Kähler field. The extremely strong electric field associated with the cell membrane is not easily understood in Maxwell's theory and almost vacuum extremal property could change the situation completely in TGD framework.

1. The configuration could be a small deformation of vacuum extremal so that the system would be highly critical as one indeed expects on basis of the general visiona about living matter as a quantum critical system. For vacuum extremals classical em and Z^0 fields would be proportional to each other. The second half of Maxwell's equations is not in general satisfied in TGD Universe and one cannot exclude the presence of vacuum charge densities in which case elementary particles as the sources of the field would not be necessarily. If one assumes that this is the case approximately, the presence of Z^0 charges creating the classical Z^0 fields is implied. Neutrinos are the most candidates for the carrier of Z^0 charge. Also nuclei could feed their weak gauge fluxes to almost non-vacuum extremals but not atomic electrons since this would lead to dramatic deviations from atomic physics. This would mean that weak bosons would be light in this phase and also Weinberg angle could have a non-standard value.

2. There are also space-time surfaces for CP_2 projection belongs to homologically non-trivial geodesic sphere. In this case classical Z^0 field can vanish [L9] , [L9] and the vision has been that it is sensible to speak about two basic configurations.

   (a) Almost vacuum extremals (homologically trivial geodesic sphere).

   (b) Small deformations of non-vacuum extremals for which the gauge field has pure gauge Z^0 component (homologically non-trivial geodesic sphere).

The latter space-time surfaces are excellent candidates for configurations identifiable as TGD counterparts of standard electroweak physics. Note however that the charged part of electroweak fields is present for them.

3. To see whether the latter configurations are really possible one must understand how the gauge fields are affected in the color rotation.

   (a) The action of color rotations in the holonomy algebra of CP_2 is non-trivial and corresponds to the action in $U(2)$ sub-group of $SU(3)$ mapped to $SU(2)_L \times U(1)$. Since the induced color gauge field is proportional to Kähler form, the holonomy is necessary Abelian so that also the representation of color rotations as a sub-group of electro-weak group must correspond to a local $U(1)$ sub-group local with respect to CP_2 point.

   (b) Kähler form remains certainly invariant under color group and the right handed part of Z^0 field reducing to $U(1)_R$ sub-algebra should experience a mere Abelian gauge transformation. Also the left handed part of weak fields should experience a local $U(1)_L$ gauge rotation acting on the neutral left handed part of Z^0 in the same manner as it acts on the right handed part. This is true if the $U(1)_L$ sub-group does not depend on point of CP_2 and corresponds to Z^0 charge. If only Z^0 part of the induced gauge field is non-vanishing as it can be for vacuum extremals then color rotations cannot change the situation. If Z^0 part vanishes and non-vacuum extremal is in question, then color rotation rotation of W components mixing them but acts as a pure $U(1)$ gauge transformation on the left handed component.

   (c) It might not be without importance that for any partonic 2-surface induced electro-weak gauge fields have always U(1) holonomy, which could allow to define what neutral part of induced electroweak gauge field means locally. This does not however hold true for the 4-D tangent space distribution. In any case, the cautious conclusion is that there are two phases corresponding to nearly vacuum extremals and small deformations of extremals corresponding to homologically non-trivial geodesic spheres for which the neutral part of the classical electro-weak gauge field reduces to photon field.

4. The unavoidable presence of long range Z^0 fields would explain large parity breaking in living matter, and the fact that neutrino Compton length is of the order of cell size would suggest the possibility that within neutrino Compton electro-weak gauge fields or even longer scales could behave like massless fields. The explanation would be in terms of the different ground state characterized also by a different value of Weinberg angle. For instance, of the p-adic temperature of weak bosons corresponds to $T_p = 1/2$, the mass scale would be multiplied by a factor $\sqrt{M_{89}}$ and Compton lengths of weak bosons would be around 10^{-4} meters corresponding to the size scale of a large neuron. If the value of Planck constant is also large then the Compton length increases to astrophysical scale.

5. From the equations for classical induced gauge fields in terms of Kähler form and classical Z^0 field [L9] , [L9]

$$\gamma = 3J - \frac{p}{2}Z^0 \quad , \quad Q_Z = I_L^3 - pQ_{em} \quad , \quad p = sin^2(\theta_W) \tag{6.3.1}$$

it follows that for the vacuum extremals the part of the classical electro-weak force proportional to the electromagnetic charge vanishes for $p = 0$ so that only the left-handed couplings to the weak gauge bosons remain. The absence of electroweak symmetry breaking and vanishing or at least smallness of p would make sense below the Compton length of dark weak bosons. If this picture makes sense it has also implications for astrophysics and cosmology since small deformations of vacuum extremals are assumed to define the interesting extremals. Dark matter hierarchy might explain the presence of unavoidable long ranged Z^0 fields as being due to dark matter with arbitrarily large values of Planck constant so that various elementary particle Compton lengths are very long.

6. The simplest option is that the dark matter -say quarks with Compton lengths of order cell size and Planck constant of order $10^7 \hbar_0$ - are responsible for dark weak fields making almost vacuum extremal property possible. The condition that Josephson photons correspond to EEG frequencies implys $\hbar \sim 10^{13} \hbar_0$ and would mean the scaling of intermediate gauge boson Compton length to that corresponding to the size scale of a larger neuron. The quarks involved with with DNA as topological quantum computer model could be in question and membrane potential might be assignable to the magnetic flux tubes. The ordinary ionic currents through cell membrane -having no coupling to classical Z^0 fields and not acting as its sourse- would be accompanied by compensating currents of dark fermions taking care that the almost vacuum extremal property is preserved. The outcome would be large parity breaking effects in cell scale from the left handed couplings of dark quarks and leptons to the classical Z^0 field. The flow of Na^+ ions during nerve pulse could take along same dark flux tube as the flow of dark quarks and leptons. This near vacuum extremal property might be fundamental property of living matter at dark space-time sheets at least.

Could nuclei and neutrinos couple to light variants of weak gauge fields in the critical phase?

One of the hard-to-kill ideas of quantum TGD inspired model of quantum biology is that neutrinos might have something do with hearing and cognition. This proposal looks however unrealistic in the recent vision. I would be more than happy to get rid of bio-neutrinos but the following intriguing finding does not allow me to have this luxury.

1. Assume that the endogenous magnetic field $B_{end} = .2$ Gauss is associated with a nearly vacuum extremal and therefore accompanied by $B_Z = 2B_{end}/p$. Assume for definiteness $m_\nu = .3$ eV and $p = sin^2(\theta_W) = .23$. The neutrino cyclotron frequency is given by the following expression

$$f_\nu = \frac{m_e}{m_\nu} \frac{1}{2 sin^2(\theta_W)} f_e \ .$$

From $f_e \simeq .57 \times$ MHz and $p = sin^2(\theta_W) = .23$ one obtains $E_\nu = 1.7 \times 10^{-2}$ eV, which is roughly one third to the Josephson frequency of electron assignable to cell membrane. Could Josephson frequency of cell membrane excite neutrino cyclotron transitions?

2. The model for photoreceptors to be discussed below forces to conlude that the value of Weinberg angle in the phase near vacuum extremal must be $p = .0295$ if one wants to reproduces the peak energies of photoreceptors as Josephson frequencies of basic biological ions. This would predict $E_\nu = .41$ eV, which is rather near to the metabolic energy quantum. The non-relativistic formula however fails in this case and one must use the relativistic formula giving

$$E = \sqrt{g_Z Q_Z B_Z 2\pi} \simeq .48 \ eV$$

giving the metabolic energy quantum. Does this mean that Z^0 cyclotron frequency for neutrino is related to the transfer of metabolic energy using Z^0 MEs in the phase near vacuum extremals.

3. Josephson frequency is proportional to $1/\hbar$, whereas neutrino cyclotron frequency does not depend on $\hbar$ at non-relativistic energies. For larger values of $\hbar$ the neutrino becomes relativistic so that the mass in the formula for cyclotron frequency must be replaced with energy. This gives
$$E = \sqrt{n} r^{1/2} \sqrt{g_Z Q_Z B_Z 2\pi} \simeq r^{1/2} \times .48 \ eV \ , \ \ r = \sqrt{\hbar/\hbar_0} \ .$$

Here n refers to the cyclotron harmonic.

These observations raise the question whether the three frequencies with maximum response assignable to the three different types of receptors of visible light in retina could correspond to the three cyclotron frequencies assignable to the three neutrinos with different mass scales? The first

objection is that the dependence on mass disappears completely at the relativistic limit. The second objection is that the required value value of Planck constant is rather small and far from being enough to have electroweak boson Compton length of order cell size. One can of course ask whether the electroweak gauge bosons are actually massless inside almost vacuum extremals. If fermions -including neutrino- receive their masses from p-adic thermodynamics then massless electroweak gauge bosons would be consistent with massive fermions. Vacuum extremals are indeed analogous to the unstable extrema of Higgs potential at which the Higgs vacuum expecation vanishes so that this interpretation might make sense.

Ionic Josephson frequencies defined by the resting potential for nearly vacuum extremals

If cell membrane corresponds to an almost vacuum extremal, the membrane potential potential is replaced with an effective resting potential containing also the Z^0 contribution proportional to the ordinary resting potential. The surprising outcome is that one could understand the preferred frequencies for photo-receptors [J18] as Josephson frequencies for biologically important ions. Furthermore, most Josephson energies are in visible and UV range and the interpretation in terms of bio-photons is suggestive. If the value of Planck constant is large enough Josephson frequencies are in EEG frequency range so that bio-photons and EEG photons could be both related to Josephson photons with large $\hbar$.

1. One must assume that the interior of the cell corresponds to many fermion state -either a state filled with neutrinos up to Fermi energy or Bose-Einstein condensate of neutrino Cooper pairs creating a harmonic oscillator potential. The generalization of nuclear harmonic oscillator model so that it applies to multi-neutrino state looks natural.

2. For exact vacuum extremals elementary fermions couple only via left-handed isospin to the classical Z^0 field whereas the coupling to classical em field vanishes. Both K_+, Na_+, and Cl_- $A - Z = Z + 1$ so that by p-n pairing inside nucleus they have the weak isospin of neuron (opposite to that of neutrino) whereas Ca_{++} nucleus has a vanishing weak isospin. This might relate to the very special role of Ca_{++} ions in biology. For instance, Ca_{++} defines an action potential lasting a time of order .1 seconds whereas Na_+ defines a pulse lasting for about 1 millisecond [J2] . These time scales might relate to the time scales of CDs associated with quarks and electron.

3. The basic question is whether only nuclei couple to the classical Z^0 field or whether also electrons do so. If not, then nuclei have a large effective vector coupling to em field coming from Z^0 coupling proportional to the nuclear charge increasing the value of effective membrane potential by a factor of order 100. If both electrons and nuclei couple to the classical Z^0 field, one ends up with difficulties with atomic physics. If only quarks couple to the Z^0 field and one has $Z^0 = -2\gamma/p$ for vacuum extremals, and one uses average vectorial coupling $\langle I_L^3 \rangle = \pm 1/4$ with + for proton and - for neutron, the resulting vector coupling is following

$$
\begin{aligned}
(\frac{Z - N}{4} - pZ)Z^0 + q_{em}\gamma &= Q_{eff}\gamma \ , \\
Q_{eff} &= -\frac{Z - N}{2p} + 2Z + q_{em} \ .
\end{aligned}
\tag{6.3.2}
$$

Here γ denotes em gauge potential. For K^+, Cl^-, Na^+, Ca^{++} one has $Z = (19, 17, 11, 20)$, $Z - N = (-1, -1, -1, 0)$, and $q_{em} = (1, -1, 1, 2)$. Table 1 below gives the values of Josephson energies for some values of resting potential for $p = .23$. Rather remarkably, they are in IR or visible range. This is basically due to the large value of weak isospin for nuclei.

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$E(Ion)/eV$	$V = -40\ mV$	$V = -60\ mV$	$V = -70\ mV$
Na^+	1.01	1.51	1.76
Cl^-	1.40	2.11	2.46
K^+	1.64	2.47	2.88
Ca^{++}	1.68	2.52	2.94

Table 1. Values of the Josephson energy of cell membrane for some values of the membrane voltage for $p = .23$. The value $V = -40$ mV corresponds to the resting potential for photoreceptors and $V = -70$ mV to the resting state of a typical neuron.

6.3.2 Are photoreceptors nearly vacuum extremals?

In Hodgkin-Huxley model ionic currents are Ohmian currents. If one accepts the idea that the cell membrane acts as a Josephson junction, there are also non-dissipative oscillatory Josephson currents of ions present, which run also during flow equilibrium for the ionic parts of the currents. A more radical possibility is that that the dominating parts of the ionic currents are oscillatory Josephson currents so that no metabolic energy would be needed to take care that density gradients for ions are preserved. Also in this case both nearly vacuum extremals and extremals with nearly vanishing Z^0 field can be considered. Since sensory receptors must be highly critical the natural question is whether they could correspond to nearly vacuum extremals. The quantitative success of the following model for photoreceptors supports this idea.

Photoreceptors can be classified to three kinds of cones responsible for color vision and rods responsible for black-white vision. The peak sensitivities of cones correspond to wavelengths (405, 535, 565) nm and energies (3.06, 2.32, 2.19) eV. The maximum absorption occurs in the wave length range 420-440 nm, 534-545 nm, 564-580 nm for cones responsible for color vision and 498 nm for rods responsible black-white vision [J5, J18] . The corresponding photon energies are (2.95, 2.32, 2.20) eV for color vision and to 2.49 eV for black-white vision. For frequency distribution the maxima are shifted from these since the maximum condition becomes $dI/d\lambda + 2I/\lambda = 0$, which means a shift to a larger value of λ, which is largest for smallest λ. Hence the energies for maximum absorbance are actually lower and the downwards shift is largest for the highest energy.

From Table 1 above it is clear that the energies of Josephson photons are in visible range for reasonable values of membrane voltages, which raises the question whether Josephson currents of nuclei in the classical em and Z^0 fields of the cell membrane could relate to vision.

Consider first the construction of the model.

1. Na^+ and Ca^{++} currents are known to present during the activation of the photoreceptors. Na^+ current defines the so called dark current [J18] reducing the membrane resting potential below its normal value and might relate to the sensation of darkness as eyes are closed. Hodgkin-Huxley model predicts that also K^+ current is present. Therefore the Josephson energies of these three ion currents are the most plausible correlates for the three colors.

2. One ends up with the model in the following manner. For Ca^{++} the Josephson frequency does not depend on p and requiring that this energy corresponds to the energy 2.32 eV of maximal sensitivity for cones sensitive to green light fixes the value of the membrane potential during hyper-polarization to $V = .055$ V, which is quite reasonable value. The value of the Weinberg angle parameter can be fixed from the condition that other peak energies are reproduced optimally. The result of $p = .0295$.

The predictions of the model come as follows summarized also by the Table 2 below.

1. The resting potential for photoreceptors is $V = -40$ mV [J22] . In this case all Josephson energies are below the range of visible frequencies for $p = .23$. Also for maximal hyper-polarization Na^+ Josephson energy is below the visible range for this value of Weinberg angle.

2. For $V = -40$ mV and $p = .0295$ required by the model the energies of Cl^- and K^+ Josephson photons correspond to red light. 2 eV for Cl^- corresponds to a basic metabolic quantum. For Na^+ and Ca^{++} the wave length is below the visible range. Na^+ Josephson energy is

below visible range. This conforms with the interpretation of Na^+ current as a counterpart for the sensation of darkness.

3. For $V = -55$ mV - the threshold for the nerve pulse generation- and for $p = .0295$ the Josephson energies of Na^+, Ca^{++}, and K^+ a correspond to the peak energies for cones sensitive to red, green, and blue respectively. Also Cl^- is in the blue region. Ca^{++} Josephson energy can be identified as the peak energy for rods. The increase of the hyper-polarization to $V = -59$ mV reproduces the energy of the maximal wave length response exactly. A possible interpretation is that around the criticality for the generation of the action potential ($V \simeq -55$ mV) the qualia would be generated most intensely since the Josephson currents would be strongest and induce Josephson radiation inducing the quale in other neurons of the visual pathway at the verge for the generation of action potential. This supports the earlier idea that visual pathways defines a neural window. Josephson radiation could be interpreted as giving rise to bio-photons (energy scale is correct) and to EEG photons (for large enough values of $\hbar$ the frequency scales is that of EEG).

4. In a very bright illumination the hyper-polarization is $V = -65$ mV [J22] , which the normal value of resting potential. For this voltage Josephson energies are predicted to be in UV region except in case of Ca^{++}. This would suggests that only the quale 'white' is generated at the level of sensory receptor: very intense light is indeed experienced as white.

The model reproduces basic facts about vision assuming that one accepts the small value of Weinberg angle, which is indeed a natural assumption since vacuum extremals are analogous to the unstable extrema of Higgs potential and should correspond to small Weinberg angle. It deserves to be noticed that neutrino Josephson energy is 2 eV for $V = -50$ mV, which correspond to color red. 2 eV energy defines an important metabolic quantum.

Ion	Na^+	Cl^-	K^+	Ca^{++}
$E_J(.04\ mV, p = .23)/eV$	1.01	1.40	1.51	1.76
$E_J(.065\ V, p = .23)/eV$	1.64	2.29	2.69	2.73
$E_J(40\ mV, p = .0295)/eV$	1.60	2.00	2.23	1.68
$E_J(50\ mV, p = .0295)/eV$	2.00	2.49	2.79	2.10
$E_J(55\ mV, p = .0295)/eV$	2.20	2.74	3.07	2.31
$E_J(65\ mV, p = .0295)/eV$	2.60	3.25	3.64	2.73
$E_J(70\ mV, p = .0295)/eV$	2.80	3.50	3.92	2.94
$E_J(75\ mV, p = .0295)/eV$	3.00	3.75	4.20	3.15
$E_J(80\ mV, p = .0295)/eV$	3.20	4.00	4.48	3.36
$E_J(90\ mV, p = .0295)/eV$	3.60	4.50	5.04	3.78
$E_J(95\ mV, p = .0295)/eV$	3.80	4.75	5.32	3.99
Color	R	G	B	W
E_{max}	2.19	2.32	3.06	2.49
energy-interval/eV	1.77-2.48	1.97-2.76	2.48-3.10	

Table 2. The table gives the prediction of the model of photoreceptor for the Josephson energies for typical values of the membrane potential. For comparison purposes the energies E_{max} corresponding to peak sensitivities of rods and cones, and absorption ranges for rods are also given. R,G,B,W refers to red, green, blue, white. The values of Weinberg angle parameter $p = sin^2(\theta_W)$ are assumed to be .23 and .0295. The latter value is forced by the fit of Josephson energies to the known peak energies if one allows that ions - rather than their Cooper pairs - are charge carriers.

It interesting to try to interpret the resting potentials of various cells in this framework in terms of the Josephson frequencies of various ions.

1. The maximum value of the action potential is +40 mV so that Josephson frequencies are same as for the resting state of photoreceptor. Note that the time scale for nerve pulse is so slow as compared to the frequency of visible photons that one can consider that the neuronal membrane is in a state analogous to that of a photoreceptor.

2. For neurons the value of the resting potential is -70 mV. Na^+ and Ca^{++} Josephson energies 2.80 eV and 2.94 eV are in the visible range in this case and correspond to blue light. This does not mean that Ca^{++} Josephson currents are present and generate sensation of blue at neuronal level: the quale possibly generated should depend on sensory pathway. During the hyper-polarization period with -75 mV the situation is not considerably different.

3. The value of the resting potential is -95 mV for skeletal muscle cells. In this case Ca^{++} Josephson frequency corresponds to 4 eV metabolic energy quantum as the table below shows.

4. For smooth muscle cells the value of resting potential is -50 mV. In this case Na^+ Josephson frequency corresponds to 2 eV metabolic energy quantum.

5. For astroglia the value of the resting potential is -80/-90 mV for astroglia. For -80 mV the resting potential for Cl^- corresponds to 4 eV metabolic energy quantum. This suggests that glial cells could also provide metabolic energy as Josephson radiation to neurons.

6. For all other neurons except photo-receptors and red blood cells Josephson photons are in visible and UV range and the natural interpretation would be as bio-photons. The bio-photons detected outside body could represent sensory leakage. An interesting question is whether the IR Josephson frequencies could make possible some kind of IR vision.

To sum up, the basic criticism against the model is that the value of Weinberg angle must be by a factor of 1/10 smaller than the standard model value, and at this moment it is difficult to say anything about its value for nearly vacuum extremals.

A possible cure could be that the voltage is not same for different ions. This is possible since at microscopic level the Josephson junctions correspond to transmembrane proteins acting as channels and pumps. The membrane potential through receptor protein is different for color receptors. For this option one would have the correspondences

$Na^+ \leftrightarrow 2.19$ eV (R) and $eV = 86.8$ eV,
$Cl^- \leftrightarrow 2.32$ eV (G) and $eV = 65.8$ eV,
$K^+ \leftrightarrow 2.49$ eV (W) and $eV = 60.2$ eV,
$Ca^{++} \leftrightarrow 3.06$ eV (B) and $eV = 67.3$ meV.

For Na^+ the value of the membrane potential is suspiciously large.

It is interesting to look what happens when the model is generalized so that Josephson energy includes the difference of cyclotron energies at the two sides of the cell membrane and Weinberg angle has its standard model value.

1. Consider first *near to vacuum extremals*. In the formula for cyclotron frequencies in the effective magnetic field the factor Z/A in the formula of is replaced with

$$\frac{\frac{N-Z}{2p} + 2Z + q_{em}}{A} \ ,$$

which is not far from unity so that the cyclotron frequency would be near to that for proton for all ions. Also neutral atoms would experience classical and magnetic Z^0 fields. Cyclotron frequency would be almost particle independent so that cyclotron contribution gives an almost constant shift to the generalized Josephson energy. When the difference of cyclotron energies vanishes, the model reduces to that discussed above.

The weak independence of the cyclotron frequency on particle properties does not conform with the idea that EEG bands correspond to bosonic ions or Cooper pairs of fermionic ions.

2. For *far from vacuum extremals* the proportionality of cyclotron energy to h_{eff} and B_{end} allows easy reproduction the energies for which photon absorption is maximal if one allows the cyclotron energies to differ at the two sides of the membrane for sensory receptors.

A remark about decade later: The model just discussed neglects the fact that superconductivity requires that Cooper pairs of fermionic ions are present unless one assumes that the nuclei are bosonic counterparts of fermionic nuclei with same chemical properties - TGD inspired nuclear

physics indeed predicts this kind of exotic nuclei [L10]. For Cooper pairs of Na^+, Cl^-, and K^+, $p = .23$ and $E_J = .04$ eV assignable to visual receptors the Josephson energies are doubled being $2.02, 2.80, 3.02$ eV. These energies could correspond to peak energies for visible photons. The assumption of ionic Cooper pairs is rather attractive since it would allow to avoid two questionable assumptions.

For electron the Josephson energy would be scaled by a factor $-1 + 1/2p$ to $E_J = 1.0859 \times eV_{rest}$ for $p = .2397$. For neutrino the energy would be given by $E_J = -0.0859 \times V_{rest}$: for $p = 1/4$ it would vanish by the vanishing of vectorial part of Z^0 charge. For proton the energy would be $E_J = (3 - 1/2p)V_{rest} = .914 \times V_{rest}$ and for neutron $E_J = V_{rest}/2p = 2.086 \times V_{rest}$.

6.4 Pollack's findings about fourth phase of water and the model of cell

The discovery of negatively charged exclusion zone formed in water bounded by gel phase has led Pollack to propose the notion of gel like fourth phase of water. In this article this notion is discussed in TGD framework. The proposal is that the fourth phase corresponds to negatively charged regions - exclusion zones - with size up to 100-200 microns generated when energy is fed into the water - say as radiation, in particular solar radiation. The stoichiometry of the exclusion zone is $H_{1.5}O$ and can be understood if every fourth proton is dark proton residing at the flux tubes of the magnetic body assignable to the exclusion zone and outside it.

This leads to a model for prebiotic cell as exclusion zone. Dark protons are proposed to form dark nuclei whose states can be grouped to groups corresponding to DNA, RNA, amino-acids, and tRNA and for which vertebrate genetic code is realized in a natural manner. The voltage associated with the system defines the analog of membrane potential, and serves as a source of metabolic energy as in the case of ordinary metabolism. The energy is liberated in a reverse phase transition in which dark protons transform to ordinary ones. Dark proton strings serve as analogs of basic biopolymers and one can imagine analog of bio-catalysis with enzymes replaced with their dark analogs. The recent discovery that metabolic cycles emerge spontaneously in absence of cell support this view.

One can find a biographical sketch [I13] (`http://faculty.washington.edu/ghp/cv/`) giving a list of publications containing items related to the notions of exclusion zone and fourth phase of water discussed in the talk.

6.4.1 Pollack's findings

I list below some basic experimental findings about fourth gel like phase of water made in the laboratory led by Gerald Pollack [L38].

1. In water bounded by a gel a layer of thickness up to 100-200 microns is formed. All impurities in this layer are taken outside the layer. This motivates the term "exclusion zone". The layer consists of layers of molecular thickness and in these layers the stoichiometry is $H_{1.5}O$. The layer is negatively charged. The outside region carries compensating positive charge. This kind of blobs are formed in living matter. Also in the splitting of water producing Brown's gas negatively charged regions are reported to emerge [H5, H1].

2. The process requires energy and irradiation by visible light or thermal radiation generates the layer. Even the radiation on skin can induce the phase transition. For instance, the blood flow in narrow surface veins requires metabolic energy and irradiation forces the blood to flow.

3. The layer can serve as a battery: Pollack talks about a form of free energy deriving basically from solar radiation. The particles in the layer are taken to the outside region, and this makes possible disinfection and separation of salt from sea water. One can even understand how clouds are formed and mysteries related to the surface tension of water as being due the presence of the layer formed by $H_{1.5}O$.

4. In the splitting of water producing Brown's gas [H5, H1] having a natural identification as Pollack's fourth phase of water the needed energy can come from several alternative sources: cavitation, electric field, etc...

6.4.2   Dark nuclei and Pollack's findings

While listening the lecture of Pollack I realized that a model for dark water in term of dark proton sequences is enough to explain the properties of the exotic water according to experiments done in the laboratory of Pollack. There is no need to assume sequences of half-dark water molecules containing one dark proton each.

Model for the formation of exclusion zones

The data about formation of exclusion zones allows to construct a more detailed model for what might happen in the formation of exclusion zones.

1. The dark proton sequences with dark proton having size of order atomic nucleus would reside at the flux tubes of dark magnetic field which is dipole like field in the first approximation and defines the magnetic body of the negatively charged water blob. This explains the charge separation if the flux tubes have length considerably longer than the size scale of the blob which is given by size of small cell. In the model inspired by Moray B. King's lectures charge separation is poorly understood.

2. An interesting question is whether the magnetic body is created by the electronic currents or whether it consists of flux tubes carrying monopole flux: in the latter case no currents would be needed. This is obviously purely TGD based possibility and due to the topology of CP_2.

3. This means that in the model inspired by the lectures of Moray B. King discussed above, one just replaces the sequences of partially dark water molecules with sequences of dark protons at the magnetic body of the $H1.5O$ blob. The model for the proto-variants of photosynthesis and metabolism remain as such. Also now genetic code would be realized [K37, L10].

4. The transfer of impurities from the exclusion zone could be interpreted as a transfer of them to the magnetic flux tubes outside the exclusion zone as dark matter.

These primitive forms of photosynthesis and metabolism form could be key parts of their higher level chemical variants. Photosynthesis by irradiation would induce a phase transition generating dark magnetic flux tubes (or transforming ordinary flux tubes to dark ones) and the dark proton sequences at them. Metabolism would mean burning of the resulting blobs of dark water to ordinary water leading to the loss of charge separation. This process would be analogous to the catabolism of organic polymers liberating energy. Also organic polymers in living matter carry their metabolic energy as dark proton sequences: the layer could also prevent their hydration. That these molecules are typically negatively charged would conform with the idea that dark protons at magnetic flux tubes carry the metabolic energy.

The liberation of energy would involve increase of the p-adic prime characterizing the flux tubes and reduction of Planck constant so that the thickness of the flux tubes remains the same but the intensity of the magnetic field is reduced. The cyclotron energy of dark protons is liberated in coherent fashion and in good approximation the frequencies of the radiation corresponds to multiplies of cyclotron frequency: this prediction is consistent with that in the original model for the findings of Blackman and others [J46].

The phase transition generating dark magnetic flux tubes containing dark proton sequences would be the fundamental step transforming inanimate matter to living matter and the fundamental purpose of metabolism would be to make this possible.

Minimal metabolic energy consumption and the value of membrane potential

This picture raises a question relating to the possible problems with physiological temperature.

1. The Josephson radiation generated by cell membrane has photon energies coming as multiples of ZeV, where V is membrane potential about .06 V and $Z = 2$ is the charge of electron Cooper pair. This gives $E = .12$ eV.

2. There is a danger that thermal radiation masks Josephson radiation. The energy for photons at the maximum of the energy density of blackbody radiation as function of frequency is given as the maximum of function $x^3/(e^x - 1)$, $x = E/T$ given by $e^{-x} + x/3 - 1 = 0$. The maximum is given approximately by $x = 3$ and thus $E_{max} \simeq 3T$ (in units $c = 1, k_B = 1$). At physiological temperature $T = 310$ K (37 C) this gives .1 eV, which is slightly below Josephson energy: living matter seems to have minimized the value of Josephson energy - presumably to minimize metabolic costs. Note however that for the thermal energy density as function of *wavelength* the maximum is at $E \simeq 5T$ corresponding to 1.55 eV which is larger than Josephson energy. The situation is clearly critical.

3. One can ask whether also a local reduction of temperature around cell membrane in the fourth phase of water is needed.

    (a) "Electric expansion" of water giving rise to charge separation and presumably creating fourth phase of water is reported to occur [H5, H1].

    (b) Could the electric expansion/phase transition to dark phase be adiabatic involving therefore no heat transfer between the expanding water and environment? If so, it would transform some thermal energy of expanding water to work and reduce its temperature. The formula for the adiabatic expansion of ideal gas with f degrees of freedom for particle ($f = 3$ if there are no other than translational degrees of freedom) is $(T/T_0) = (V/V_0)^{-\gamma}$, $\gamma = (f + 2)/f$. This gives some idea about how large reduction of temperature might be involved. If p-adic scaling for water volume by a power of two takes place, the reduction of temperature can be quite large and it does not look realistic.

    (c) The electric expansion of water need not however involve the increase of Planck constant for water volume. Only the Planck constant for flux tubes must increase and would allow the formation of dark proton sequences and the generation of cyclotron Bose-Einstein condensates or their dark analog in which fermions (electrons in particular) effectively behave as bosons (the anti-symmetrization of wave function would occur in dark degrees of freedom corresponding to multi-sheeted covering formed in the process).

6.4.3 Fourth phase of water and pre-biotic life in TGD Universe

If the fourth phase of water defines pre-biotic life form then the phase transition generating fourth phase of water and its reversal are expected to be fundamental elements of the ordinary metabolism, which would have developed from the pre-biotic metabolism. The following arguments conforms with this expectation.

Metabolism and fourth phase of water

1. Cell interiors, in particular the interior of the inner mitochondrial membrane are negatively charged as the regions formed in Pollack's experiments. Furthermore, the citric acid cycle, (`http://www.en.wikipedia.org/wiki/Citric_acid_cycle`), which forms the basic element of both photosynthesis (`http://www.en.wikipedia.org/wiki/Photo-synthesis`) and cellular respiration `http://www.en.wikipedia.org/wiki/Cellular_respiration`, involves electron transport chain (`http://www.en.wikipedia.org/wiki/Electron_transport_chain`) in which electron loses gradually its energy via production of NADP and proton at given step. Protons are pumped to the other side of the membrane and generates proton gradient serving as metabolic energy storage just like battery. The interpretation for the electron transport chain in terms of Pollack's experiment would be in terms of generation of dark protons at the other side of the membrane.

2. When ATP is generated from ADP three protons per ATP flow back along the channel formed by the ATP synthase molecule (`http://www.en.wikipedia.org/wiki/ATP_synthase`) (perhaps Josephson junction) and rotate the shaft of a "motor" acting as a catalyst generating three ATP molecules per turn by phosphorylating ADP. The TGD based interpretation is that dark protons are transformed back to ordinary ones and possible negentropic entanglement is lost.

3. ATP is generated also in glycolysis (`http://www.en.wikipedia.org/wiki/Glycolysis`), which is ten-step process occurring in cytosol so that membrane like structure need not be involved. Glycolysis involves also generation of two NADH molecules and protons. An open question (to me) is whether the protons are transferred through an endoplasmic reticulum or from a region of ordered water (fourth phase of water) to its exterior so that it would contribute to potential gradient and could go to magnetic flux tubes as dark proton. This would be natural since glycolysis is realized for nearly all organisms and electron transport chain is preceded by glycolysis and uses as input the output of glycolysis (two pyruvate molecules (`http://www.en.wikipedia.org/wiki/Pyruvate`)).

4. Biopolymers - including DNA and ATP - are typically negatively charged. They could thus be surrounded by fourth phase of water and neutralizing protons would reside at the magnetic bodies. This kind of picture would conform with the idea that the fourth phase (as also magnetic body) is fractal like. In phosphorylation the metabolic energy stored to a potential difference is transferred to shorter length scales (from cell membrane scale to molecular scale).

In glycolysis (`http://www.en.wikipedia.org/wiki/Glycolysis`) the net reaction $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2(g) + 6H_2O(l) + heat$ takes place. The Gibbs free energy change is $\Delta G = -2880$ kJ per mole of $C_6H_{12}O_6$ and is negative so that the process takes place spontaneously. Single glucose molecule is theoretized to produce $N = 38$ ATP molecules in optimal situation but there are various energy losses involved and the actual value is estimated to be 29-30. From $Joule = 6.84 \times 10^{18}$ eV and $mol = 6.02 \times 10^{23}$ and for $N = 38$ one would obtain the energy yield .86 eV per single ATP. The nominal value that I have used .5 eV. This is roughly 5 to 8 times higher than $E = ZeV, Z = 2$, which varies in the range .1-.16 eV so that the metabolic energy gain cannot be solely due to the electrostatic energy which would actually give only a small contribution.

In the thermodynamical approach to metabolism the additional contribution would be due to the difference of the chemical potential μ for cell exterior and interior, which is added to the membrane potential as effective potential energy. The discrepancy is however rather large and this forces the question the feasibility of the model. This forces to reconsider the model of osmosis in the light of Pollack's findings.

Pollack's findings in relation to osmosis and model for cell membrane and EEG

Osmosis (`http://en.wikipedia.org/wiki/Osmotic`) has remained to me poorly understood phenomenon. Osmosis means that solvent molecules move through a semipermeable membrane to another side of the membrane if the concentration of solute is higher at that side. Solute can be water or more general liquid, supercritical liquid, and even gas.

Osmosis is not diffusion: it can occur also towards a higher concentration of water. Water molecules are not attracted by solute molecules. A force is required and the Wikipedia explanation is that solute molecules approaching pores from outside experience repulsion and gain momentum which is transferred to the water molecules.

The findings of Pollack inspire the question whether the formation of exclusion zone could relate to osmosis and be understood in terms of the fourth phase of water using genuine quantal description.

In the thermodynamical model for ionic concentrations one adds to the membrane resting potential a contribution from the difference of chemical potentials μ_i at the two sides of the membrane. Chemical potentials for the ions parametrize the properties of the cell membrane reducing basically to the properties of the channels and pumps (free diffusion and membrane potential do not entirely determine the outcome).

If the transfer of ions - now protons - through cell membrane is quantal process and through Josephson junctions defined by transmembrane proteins, then the thermodynamical model can at

best be a phenomenological parameterization of the situation. One should find the quantum counterpart of thermodynamical description, and here the identification of quantum TGD as square root of thermodynamics in Zero Energy Ontology (ZEO) suggests itself. In this approach thermodynamical distributions are replaced by probability amplitudes at single particle level such that their moduli squared give Boltzmann weights.

1. Simplest Josephson junction model for cell membrane

The first guess is that quantum description is achieved by a generalization of the Josephson junction model allowing different values of Planck constant at magnetic flux tubes carrying dark matter.

1. Josephson junctions correspond microscopically to transmembrane proteins defining channels and pumps. In rougher description entire cell membrane is described as Josephson junction.

2. The magnetic field strength at flux tube can differ at the opposite side of the membrane and even the values of h_{eff} could in principle be different. The earlier modelling attempts suggest that $h_{eff}/h = n = 2^k A$, where A is the atomic weight of ion, is a starting assumption deserving testing. This would mean that each ion resides at its own flux tubes.

   The phase transitions changing the value of h_{eff} could induce ionic flows through cell membrane, say that occurring during nerve pulse since the energy difference defining the ratio of square roots of Boltzmann weights at the two sides of the membrane would change. Also the change of the local value of the magnetic field could do the same.

Consider first the simplest model taking into account only membrane potential.

1. The simplest model for Josephson junction defined by the transmembrane protein is as a two state system (Ψ_1, Ψ_2) obeying Schrödinger equation.

$$i\hbar_1 \frac{\partial \Psi_1}{\partial t} = ZeV\Psi_1 + k_1\Psi_2 \ ,$$

$$i\hbar_2 \frac{\partial \Psi_2}{\partial t} = k_2\Psi_2 \ .$$

One can use the decomposition $\Psi_i = R_i exp(i\Phi(t)$ to express the equations in a more concrete form. The basic condition is that the total probability defined as sum of moduli squared equals to one: $R_1^2 + R_2^2 = 1$. This is guaranteed if the hermiticity condition $k_1/\hbar_1 = \overline{k_2}\hbar_2$ holds true. Equations reduce to those for an ordinary Josephson junction except that the frequency for the oscillating Josephson current is scaled down by $1/h_{eff}$.

2. One can solve for R_2 assuming $\Phi_1 = eVt/\hbar_{eff}$. This gives

$$R_2(t) = sin(\Phi_0) + \frac{k_1}{\hbar_1} sin(\frac{eVt}{\hbar_1}) \ .$$

R_2 oscillates around $sin(\Phi_0)$ and the concentration difference is coded by $\Phi0$ taking the role of chemical potential as a phenomenological parameter.

3. The counterparts of Boltzmann weights would be apart from a phase factor square roots of ordinary Boltzmann weights defined by the exponent of Coulomb energy:

$$R = sin(\phi_0) = exp(\frac{ZeV(t)}{2T}) \ .$$

Temperature would appear as a parameter in single particle wave function and the interpretation would be that thermodynamical distribution is replaced by its square root in quantum theory. In ZEO density matrix is replaced by its hermitian square root multiplied by density matrix.

2. The counterpart of chemical potential in TGD description

This model is not as such physically realistic since the counterpart of chemical potential is lacking. The most straightforward generalization of the thermodynamical model is obtained by the addition of an ion dependent chemical potential term to the membrane potential: $ZeV \rightarrow ZeV + \mu_I$. This would however require a concrete physical interpretation.

1. The most obvious possibility is that also the chemical potential actually correspond to an interaction energy - most naturally the cyclotron energy $E_c = \hbar_{eff} ZeB_{end}/m$ of ion - in this case proton - at the magnetic flux tube. Cyclotron energy is proportional to h_{eff} and can be rather large as assumed in the model for the effects of ELF em fields on brain.

2. This model would predict the dependence of the effective chemical potential on the mass and charge of ion for a fixed value of on h_{eff} and B_{end}. The scales of ionic chemical potential and ion concentrations would also depend on value of h_{eff}.

3. The model would provide a different interpretation for the energy scale of bio-photons, which is in visible range rather than infrared as suggested by the value of membrane potential.

   The earlier proposal [K32] was that cell membrane can be in near vacuum extremal config-uration in which classical Z^0 field contributes to the membrane potential and gives a large contribution for ions. The problematic aspect of the model was the necessity to assume Weinberg angle in this phase to have much smaller value than usually. This difficulty could be perhaps avoided by noticing that the membrane potentials can differ for color receptors so that the earlier assignment of specific ions to color receptors could make sense for ordinary value of Weinberg angle. Second problem is that for proton the Z^0 contribution is negligible in good approximation so that this model does not explain the high value of the metabolic energy currency.

4. The simplest model the communications to magnetic body rely on Josephson radiation whose fundamental frequency f_J is at resonance identical with the cyclotron frequency $f_c(MB)$ at particular part of the flux tube of the magnetic body:$(f_c(MB) = f_J$. $f_c(MB)$ corresponds to EEG frequency in the case of brain and biophotons are produced from dark EEG photons as ordinary photons in phase transition reducing $h_{eff} = n \times h$ to h.

   In the modified model the sum $f_c + f_{J,n}$ ($f_{J,n} = E_J/n \times h$) of h_{eff}-independent cyclotron frequency and Josephson frequency proportional to $1/h_{eff}$ equals to cyclotron frequency $f_c(MB)$ at "personal" magnetic body varying slowly along the flux tube: $f_c + f_{J,n} = f_c(MB)$. If also the variation of f_J assignable to the action potential is included, the total variation of membrane potential gives rise to a frequency band with width roughly

   $$\frac{\Delta f}{f} \simeq \frac{2f_{J,n}}{f_c + f_{J,n}} = \frac{2f_{J,1}}{nf_c + f_{J,1}} \quad .$$

   If dark photons correspond to biophotons the energy is of cyclotron photon is in visible and UV range one has $nf_c = E_{bio}$ and

   $$\frac{\Delta f}{f} \simeq \frac{2ZeV}{E_{bio} + ZeV} \quad .$$

   The prediction is scale invariant and same for all ions and also electron unless E_{bio} depends on ion. For $eV = .05$ eV, $Z = 1$, and $E_{bio} = 2$ eV ($f \simeq 5 \times 10^{14}$ Hz) one has $\Delta f/f \sim .1$ giving 10 per cent width for EEG bands assumed in the simpler model.

If this vision is on the correct track, the fundamental description of osmosis would be in terms of a phase transition to the fourth phase of water involving generation of dark matter transferred to the magnetic flux tubes. For instance, the swelling of cell by an in-flow of water in presence of higher concentration inside cell could be interpreted as a phase transition extending exclusion zone as a process accompanied by a phase transition increasing the value of h_{eff} so that the lengths of the flux tube portions inside the cell increase and the size of the exclusion zone increases. In general case the phase transitions changing h_{eff} and B_{end} by power of two factor are possible.

This description should bring magnetic body as part of bio-chemistry and allow understanding of both equilibriumion distributions, generation of nerve pulse, and basic metabolic processes leading to the generation of ATP.

One can also model sensory receptors and try to understand the maximal sensitivity of color receptors to specific wavelengths in this framework. The new degrees of freedom make this task easy if one is only interested in reproducing these frequencies. More difficult challenge is to understand the color receptors from the first principles. It is also possible to combine the new view with the assumption that sensory receptor cells are near to vacuum extremals. This would add a cyclotron contribution to the generalized Josephson frequency depending only weakly on particle and being non-vanishing also for em neutral particles.

Why would charge separation generate large h_{eff}?

The basic question is whether and how the separation of electron and proton charges generates large h_{eff}? A possible mechanism emerged from a model [K118] explaining anomalously large gravimagnetic effect claimed by Tajmar et al [E1, **?**] to explain the well-established anomaly related to the mass of Cooper pairs in rotating super-conduction. The mass is too large by fraction of order 10^{-4} and the proposal is that gravimagnetism changes slightly the effective Thomson magnetic field associated with the rotating super-conductor leading to wrong value of Cooper pairs mass when only ordinary Thomson field is assumed to be present. The needed gravimagnetic field is however gigantic: 28 orders larger than that predicted by GRT. Gravimagnetic field is proportional h_{eff}^2 in TGD and if one uses h_{gr} for electron-Earth system one obtains correct order of magnitude.

Nottale's finding that planetary orbits seem to correspond to Bohr orbits in gravitational potential with gigantic value of gravitational Planck constant is the basic input leading to the model of gravimagnetic anomaly.

1. By Equivalence Principle h_{gr} has the general form $h_{gr} = GMm/v_0$, where M and m are the interacting masses and v_0 is a parameter with dimensions of velocity. For three inner planets one has $v_0/c \simeq 2^{-11}$.

2. The notion of h_{gr} generalizes to that for other interactions. For instance, in electromagnetic case the formation of strong em fields implying charge separation leads to systems in which $h_{em} = Z_1 Z_2 e^2/v_0$ is large. Pollack's exclusion zone and its complement define this kind of systems and is identified as prebiotic life form.

3. Since the natural expansion parameter of perturbative expansion is the $g^2/4\pi\hbar$, one can say that transition to dark matter phase make the situation perturbative. Mother Nature is theoretician friendly.

h_{em} might be large in the exclusion zones (EZ) appearing in the water bounded by gel and their variants could play central role in living matter.

1. EZ carries very large negative charge with positive charge outside the exclusion zone.

2. TGD interpretation is in terms of $H_{1.5}O$ phase of water formed when every 4:th proton is transferred to magnetic body as dark particle with large value of h_{eff}. The proposal is that primitive life form is in question.

3. The pair formed by EZ and its complement could have large value of $h_{eff} = h_{em} = Z^2 e^2/v_0$.

4. The velocity parameter v_0 should correspond to some natural rotation velocity. What comes in mind is that complement refers to Earth and v_0 is the rotation velocity at the surface of Earth. The prediction for h_{eff} would be of order $h_{em}/h = 4\pi\alpha Z^2 \times .645 \times 10^6 \simeq 5.9 \times 10^4 Z^2$.

5. Cell membrane involves also large charge separation due to very strong electric field over the cell membrane. Also now dark phases with large h_{em} or h_{gr} could be formed.

I have proposed that metabolic machinery generates large h_{eff} phase somehow. $h_{eff} = h_{em}$ hypothesis allows to develop this hypothesis in more detail.

1. I have speculated earlier [K40] that the rotating shaft of a molecular motor associated with ATP synthase plays a key role in generating dark matter phase. What comes in mind is that charge separation takes place associating exclusion zone with the shaft and the rotational velocity v_0 of the shaft appears in the formula for h_{em}. Of course, some numerical constant not far from unity could be present. The electric field over the mitochondrial membrane generates charge separation. One can imagine several identifications for the product of charges. The charge Z associated with the complement would be naturally associated with single dark flux tube containing dark nucleon consisting of dark protons. For instance, the charge associated with the exclusion zone could be the charge of the electronic Cooper pair giving $h_{em} = 2e \times Z/v_0$.

2. The value of v_0/c is expected to be of order 10^{-14} from the angular rotation rate of ADP synthase about few hundred revolutions per second. The order of magnitude for h_{em} could be same as for h_{gr} associated with Earth-particle system.

$h_{eff}(ATP synthase) = h_{gr}(2e, Earth)$ would make possible reconnection of electromagnetic flux tubes with gravimagnetic flux tubes [K64].

Which came first: metabolism or cell membrane?

One of the basic questions of biology is whether metabolism preceded basic biopolymers or vice versa. RNA world scenario assumes that RNA and perhaps also genetic code was first.

1. The above view suggests that both approaches are correct to some degree in TGD Universe. Both metabolism and genetic code realized in terms of dark proton sequences would have emerged simultaneously and bio-chemistry self-organized around them. Dark proton sequences defining analogs of amino-acid sequences could have defined analogs of protein catalysts and played a key role in the evolution of the metabolic pathways from the primitive pathways involving only the phase transition between ordinary water and fourth phase of water.

2. There is very interesting article [?]eporting that complex metabolic pathways are generated spontaneously in laboratory environments mimicking hot thermal vents. Glycolysis and pentose phosphate pathway were detected. The proposal is that these pathways are catalyzed by metals rather than protein catalysts.

3. In standard biology these findings would mean that these metabolic pathways emerged before basic biopolymers and that genetic code is not needed to code for the metabolic pathways during this period. In TGD framework dark genetic code [K37, L10] would be there, and could code for the dark pathways. Dark proton strings in one-one correspondence with the amino-acid sequences could be responsible for catalysts appearing in the pathways. Only later these catalysts would have transformed to their chemical counterparts and might be accompanied by their dark templates. One cannot even exclude the possibility that the chemical realization of the DNA-aminoacid correspondence involves its dark analog in an essential manner.

6.5 Constraints on the fermionic realization of genetic code from the model for color qualia

The original model for DNA as topological quantum computer assigns to DNA nucleotides quarks at ends of flux tubes or quark pairs at the ends of wormhole flux tubes. This is only the realization that came first to my mind in TGD Universe where dark variants of quarks can define QCD like physics even in cellular length scales. One can actually imagine several realizations of the genetic code and the first realization is far from being the simplest one. It is enough to have four different particles or many-particle quantum states to build at least formally a map from A,T,C, G to four states. It is obvious that the number of possible formal realizations is limited only by the imagination of the theoretician. Additional conditions are required to fix the model.

6.5.1   Fermionic representation

Consider first the fermionic representations in the general case without specifying what fermions are.

1. The original proposal was that DNA nucleotides correspond to flux tubes with quark q and antiquark $\bar{q}$ at the ends of the parallel flux sheets extremely near to each other. Second options relies on wormhole magnetic flux tubes in which case quark pair $q\bar{q}$ is at both ends. Quarks u, d and their antiquarks would code for A,T,C,G. The spin of quarks is not taken into account at all in this coding: why not restrict the consideration to single quark. The total quark charge at given end of flux tube pair vanishes and flux tube ends carry opposite quark charges.

   The nice feature of this option is that one could understand the generation of color qualia in the model of sensory receptor in simple manner to be discussed below. Even if one accepts the arguments supporting the view that dark quarks in cell scale are natural outcome of the hierarchy of Planck constants, one could argue that the presence of both quarks and antiquarks does not conform with matter antimatter asymmetry (not that one can however identify the analog of matter antimatter asymmetry at DNA level).

2. Spin states for fermion pairs assigned with two parallel magnetic flux tubes with the magnetic field generated by spin provide much simpler representation for nucleotides. Similar fermion pair would reside at the second end of flux tube pair.

   (a) It is is essential that rotational symmetry is broken and reduces to rotational symmetry around the direction of flux tubes so that spin singlet and spin 0 state of triplet mix to form states for which each fermion is in spin eigenstate. The states must be antisymmetric under exchange of the protons and spin 1/0 states are antisymmetric/symmetric in spatial degrees of freedom (wave functions located to the ends of flux tubes). The states with definite spin for given flux tube are mixtures of s=1 states with vanishing spin projection and s=0 state.

   (b) It is not quite clear whether one should treat fermion pairs as identical bosons with 3+1 spin states since in TGD framework one considers disjoint partonic 2-surfaces and the situation is not that of QFT in M^4. This interpretation would require totally symmetry of the states under permutations of bosonic states defined by the 3+1 spin states. Coding by spin requires that each nucleotide corresponds to a state with a well defined spin. In field theory language the state would be obtained by applying bosonic oscillator operators generating states of given spin localized to a given nucleotide position.

   (c) The classical correlate for the permutations of coordinates of fermions has interpretation as braiding for the flux tubes of the flux tube pair. In the similar manner the permutation of the flux tube pairs associated with nucleotides has interpretation as braiding of the 3-braids formed form from flux tube pairs. Braiding therefore gives a representation of spin analogous to the well-known orientation entanglement relation invented by Dirac and providing geometric representation of spin 1/2 property.

6.5.2   Various options for the fermionic representation of A,T,C,G

Fermionic representations allows several options since fermion can be electron, u or d quark, or proton. Wormhole magnetic fields would not be needed in this case.

1. The problem of electron and proton options is that it does not allow realization of color qualia. There is also the well-known problem related to the stability of DNA caused by the phosphate charge of -2 units per nucleotide. Somehow this charge should be screened. In any case, the charge -2 should correspond to the electron pair at the DNA end of the flux tube for electron option. For proton option the charge would be screened completely. One could of course consider also the large $\hbar$ color excitations of ordinary protons instead of quark at its nucleotide ends. This option would however require the modification of quark wave functions inside proton and this option will not be discussed here.

2. Quark option would give rise to both color and allow also to reduce the electronic charge of -2 units by 4/3 units to -2/3 units in the case of u quark pair. This would help to stabilize DNA. In the case of d quarks the charge would increase to -10/3 units and is not favored by stability argument. Flux tube pairs assigned to single nucleotide define diquarks with spin 1 or spin 0.

   (a) Diquarks behave ass identical bosons with 3+1 spin states and 3×3 color states. The states with well defined symmetry properties in spin degrees of freedom have such properties in spatial degrees of freedom. This means that one obtains a superposition of flux tube pairs with are either braided or unbraided. Triplet/singlet state is symmetric/antisymmetric and total asymmetry could be guaranteed by assuming symmetry/antisymmetry in spatial degrees of freedom and antisymmetry/symmetry in color degrees of freedom. This would give anti-triplet/6-plet in color degrees of freedom. Spatial symmetry would favor antitriplet and diquark would behave like antiquark with respect to color. Let us assume antitriplet state for definiteness.

   (b) DNA codon corresponds to three-di-quark state. This state must be totally symmetric under the exchange of bosons. One can have total symmetry in both spatial and color degrees of freedom or total antisymmetry/symmetry in spatial and total antisymmetry/symmetry in color degrees of freedom.The first option gives 10-dimensional color multiplet and the second one color singlet. Braiding is maximal and symmetric/antisymmetric in these case. One can consider also mixed symmetries. In this case one has color octet which is antisymmetric with respect to the first nucleotide pair and symmetric with respect to first nucleotide pair and third nucleotide. The braiding of the first two nucleotides must be antisymmetric and the braiding of this pair with third nucleotide. The conclusion would be that color multiplets correspond to well defined braidings and one would therefore have directed connection with topological quantum computation. Color octet is especially interesting concerning the representation of color qualia.

The challenge of all these options (note that the representability of color selects quark option) is to find a good justification for why the assignment of A,T,C,G to quark states or spin states is unique dynamically. Stability argument is expected to help here.

6.5.3 Realization of color qualia for quark option

Consider now how one could understand the generation of qualia for quark option.

1. The generation of qualia involves interaction with external world giving rise to a sensory percept. In the case of visual colors it should correspond to a measurement of quark color and should give rise to eigenstages of color at the ends of flux tubes at DNA nucleotides for a nucleus or cell of photoreceptor. A modification of capacitor model is needed. Color polarization is still essential but now polarization in nucleus or cell scale is transformed in the generation of color quale to a polarization in longer length scale by the reconnection of flux tubes so that their ends attach to "external world". The nucleus/cell becomes color and state function reduction selects well defined quantum numbers. It is natural to assume that the entanglement in other degrees of freedom after color measurement is negentropic.

2. Does the "external world" correspond to another cell or to the inner lipid layers of the cell membrane containing the nucleus. In the first case flux tubes would end to another cell. If the nuclei of receptor cells are integrate to a larger structure by magnetic flux sheets traversing through them one can also consider the possibility that the polarization in the scale of cell nucleus (recall that the nucleus has also double lipid layer) is transformed to a polarization in cell scale so that similar process in cell scale gives rise to qualia.

3. The entire receptor unit must have net color charge before the state function reduction. This requires that there are flux tubes connecting the receptor unit to a unit representing "external world and having vanishing color charge. If second cell is the "external world"

these flux tubes must go through the pair of lipid layers of both cell membrane and end up to the nucleus of cell in the environment. If external world correspond to the complement of nucleus inside cell the inner layers of cell membrane represents external world. Cell membrane indeed serves as sensory receptor in cell length scale. One can of course have sensory qualia in various length scales so that both options are probably correct and a kind of fractal hierarchy is very natural giving rise also to our qualia at some higher level. Living matter as conscious hologram metaphor suggests a fractal hierarchy of qualia.

After state function reduction reducing the entanglement the flux tubes split and the receptor becomes un-entangled with external world and has vanishing color charges. At the level of conscious experience this means that there can be only memory about the quale experience. The sensation of quale lasts with respect to subjective time as long as the negentropic entanglement (see fig. `http://www.tgdtheory.fi/appfigures/cat.jpg` or fig. 21 in the appendix of this book) prevails. There is an obvious analogy with Orch OR proposal of Hameroff and Penrose in which also conscious experience ends with state function reduction.

4. Consider now how the color qualia are generated.

   (a) There must be two flux tube states. In the first state there are two flux tube beginning from cell nucleus A and ending to the inner lipid layer a_1 and flux tube beginning from the outer lipid layer a_2 and ending cell nucleus B. Both flux tubes have vanishing net color so that cells have vanishing net colors. This could be regarded as the resting state of the receptor. The lipids in layers a_1 and a_2 are connected by another short flux tube. Same for b_1 and b_2.

   (b) The second flux tube state corresponds to long flux tubes connecting the nuclei of cells A and B. The ends carry opposite color charges. In this case the net color of both A and B is non-vanishing. This state would be an outcome of a reconnection process in which the flux tubes from A to a_1 and B to a_2 re-connect with the short flux tube connecting lipid layers a_1 and a_2.

   (c) When these flux tubes carry opposite colors numbers at their ends, the cell possess net color charge and can represent color quale. Or rather, creation of this kind of flux tube connections would give rise to the color charging of the receptor cell with external world carrying opposite color charge.

One can argue that this mechanism is not quite in spirit with color capacitor model for sensory receptor. Polarization is still essential but now polarization in receptor scale is transformed to polarization in longer length scale by the reconnection of flux tubes. The analog of di-electric breakdown however still applies in the sense that its analog induces large polarization. Several mechanisms generating larger polarization are of course possible. One can ask how essential the electromagnetic polarization of cell membrane is for the generation of qualia at cell level. Note also that biomolecules are quite generally polar molecules.

The unexpected prediction of the model is that braiding would correlate directly with qualia. This would mean also a connection between quantum computation and qualia. This condition emerges from Fermi/Bose-Einstein statistics correlating braiding with symmetric properties of color states and spin states. Quite generally, the correlation of braiding with the symmetries of wave functions as functions of points of braid end points would allow to have direct geometric correlate between induced entanglement and braiding as naive intuitive expectations have suggested.

This model is not consistent with the naive expectation that the quale is generated after state function reduction. Rather, the beginning of sensation of quale means beginning of negentropic entanglement and fusion with external world and state function usually associated with the quantum measurement would mean the end of the sensation and separation from the external world! Maybe one can say that state function reduction means that experience is replaced with a memory "I had the sensation of quale"! Krishnamurti would certainly agree!

6.6   Model for nerve pulse

The basic idea behind the model of nerve pulse is that some kind of quantum jump reduces the magnitude of membrane potential below the threshold leading to the generation of nerve pulse. Several identifications of this quantum jump have been discussed during years but no really convincing option has been found. The evolution of ideas about dark matter hierarchy and associated hierarchy of Planck constants led to a breakthrough in several sectors. The assignment the predicted ranged classical weak and color gauge fields to dark matter hierarchy was the crucial step and led among other things to a model of high T_c superconductivity [K12, K13] providing interpretation for the basic scales of cell in terms of the p-adic length scale hypothesis and Gaussian Mersennes.

6.6.1   Background

The model for nerve pulse is discussed in detail in [K66]. TGD inspired model for high T_c super-conductivity involving dark electrons with large $\hbar$ in an essential manner is a prerequisite for the model and is discussed in [K12, K13]. The basic philosophy behind the model discussed in detail in is following.

1. In TGD Universe the function of EEG and its variants is to make possible communications from the cell membrane to the magnetic body and the control of the biological body by the magnetic body via magnetic flux sheets traversing DNA by inducing gene expression. This leads to the notions of super- and hyper-genome predicting coherent gene expression at level of organs and population.

2. The assignment the predicted ranged classical weak and color gauge fields to dark matter hierarchy was a crucial step in the evolution of the model, and led among other things to a model of high T_c superconductivity predicting the basic scales of cell, and also to a generalization of EXG to a hierarchy of ZXGs, WXGs, and GXGs corresponding to Z^0, W bosons and gluons.

3. Dark matter hierarchy and the associated hierarchy of Planck constants plays a key role in the model. For instance, in the case of EEG Planck constant must be so large that the energies of dark EEG photons are above thermal energy at the physiological temperature. The assumption that a considerable fraction of the ionic currents through the cell membrane are dark currents flowing along the magnetic flux tubes explains the strange findings about ionic currents through cell membrane. Concerning the model of nerve pulse generation, the newest input comes from the model of DNA as a topological quantum computer and experimental findings challenging Hodgkin-Huxley model as even approximate description of the situation.

4. The identification of the cell interior as gel phase containing most of water as structured water around cytoskeleton - rather than water containing bio-molecules as solutes as assumed in Hodkin-Huxley model - allows to understand many of the anomalous behaviors associated with the cell membrane and also the different densities of ions in the interior and exterior of cell at qualitative level. The proposal of Pollack [I86] that basic biological functions involve phase transitions of gel phase generalizes in TGD framework to a proposal that these phase transitions are induced by quantum phase transitions changing the value of Planck constant. In particular, gel-sol phase transition for the peripheral cytoskeleton induced by the primary wave would accompany nerve pulse propagation. This view about nerve pulse is not consistent with Hodkin-Huxley model.

6.6.2   New view about nerve pulse generation

The basic hypothesis has been that quantum jump takes the resting potential below the threshold for the generation of nerve pulse. One can imagine several manners for how this could happen. According to [J19] nerve pulse propagation seems to be an adiabatic process and thus does not dissipate: the authors propose that 2-D acoustic soliton is in question. Adiabaticity is what one

expects if the ionic currents are dark currents (large $\hbar$ and low dissipation) or even supra currents. Furthermore, Josephson currents are oscillatory so that no pumping is needed. Combining this input with the model of DNA as topological quantum computer (TQC) leads to a rather precise model for the generation of nerve pulse [K66].

1. The system would consist of two superconductors- microtubule space-time sheet and the space-time sheet in cell exterior- connected by Josephson junctions represented by magnetic flux tubes defining also braiding in the model of TQC. The phase difference between two super-conductors would obey Sine-Gordon equation allowing both standing and propagating solitonic solutions. A sequence of rotating gravitational penduli coupled to each other would be the mechanical analog for the system. Soliton sequences having as a mechanical analog penduli rotating with constant velocity but with a constant phase difference between them would generate moving kHz synchronous oscillation. Also moving oscillations in EEG range can be considered and would require larger value of Planck constant in accordance with vision about evolution as gradual increase of Planck constant.

2. During nerve pulse one pendulum would be kicked so that it would start to oscillate instead of rotating and this oscillation pattern would move with the velocity of 1 kHz soliton sequence. The velocity of 1 kHz wave and nerve pulse is fixed by periodic boundary conditions at the ends of the axon implying that the time spent by the nerve pulse in traveling along axon is always a multiple of the same unit: this implies 1 kHz synchrony. The model predicts the value of Planck constant for the magnetic flux tubes associated with Josephson junctions and the predicted force caused by the ionic Josephson currents is of correct order of magnitude for reasonable values of the densities of ions. The model predicts kHz em radiation as Josephson radiation generated by moving soliton sequences. EEG would also correspond to Josephson radiation: it could be generated either by moving or standing soliton sequences (latter are naturally assignable to neuronal cell bodies for which $\hbar$ should be correspondingly larger): synchrony is predicted also now.

3. The previous view about microtubules in nerve pulse conduction can be sharpened. Microtubular electric field (always in the same direction) could explain why kHz and EEG waves and nerve pulse propagate always in same direction and might also feed energy to system so that solitonic velocity could be interpreted as drift velocity. This also inspires a generalization of the model of DNA as TQC since also microtubule-cell membrane systems are good candidates for performers of TQC. Cell replication during which DNA is out of game seems to require this and microtubule-cell membrane TQC would represent higher level TQC distinguishing between multi-cellulars and mono-cellulars.

4. New physics would enter in several manners [K7]. Ions should form Bose-Einstein cyclotron condensates. The new nuclear physics predicted by TGD predicts that ordinary fermionic ions (such as K^+, Na^+, Cl^-) have bosonic chemical equivalents with slightly differing mass number. Anomalies of nuclear physics and cold fusion provide experimental support for the predicted new nuclear physics [L10]. Electronic supra current pulse from microtubules could induce the kick of pendulum inducing nerve pulse and induce a small heating and expansion of the axon. The return flux of ionic Josephson currents would induce convective cooling of the axonal membrane. A small transfer of small positive charge into the inner lipid layer could induce electronic supra current by attractive Coulomb interaction. The exchange of dark scaled up variants of ordinary $W^{\pm}$ bosons is a natural manner to achieve this if new nuclear physics is indeed present. A lot of unknown is involved but model builder assuming that dark matter is responsible for the special properties of living matter must tolerated this.

6.6.3 The function of neural transmitters

TGD leads to a general view about the functions of membrane oscillations, nerve pulse and neural transmitters. The binding of various information molecules to the corresponding receptors gives rise to neuronal qualia analogous to tastes and odors but providing information about external world whereas ordinary receptors give information about nearby environment. At our level of hierarchy these qualia probably are coded to emotions in consistency with the finding that neurotransmitters

can be identified as information molecules. Neurotransmitters might be also seen as conscious links in quantum web.

6.6.4 Microtubular level

The view about what happens at the micro-tubular level during synchronous neuronal firing relies on a many-sheeted model for sol-gel phase transitions as conscious bits and on the seesaw mechanism of remote metabolism according to which sol-gel transitions induces gel-sol transitions elsewhere in the cell and vice versa. Micro-tubular surfaces can be seen as analogs of cortical sensory and motor areas providing kind of conscious log files about sensory and motor history of the cell in terms of conformational transitions of tubulin dimers representing conscious bits.

What happens at the micro-tubular level during the nerve pulse, how gel phase differs from sol phase, and what occurs in sol-gel transition, belong to the principal challenges for quantum theories of consciousness. Charge entanglement associated with various bosonic ions allows to tackle these questions. The Bose-Einstein condensates of hydrogen atoms at tubular $k = 139$ space-time sheets with size scale of 5 Angstrom ($p \simeq 2^k$ labels space-time sheets for which electronic Compton scale $L_e(k) = \sqrt{5}L(k)$ is given by $L_e(k) = 2^{(151-k)/2}L_e(151)$, where $L_e(151) \simeq 10$ nm corresponds to cell membrane thickness) form a bundle behaving like a liquid crystal identifiable as the gel phase. Positive and negative energy IR photons at energy of .1 eV belong to the predicted fractal hierarchy of metabolic currencies, and allow to control the stability of this B-E condensate so that a precisely targeted control of the cellular state by local sol-gel transitions becomes possible. Albrecht-Buehler has demonstrated that photons with this energy have a maximal effect on cells.

Negative energy MEs (topological light rays) are especially important: they make possible intentional action at the micro-tubular level, they are crucial for the understanding of the micro-temporal quantum coherence, and have also inspired the notions of remote metabolism and quantum credit card. The newest discovery along this line is what might be called seesaw mechanism of energy metabolism. Seesaw mechanism minimizes dissipative losses and allows to understand how micro-tubular surfaces provide dynamical records for the cellular sol-gel transitions, and thus define fundamental micro-tubular representation of declarative long term memories. Also the notion of micro-tubuli as quantum antennae [K56] becomes precisely defined.

The model of DNA as topological quantum computer [K23] brings in a new element. Microtubule-axonal membrane system could perform topological quantum computation just as DNA-membrane (nuclear and perhaps also cell membrane) system has been proposed to do. The braiding of the magnetic flux tubes connecting microtubules to axon would define TQC programs and also provide a representations for sensory input from sensory organs in time scale shorter than millisecond if one assumes that gel-sol-gel transition of microtubule accompanies the nerve pulse. The entire sensory pathway from sensory receptor to brain would define linear representations of nerve pulse patterns and this might explain why the lengths of sensory pathways are maximized. Whether one it one say that nerve pulse is initiated at microtubular or axonal level or by both collectively is not clear since the magnetic flux tubes connecting these two systems make them to act like single coherent whole.

6.7 Model for EEG

The emergence of zero energy ontology, the explanation of dark matter in terms of a hierarchy of Planck constants requiring a generalization of the notion of imbedding space, the view about life as something in the intersection of real and p-adic worlds, and the notion of number theoretic entanglement negentropy led to a breakthrough in TGD inspired quantum biology and also to the recent view of qualia and sensory representations including hearing allowing a precise quantitative model at the level of cell membrane.

Also long range weak and color forces play a key role. Long range weak forces are made possible by the exotic ground state represented as almost vacuum extremal of Kähler action for which classical em and Z^0 fields are proportional to each other whereas for far form vacuum extremals with large Planck constant classical Z^0 fields are very weak and long range color forces strong. In this phase color forces are very weak. This leads to a correct prediction for the frequencies of peak sensitivity for photoreceptors - something highly non-trivial remembering that also the large parity

breaking effects in living matter find a natural explanation. Second quantitative key observation was that for electrons and quarks the time scales of causal diamonds correspond to fundamental biorhythms assignable to central nervous system.

The general model for EEG follows neatly from this picture combined with the general model of high T_c superconductivity. A fractal hierarchy of EEGs extending over a wide frequency range beginning from visible photon frequencies and its generalizations identified in terms of Josephson radiation is predicted with levels labeled by p-adic length scales and the value of $\hbar$ at various levels of dark matter hierarchy. Cell membrane would represent only one level in this hierarchy. Besides EEG one would have its counterparts for various organs, organelles and even cell. Also the possibility of ZEG, WEG and QEG corresponding to Z^0 bosons, W bosons, and gluons must be considered. The fractal hierarchy of EEGs is described in two chapters of the book "TGD and EEG" [K20, K69].

6.7.1   Fractal hierarchy of EEGs

EEG is replaced with a fractal hierarchy of EEGs corresponding to various values of Planck constants involved.

1. There are three contributions to EEG besides the contributions due to the neural noise and evoked potentials. These contributions correspond to Schumann frequencies, cyclotron frequencies f_c of biologically important ions in magnetic field $B_{end} = .2$ Gauss, and to the Josephson frequencies f_J associated with Josephson junctions assigned with cell membranes. If Josephson radiation modulates cyclotron radiation also the frequencies $mf_J \pm nf_c$ appear in the spectrum.

2. In standard model $f_J = ZeV/\hbar$ would determined by the membrane potential and would correspond to energy in infrared. This sounds completely reasonable. TGD however suggests that cell membrane as a critical system correspond to an almost vacuum extremal. This predicts classical Z^0 field proportional to em field to which nuclei and neutrinos are assumed to couple. This would explain chiral selection in living matter and predict correctly the frequencies of peak sensitivity for photoreceptors as Josephson frequencies assignable to the biologically most important ions. The effective couplings of ions to membrane potential are modified and the Josephson frequencies correspond to energies in visible and UV range. Bio-photons and EEG could be seen as manifestations of one and same thing: Josephson radiation with a large value of Planck constant with energies of bio-photons and frequencies of EEG.

3. An important point is that the ions involved must behave like bosons. For cyclotron condensates either Cooper pairs of ordinary fermionic ions or exotic ions chemically similar to their standard counterparts obtained from neutral bosonic atom by making one or more neutral color flux tubes connecting nucleons charged. For Josephson radiation only the latter option works. TGD based nuclear physics indeed predicts this kind of nuclei and there is experimental evidence for their existence [L10].

4. For cyclotron frequencies the extremals are assumed to be far from vacuum extremals carrying very small classical Z^0 fields but non-vanishing classical W fields and color fields (with $U(1)$ holonomy). The corresponding flux quanta would naturally correspond to flux sheets traversing through DNA strands while Josephson radiation would propagate along flux tubes parallel to the cell membrane. Far from biological body one expects both kinds of flux quanta to fuse to form larger ones so that one has parallel space-time sheets carrying cyclotron *resp.* Josephson radiation. Wormhole contacts between Josephson and cyclotron flux sheets would induce a non-linear interaction giving rise to a superposition of harmonics of Josephson and cyclotron frequencies.

5. Josephson frequencies are assignable to the cell membrane and would naturally correspond to the communication of sensory data to the magnetic body. This would suggest that cyclotron frequencies are assignable to the magnetic flux sheets going through DNA strands responsible for quantum control via genome expression. This picture might be too naive. Josephson

radiation would induce transitions between cyclotron states should generate sensory representations at magnetic body so that both frequencies would be involved with sensory representations. Furthermore, the identification of motor action as time reversal of sensory perception allowed by zero energy ontology would mean that same mechanisms are at work for negative energies (phase conjugate radiation). Resonance is achieved if the condition $mf_J = nf_c$ is satisfied. For small values of integers m and n the condition is quite restrictive. Schumann frequencies can be assigned with the magnetic body of Earth and would correlate with the collective aspects of consciousness.

6. The model of hearing forces to assume quite a wide spectrum of Planck constants- at least the values coming as powers of two and the safest assumption is that at least integer multiples of the ordinary Planck constant are possible. Josephson radiation and cyclotron radiation have same scale if $B_{end} \propto 1/\hbar$ proportionality holds true. For 5 Hz Josephson frequency and membrane potential and for V=.70 mV corresponding to the resting potential of neuron one obtains $r = (0.96, 1.20, 1.34, 1.01) \times 2^{47}$. For Ca^{++} ion r is very near to a power of 2.

6.7.2   Basic aspects of EEG

Consider now how one could understand basic characteristics of EEG during wake-up and sleep in this framework.

1. For small amplitudes and for the lowest harmonics this implies that alpha band to which the cyclotron frequencies most biologically important bosonic ions correspond has as satellites theta and beta bands. Higher harmonics correspond to gamma and higher bands having also satellites.

2. For large amplitudes EEG becomes chaotic which is indeed the property of beta band during say intense concentration or anxiety. The findings of Nunez about narrow 1-2 Hz wide bands at 3,5,7 Hz and 13,15,17 Hz confirm with the prediction of satellite bands and fix the Josephson frequency to 5 Hz. This picture explains the general characteristics of EEG in wake-up state qualitatively and quantitatively.

3. In order to understand the characteristics during various stages of deep sleep one must assume that the cyclotron frequency scale of ions is scaled down by a factor of 1/2. The simplest explanation is that the value of Planck constant increases by a factor 2 in a phase transition having interpretation as a leakage of cell membrane space-time sheet between the pages of Big Book defined by the generalized imbedding space. During stage 4 sleep only only DNA cyclotron frequencies in delta band are around 1 Hz and just above the thermal threshold are predicted to be present. This stage could correspond to a value of Planck constant which is 4 times its value in wake-up state.

   The generalization of the model for EEG hierarchy to the case of ZEGs is straightforward and Josephson frequency spectrum is the same. Any atom, almost always boson, has an exotically charged counterpart with same statistics so that very rich spectrum of Bose-Einstein condensates results.

6.7.3   The effects of ELF em fields on brain

The experimental data about the effects of ELF em fields at cyclotron frequencies of various ions in Earth's magnetic field on vertebrate brains were crucial for the development of the model of EEG. As a matter fact, it was the attempt to explain these effects, which eventually led to the discovery of the fractal hierarchy of EEGs and its generalizations.

   The reported effects occur for harmonics of cyclotron frequencies of biologically important ions in Earth's magnetic field. They occur only in amplitude windows. The first one is around 10^{-7} V/m and second corresponds to the range $1 - 10$ V/m: the amplitudes of EEG waves are in the range 5-10 V/m. The effects are present only in the temperature interval 36-37 C.

1. Cyclotron frequencies led to the vision about cyclotron condensates of biologically important ions and their Cooper pairs at the flux quanta of dark magnetic field with so large Planck

constant that the energies of cyclotron photons are above thermal threshold. The model for EEG and bio-photons in terms of Josephson radiation from cell membrane which is almost vacuum extremal allows to make this model more quantitative.

2. The temperature window has one interpretation in terms of a competition of almost vacuum extremal property of cell membrane possible above some critical temperature and high T_c super-conductivity possible below some critical temperature.

3. The amplitude window 10^{-7} V/m follows from a quantized form of Faraday law whose existence is supported by the fact that space-time sheets are analogs of Bohr orbits in exact sene. The quantisation condition relates the amplitude of electric field to Planck constant and frequency. For the value $r = \hbar/\hbar_0 = 2^{47}$ of Planck constant required by 5 Hz Josephson frequency the 10^{-7} V/m amplitude is predicted correctly.

4. The amplitude window around 1-10 V/m (EEG amplitudes are in the range 5-10 V/m) follows if the values of Planck constant in the range $10^7 r - 10^8 r$ can be justified. A possible justification is based on the observation that for $r_1 = 10^8 r$ the Compton wave length of intermediate gauge bosons corresponds to $k = 163$ defining Gaussian Mersenne and wavelength corresponding to 2 eV energy for photon which also corresponds to bio-photon energies assignable to 70 mV resting potential of neuron membrane. Electron's Compton length corresponds for $r_1 = 10^8 r$ to 28 cm, which defines the size scale of brain. One might hope that these findings could allow to build an internally consistent story about what happens.

6.7.4 Vision about biological evolution and evolution of brain

The proposed model for EEG, the idea that Gaussian Mersennes (four electron Compton lengths associated with them are in the range 10 nm-2.5 micrometers) define p-adic length scales allowing exotic variants of color and electro-weak physics with light intermediate gauge bosons at space-time sheets near vacuum extremals, and the assumption that the preferred values of Planck constant are such that they relate these p-adic scales to each other leads to a detailed quantitative vision about evolution of life as emergence of longer scales belonging to this hierarchy and as special case also to a vision about evolution of cell, nervous system, EEG, and long term memory. The increase of the largest Planck constant in the hierarchy of Planck constants associated with the organism would mean increase of the time scales of planned action and memory and therefore evolutionary leap. The model predicts a hierarchy of preferred size scales for various sub-systems of organisms and corresponding time scales identifiable in terms of bio-rhythms and memory span. Also cells and neurons could be classified according the their evolutionary level characterized by the largest Planck constant involved.

The evolution at our level of hierarchy would most naturally correspond to cultural evolution taking mainly place at the level of magnetic bodies responsible for higher levels of collective consciousness. This would explain why we differ so dramatically from our cousins although genomes are virtually identical. Evolution of quantum computer programs associated with DNA would be one aspect of this evolution.

6.7.5 Does memory code exist?

Stuart Hameroff is one of the pioneers of the quantum conscious and quantum biology. Quite recently Hameroff and collaborators publishes a proposal for memory code based on microtubules. The simplest version would identify code words as 6 bit sequences just as in case of genetic code. The bit would be represented by the presence or absence of phosphate. TGD suggests a different interpretation in terms of flux tubes connecting microtubule surface with lipid layer and now the presence of ATP would mean that flux tube is in active state and gives rise to negentropic entanglement (See the article A Proposal for Memory Code [L24]).

In an article in the March 8 issue of the journal PLoS Computational Biology, physicists Travis Craddock and Jack Tuszynski of the University of Alberta, and anesthesiologist Stuart Hameroff of the University of Arizona propose a mechanism for encoding synaptic memory in microtubules, major components of the structural cytoskeleton within neurons. The self-explanatory title of

the article is Cytoskeletal Signaling: Is Memory Encoded in Microtubule Lattices by CaMKII Phosphorylation? [J32].

The basic ideas of the model of the model of memory code are following.

1. The hexagonal cylindrical lattice of microtubule suggests the possibility of lattice consisting of bits and probably very many proposals have been made. One such idea is that bit is represented in terms of the two basic conformations of tubulin molecules called α and β. The recent proposal is that bit corresponds to the phosphorylation state of tubulin. Also a proposal that the bits form 6-bit bytes is considered: 64 different bytes are possible which would suggest a connection with the genetic code.

2. The motivation for the identification of byte is that CaMKII enzyme has in the active state insect like structure: 6 + 6 legs and the legs are either phosphorylated or not. This geometry is indeed very suggestive of connexion with 6 inputs and 6 outputs representing genetic codons representable as sequences of 6 bits. The geometry and electrostatics of CaMKII is complementary to the microtubular hexagonal lattice so that CaMKII could take care of the phosphorylation of microtubulins: 6 tubulins at most would be phosphorylated at one side. The presence of Ca^{+2} or calmodulin flux flowing to the neuron interior during nerve pulse is responsible for self-phosphorylation of CaMKII: one can say that CaMKII takes itself care that it remains permanently phosphorylated. I am not sure whether this stable phosphorylation means complete phosphorylation.

It is however difficult to imagine how Ca^{+2} and calmodulin flux could contain the information about the bit sequence and how this information could be coded in standard manner to phosphorylation pattern of legs. The only possibility which looks natural is that phosphorylation is a random process and only the fraction of phosphorylated legs depends on Ca^{+2} and calmodulin fluxes. Another possibility would be that the subsequence process of phosphorylation MT by completely phosphorylated CaMKII manages to do it selectively but it is very difficult to imagine how the information about codon could be transferred to the phosphorylation state of MT.

For these reasons my cautious conclusion is that phosphorylation/its absence cannot represent bit. What has been however found is a mechanism of phosphorylation of MTs, and the question is what could be the function of this phosphorylation. Could this phosphorylation be related to memory but in different manner? The 6+6 structure of CaMKII certainly suggests that the analog of genetic code based on 6 bits might be present but realized in some other manner. The presence of ATP would make a bit active and a rather natural expectation is that typically all bits are either in-active or active. This would give a direction connection with negentropic entanglement. The negative energy signal from future would naturally transform ATP to ADP and mean transfer of mental image made possible by negentropic entanglement to geometric now. The original mental image representing memory would be destroyed in accordance with no-cloning theorem.

6.8   Bio-photons

MEs (massless extremals) can be carriers of light like vacuum currents generating coherent light. Bio-photons [I37, I55, I87] were the first proposed identification for this coherent light in living matter [K56] . In absence of material about bio-photons I did not develop these ideas in any quantitative detail. Situation has changed with the development of web and recently I learned from Lian Sidorov about home page containing online articles of Fritz-Albert Popp and colleagues about bio-photons and related phenomena. I am grateful for Lian also for very useful discussions and keen questions helping me to become and stay conscious about the many poorly understood aspects of the 'great vision'. This homepage is recommended also to the reader and the data used below mostly derive from the articles therein [J100] .

6.8.1   What bio-photons are?

The web articles [J100] provide the basic facts about bio-photons and in the following I summarizes my novice view about bio-photons.

Bio-photons have frequencies in the range 200-800 nm (at least). The intensity of bio-photons is extremely low: from one photon to few hundred photons/$cm^2 s$, which is 20 orders of magnitude weaker than common fluorescence of photophosphorence. There is evidence for coherent radiation also at longer wave length scales. A far from thermal equilibrium situation is in question: the intensity of photons is about 10^{10} times higher than that associated with the thermal visible photons at body temperature. The spectral density $f(\nu)$ defined as the counterpart of Boltzmann weight is essentially constant. This means that the effective temperature increases linearly with frequency. The experimental work of Popp and colleagues provides support for the view that bio-photons are indeed coherent light rather than some waste radiation resulting as a by-product of biological processes [J100] . Poisson statistics for the number of photons in coherent state ($p_n = exp(-\alpha)\alpha^n/n!$) is the basic signature for the coherent light and it is found that photon counts obey this distribution.

Since $\tau \sim 1$ nanoseconds is the characteristic time constant for em emissions and absorptions at visible wave lengths, one can argue that the length scale $L = c\tau \sim 10$ cm defines the length scale below which it is not sensible to speak about localized photon and thus bio-systems must be treated as macroscopic quantum systems as far as coherent photons are considered. The timescale means also that 10^9 reactions per second can in principle catalyzed by absorption and emission of single photon in single cell: the typical number of reactions is 10^5 per second inside single cell [J100] . If bio-photons Bose-Einstein condense at magnetic mirrors (ME-magnetic flux tube pairs), extremely sharp control of biological reactions could be indeed achieved. Of course, if Bose-Einstein condensed bio-photons are most important for bio-control, one cannot exclude the interpretation of the observed bio-photons as some kind of leakage radiation from living matter (of course, these bio-photons might serve communication purposes).

Even the wave length of the visible photons, which is somewhat below the cell size, implies that molecules see classical em field like boat sees the sea. One could argue that photons as CP_2 type extremals are essentially point-like. One the other hand, if MEs are classical correlates for photons or if the classical interaction of atoms and molecules with MEs is additional aspect of their interaction with em fields, this is not the case. The situation is not conceptually completely clear in this respect.

Interference effects provide also support for the notion of macroscopic coherent states. Popp proposes that in a healthy organism constructive interference tends to occur inside cells for bio-photons whereas destructive interference takes place outside [I90, I87]. Or stating it differently, cells are able to store visible bio-photons inside them. For healthy cells the bio-photon emission and well as delayed luminescence have been found to increase as a function of cell density up to some critical density and to decrease after that. For cancer cells the intensity increases indefinitely and nonlinearly [I90]. This supports the view that in cancer cell population bio-photons leak out and do not properly participate to the bio-control.

Bio-photon emission is a signature of living matter in the sense that the presence of oxidative process accompanies always the emission. This is true also for the delayed luminescence resulting as a delayed response to electromagnetic or some other perturbation. The dependence of the delayed luminescence on temperature suggests that the activation energy for the process controlling photoluminescence is roughly .53 eV [I26] : this is rather near to the energy .49 eV stored in the ATP molecule. The experiments involving the insertion of inert molecules to DNA indicate that DNA is a source of bio-photons [I47] , [J100] . The spectrum of bio-photons and delayed luminescence correlates strongly with various biological processes. For this reason bio-photons have several applications to bio-search, food quality control, cancer research, pharmacology and heal prophylaxis.

6.8.2   Some phenomena related to bio-photons

There are several interesting and theoretically challenging phenomena involving bio-photons.

1. Delayed luminescence [I100, I85] results after an exposure to an external perturbation, which can be light or ultrasound. Delayed luminescence accompanies also biological processes like cell mitosis. The intensity of the coherent light varies from few photons to 10^5 photons/$cm^2 s$. The characteristic feature of the delayed luminescence is hyperbolic ($I(t) \propto 1/(1+\lambda t)$) decay instead of the exponential one expected if incoming light just scatters from the system.

The intensity involves oscillatory modulations with respect to a variable u which depends logarithmically on time coordinate ($u = log(1 + \lambda t)$). As a function of cell density delayed luminescence increases up to some critical cell density for a healthy cell population and begins to decrease after that. For cancer cell population there is no such critical cell density.

2. Some animal populations can 'see' each other. For instance, when populations of dinoflagellates become to optical contact they begin to flicker synchronously [I26] (also fireflies in mangrove trees in Thailand flicker in a synchronous manner). In TGD framework this could be interpreted as evidence for magnetic mirror bridges connecting the populations such that the MEs associated with visible light propagate along them from population to another one. The bridges could also contain ELF em waves serves as synchronizers in the time scale in which flickering occurs.

3. Bacteria absorb bio-photons from nutrition media in a way that the absorption is highest for some critical cell density [I90]. Female inbred daphnia in the same developmental stage and about the same size do not display the increasing bio-photon emission with increasing number [I90]. Rather, a typical interference pattern of emission is observed showing maxima and minima of the bio-photon intensity at definite average distances between the animals. This could be seen as evidence for the hypothesis that the pattern of coherent light from DNA serves as kind of hologram representing 4-D template for the self-organization.

6.8.3   General TGD based model for coherent bio-photons

MEs with light like vacuum currents indeed generate coherent photons so that bio-photons indeed have a place in TGD Universe. ATP energy about .49 eV and near to the rough estimate .53 eV for the activation energy deduced by studying the temperature dependence of the delayed luminescence [I26] . This encourages to think that the MEs are closely related with the process transforming ADP to ATP serving as energy batteries (see [K39] for the TGD based model of ATP). This assumption conforms also with the fact that coherent light is associated with the oxidative process.

Bio-photons and MEs

The empirical data are consistent with the assumption that the MEs are associated with DNA (at least) and are perhaps responsible for the electromagnetic expression of the genetic information below cellular length scales (and corresponding scaled up dark length scales since there is no reason to exclude the dark variants of MEs).

MEs can carry Bose-Einstein condensates of parallel photons and the observed coherent photons represent leakage of the coherent light from cells. Both positive and negative energy MEs are possible and most naturally they are created in a pairwise manner: pairs (which do not form bound states) with a vanishing net energy and momenta are especially interesting since classical conservation laws do not pose any constraints on their creation and annihilation by p-adic-to-real transition. The buy now-pay later energy production by feeding negative energy to the environment might be closely related with the generation of pairs of MEs which vanishing net energy. It must be emphasized that also magnetic mirrors with positive and negative energies might be in question.

Bio-photons as a signature of dark matter hierarchy

Dark matter hierarchy allows perhaps the most plausible interpretation of bio-photons and is also in spirit with the general ideas about quantum holograms. The model of EEG (actually hierarchy of them) based on dark matter hierarchy [K20] assumes that the basic structures assignable to cell have fractal scaled up variants at higher levels of dark matter hierarchy. These higher level structures could generate dark photons with energies in the range corresponding to visible photons.

At the k_d^{th} level of the hierarchy predicted by Mersenne hypothesis the wavelength of photon is scaled up by a factor 2^{k_d} with possible values of k_d fixed by the Mersenne hypothesis [K20] so that communications using "visible dark" light become possible in arbitrarily long length scales. The model for cell membrane as a sensory receptor leads to the identification of these photons in

terms of dark Josephson radiation and EEG and bio-photons have identification in terms of decay products of dark Josephson photons.

MEs would have lengths of order wave length (which are below cell size for visible light), and there would be a constant distribution of MEs with respect to the direction and length of ME in the scaled up length scale interval corresponding to wavelengths of visible light. The scaled up wavelengths would correspond to the distances between source and receiver of bio-photons and $k_d \equiv\equiv 0$ would correspond to intracellular bio-photons assignable to MEs connecting sub-cellular structures having distance distribution which is more or less constant. The higher level contributions would tend to smooth out the wavelength distribution even if this is not strictly the case.

The general vision about quantum control of motor actions and sensory representations is consistent with the interpretation of positive energy MEs as space-time correlates for the emission of photons responsible for communications and negative energy MEs as correlates for phase conjugate photons involved with generalized motor control. In this framework bio-photons could result from the de-coherence of $k_d > 0$ dark photons and also as a leakage of $k_d = 0$ photons from cell interior. The synchronous flickering of dinoflagellates suggests $k_d > 0$ bio-photons are indeed present.

About the anatomy of dark MEs

MEs at the k_d^{th} level of dark matter hierarchy correspond to $r = 2^{k_d}$-fold covering of M^4, which are analogs of multi-sheeted Riemann surfaces (note that the meaning of "sheet" in this context is different from that in the context of many-sheeted space-time). Each sheet of the covering corresponds to scaled up variant of the space-time sheet associated with ordinary photon with r-fold size scale and classical energy E/r. This allows to interpret the formula $E = \hbar(k)f = r\hbar_0 f$ at space-time level.

r-fold MEs could be generated by r-sheeted magnetic flux sheets containing Bose-Einstein condensates of bosonic ions in quantum coherent manner such that each sheet is responsible for one sheet of r-fold ME.

The decay to ordinary photons can occur in two manners.

1. In de-coherence a downwards scaling of the structure by a factor $1/r$ and collapse to a single sheeted structure with energy E representing ordinary photon occurs. Since frequency is replaced with rf and $\hbar$ by $\hbar_0$, energy does not change.

2. The multi-sheeted structure could also decay to r single sheeted structures with energy E/r.

Constraint to the intensity of the vacuum current

The decomposition of dark MEs to r ordinary MEs cannot correspond to the generation of coherent photons by vacuum current since the frequencies involved would be much lower than the frequencies $\sim 10^{14}$ Hz associated with the visible light. Thus one can restrict the consideration to $k_d = 0$ case. This process might however also occur as the experimental findings of Gariaev [I52] about laser light induced radio-wave emission to be discussed in the next section indicate.

The source of photons at the second end of ME is responsible for the Bose-Einstein condensate of photons associated with ME. These photons are not observed unless some kind of leakage occurs at the receiving end of ME: suppose that this does not happen. Physical intuition suggests that the light-like vacuum currents associated with MEs generate coherent states of ordinary photons and that these photons leak out and give rise to the observed bio-photons. MEs lose their energy in the process and become eventually vacuum extremals.

These assumptions allow to deduce a constraint to the intensity of the vacuum current associated with ME.

The interaction Lagrangian of the vacuum current with the vector potential of the quantized photon field is given by

$$L_{int} \quad = \quad e \int d^4x j \cdot A \tag{6.8.1}$$

where the indices of the second quantized vector potential and vacuum current have been dropped away for simplicity and the units $\hbar = c = 1$ are used and e denotes the electromagnetic coupling.

This interaction term describes an infinite number of harmonic oscillators coupled to an external oscillatory force. In each Fourier mode initial vacuum state is transformed to a coherent state which is an eigenstate of the corresponding annihilation operator. By standard calculations [B10] one can deduce the expression for the effective classical vector potential defined by the eigenvalues of the annihilation operators is given by

$$
\begin{aligned}
A(x,t) &= \frac{ie}{(2\pi)^3} \int d^3k \frac{1}{2\omega(k)} exp\left[-ik \cdot x - i\omega(k)t\right] j\left(k, \omega(k)\right) \;, \\
\omega(k) &= |k| \; .
\end{aligned}
\tag{6.8.2}
$$

The eigenvalues $\alpha(\epsilon, k)$ for the annihilation operator $a(\epsilon, k)$ associated with polarization ϵ is given by the expression

$$
\alpha(\epsilon, k) = \frac{ie}{2(2\pi)^3\omega(k)}\epsilon \cdot j(k, \omega(k)) \; .
\tag{6.8.3}
$$

$\alpha(k)$ indeed has the dimension length to $3/2$ as it should be on basis of the commutation relations in the continuous momentum basis. If finite quantization volume with a discrete momentum basis is used, $\alpha(k)$ contains additional $1/\sqrt{V}$ factor guaranteeing that the eigenvalues are dimensionless.

The eigenvalues characterizing the coherent states are proportional to the massless Fourier components of the vacuum current so that the intensities of bio-photons determining the values of the parameters $\alpha(k)$ allow to deduce the on mass shell Fourier components of the light like vacuum current. Of course, the coherent field of photons is superposition of several interfering contributions coming from MEs with light like currents and only the sum of these contributions appears in the detected field.

Sucking force in TGD framework

The mechanism by which sun flowers turn towards Sun as well as the attraction between cells are not very well well-understood processes. Popp and Chang introduce as an explanation an interaction which they call sucking force [I90]. The notion is inspired by the assumed analogy with the vacuum cleaner which is a particular kind of a pump. The pressure gradient along the tube of the vacuum cleaner generates airflow towards the tube. Since pumping is always done when dissipative processes are present, a process involving essentially the dynamics of quantum jumps is in question and the force does not have counterpart at the level of the irreversible classical dynamics.

In case of em fields radiation pressure gradient replaces the ordinary pressure gradient. The counterpart of the tube of vacuum cleaner is naturally a ME along which Bose-Einstein condensed photons propagate and are absorbed at the second end of the tube, most naturally cell in case of visible photons. The pumping implies an attractive force between living systems connected by MEs. This force would be present at all levels of the length scale hierarchy. The force is only between systems having common characteristic frequencies so that they can be connected by MEs. For instance, this force could explain why tRNA carrying amino-acids finds the corresponding mRNA in the translation of DNA to proteins.

The sucked MEs can propagate along larger ME serving as an em bridge to the receiving system and the absorbtion most naturally corresponds to the annihilation with MEs of opposite energy. Both negative and positive energy MEs can be sucked. The sucking of negative energy MEs makes possible very flexible buy now-pay later type energy consumption: the user (say DNA) generates pairs of positive and negative energy MEs and utilizes the positive energy MEs, whereas the negative energy MEs are received by the payer, most naturally mitochondria where they annihilate with the positive energy MEs produced by ATP process.

6.8.4 The interpretation of bio-photons and EEG as decay products of dark Josephson radiation

The foregoing considerations have been classical in the sense that MEs have been taken as a model for bio-photons. The model of EEG [K20] leads to the prediction that cell membranes act as Josephson junctions generating Josephson radiation. If the cell membrane is assumed to be almost vacuum extremal which brings in classical Z^0 field proportional to em field and raises the energy scale of Josephson junction from .07 eV for neuron to UV range. The electromagnetic charge of ion must be replaced with effective charge which is non-vanishing also for neutral atoms and molecules.

The energies of dark photons involved are in visible and UV range for most ions in the range of resting potentials just as the energies of bio-photons. The model also predicts correctly the peak frequencies of maximal sensitivity for the four kinds of photoreceptors. The frequencies are inversely proportional to the value of Planck constant characterizing the cell membrane. Quite generally, the value of Planck constant characterizes the evolutionary level of neuron.

Both EEG photons and bio-photons can be identified as decay products of dark Josephson photons producing either a bunch of EEG photons or single bio-photon. The frequency modulation of Josephson frequencies provides a general coding of sensory percepts and other information in terms of Josephson radiation communicating this data to the magnetic body. This modulation could also explain the observed periodic modulations.

Chapter 7

Comments about the recent experiments by the group of Michael Persinger

7.1   Introduction

Michael Persinger's group reports [J85, J86, J87] three very interesting experimental discoveries relating to EEG, magnetic fields, photon emissions from brain, and macroscopic quantum coherence.

In the first article [J85] entitled *Congruence of Energies for Cerebral Photon Emissions, Quantitative EEG Activities and* ~ 5 *nT Changes in the Proximal Geomagnetic Field Support Spin-based Hypothesis of Consciousness* correlations between cerebral photons emissions, EEG, and changes of the proximal geomagnetic field are reported. The findings provide support for the proposal of Hu and Wu [J116] that nerve pulse activity could induce spin flips of spin networks assignable to cell membrane motivated by the observation that the magnetic spin-spin interaction between protons at a distance of 10 nm (cell membrane thickness) corresponds to energies for which frequency is in EEG range.

In the second article [J86] entitled *Demonstration of Entanglement of Pure Photon Emissions at Two Locations That Share Specific Configurations of Magnetic Fields: Implications for Translocation of Consciousness* the group reports an excess correlation between "pure" photon emissions at two locations separated by few meters that share specific correlations of frequency modulated magnetic fields. The photon emissions were from LEDs in the experiment consider. In an earlier similar experiment, which is also discussed, they were from chemical reactions occurring in solutions contained by cell cultures.

In the third article [J87] entitled *Experimental Demonstration of Potential Entanglement of Brain Activity over 300 Km for Pairs of Subjects Sharing the Same Circular Rotating, Angular Accelerating Magnetic Fields: Verification by s_ LORETA, QEEG Measurements* an excess correlation of brain activity of subject persons separated by 300 km and sharing the same circular rotating, angular accelerating magnetic fields is reported.

It turns out that the experiments provide support for several TGD inspired ideas about living matter: magnetic flux quanta as generators of macroscopic quantum entanglement, dark matter as a hierarchy of macroscopic quantum phases with large effective Planck constant, DNA-cell membrane system as a topological quantum computer with nucleotides and lipids connected by magnetic flux tubes with ends assignable to phosphate containing molecules, and the proposal that "dark" nuclei consisting of dark proton strings could provide a representation of the genetic code. The proposal of Hu and Wu [J116] translates into the assumption that lipids of the two layers of the cell membrane are accompanied by dark protons which arrange themselves as dark protonic strings defining representation for DNA sequences.

In the sequel I briefly explain my own interpretation of these experiments and their outcomes from TGD point of view and show that a nice interpretation of the findings emerges. Before going

into this it is however appropriate to summarize briefly those aspects of TGD-based view about living matter which are relevant for the interpretation of the experiments.

7.1.1 Key aspects of the TGD-inspired vision about living matter

The following are the key ingredients of TGD-inspired vision about living matter needed for our argument:

1. The notion of many-sheeted space-time is the first new element [K30, K31]. Space-times are 4-D surfaces in 8-D space-time $M^4 \times CP_2$ so that one has what might be called sub-manifold gravity. Any physical system corresponds to a space-time sheet characterizing its shape and size. The outer boundaries of macroscopic objects correspond to causal boundaries at which the signature of the induced metric of the space-time surface changes. Therefore space-time surfaces are topologically non-trivial in all scales and we directly perceive it. Space-time surfaces form a fractal hierarchy in the sense that subsystems of a system correspond to space-time sheets topologically condensed on it via the formation of wormhole contacts which are regions of space-time with an Euclidian signature of the induced metric.

   Also the notion of classical field is topologized. Various classical fields are subject to what might be called topological field quantization. For instance, radiation fields decompose to topological light rays and magnetic field to magnetic flux quanta (flux tubes and flux sheets). Topological field quantization is of special importance in living matter and leads to the notion of field body and magnetic body as additional structural and functional parts of a living system.

2. p-Adic physics [K85] defines a further basic element. p-Adic number fields are proposed to serve as correlates for cognition in the sense that one can speak about p-adic space-time sheets as correlates for cognition and for intentions [K53, K119] The quantum jump transforming p-adic space-time sheet to a real one corresponds to a transformation of intention to action. The generation of though in turn corresponds to an opposite of this transition. Zero energy ontology makes this picture internally consistent and no breaking of conservation laws is implied.

   p-Adic length scale hypothesis [K54] states that p-adic primes near powers of 2 are of special physical significance and Mersenne primes $M_n = 2^n - 1$ especially so. A possible explanation for the importance of these primes is that evolution corresponds to a gradually increasing complexity. The primes slightly below power of two are simple in the sense that all digits in their pinary expansion are '1':s expect possibly for some of the first ones, and are physically especially interesting because they should have emerged first if the number theoretical evolution proceeds from simple to more complex. Mersenne primes have only '1':s in their pinary expansion so that they are the simplest possible primes and indeed seem to correspond to fundamental physical scales. This leads to quite powerful predictions in particle physics context.

   In the scales of living matter a number theoretical miracle occurs: the length scale range from 10 nm (cell membrane thickness to 2.5 μm (size scale of cell nucleus) contains as many as four electron Compton scales $L_e(k) = \sqrt{5}L(k)$ defined by Gaussian Mersennes $M_{G,n} = (1+i)^n - 1$: obviously they correspond to p-adic primes near p^k, $k = 151, 157, 163, 167$.

3. The hierarchy of *effective* Planck constants [K24] coming as integer multiples $\hbar_{eff} = n\hbar$ of the ordinary Planck constant was partially motivated by the findings of Blackman [J46] and others related to the unexpected effects of ELF em fields on vertebrate brain. These effects look quantal but this should not be possible since the cyclotron energies in the magnetic field $.2 \times 10^{-4}$ T (2/5 times the nominal value of the Earth's magnetic field $B_E = .5 \times 10^{-4}$ T) are 10 orders of magnitude below the thermal threshold.

   This led to the hypothesis about the value spectrum of Planck constants. The phases of ordinary matter with non-standard value of effective Planck constant are identified as dark matter. Later two different - possibly equivalent - reductions of the hierarchy to that for *effective* values of $\hbar$ have emerged in TGD framework [K119].

One of the most speculative ideas related to the dark matter hierarchy is based on the observation that a simple model for dark proton implies that the states of dark proton are in 1-1 correspondence with DNA, RNA, tRNA, and amino-acids, and that there is a simple rule reproducing vertebrate genetic code [L10, K37]. Dark nuclei defined by sequences of dark protons would define the analogs of DNA sequences so that genetic code would not be a outcome of random bio-chemical selection but a basic element of particle physics, and biological systems would only define a secondary representation of the fundamental genetic code. This proposal has far reaching implications. Surprisingly, the findings of the first article [J85] supporting the hypothesis of Hu and Wu [J116] about proton spin networks combined with the dark DNA hypothesis lead to a concrete model for the proton spin networks as paired dark DNA sequences assignable to the two lipid layers of the cell membrane.

4. Magnetic flux tubes carrying dark matter take central role in TGD inspired quantum biology. The knotting and braiding of the flux tubes makes possible topological quantum computation and leads to the hypothesis that DNA and cell membrane connected by flux tubes form a topological quantum computer [?]. Flux tubes can connect sub-systems of living organisms or even different organisms to form coherent structural and functional units. Indeed, the large value of $\hbar_{eff}$ makes possible macroscopic quantum coherence. In particular, biomolecules can be connected by flux tubes to coherent structures. The reconnection of flux tubes plays a key role in the proposed model bio-chemical reactions and bio-catalysis. Important are also the phase transitions changing the value of Planck constant inducing in turn a change of the length of the flux tube identified as a quantal length scale depending of $\hbar_{eff}$. These phase transitions could be responsible for the phase transitions changing dramatically the density of matter in cellular interior (say sol-gel transition).

Cyclotron Bose-Einstein condensates at magnetic flux tubes are proposed to be a characteristic of living systems [K7]. Cyclotron frequencies are classical (no dependence on Planck constant) but cyclotron energies scale like $\hbar_{eff}$ so that for a large enough value of the effective Planck constant cyclotron energies of dark photons are above thermal threshold, and can induce macroscopic quantum coherence. Dark photons decay to bunches of ordinary photons and an attractive hypothesis is that bio-photons result as decay products of dark photons.

The notion of magnetic body emerges naturally. Any physical system is accompanied by magnetic fields which in TGD Universe defines separate entity, which can be called magnetic body. Magnetic body is identified as an intentional agent using biological body as sensory receptor and motor instrument. Magnetic body has an onion like structure corresponding to the hierarchy of space-time sheets defining physical system, say biological body. The size of the magnetic body is much larger than that of biological body. 10 Hz frequency corresponds to a layer with size large than the size scale of Earth.

5. Zero energy ontology (ZEO) [K6] is a further basic element. In zero energy ontology physical states are zero energy states consisting of pairs of positive and negative energy states having opposite net quantum numbers and being localized to the opposite light-like boundaries of $CD \times CP_2$, where CD is the causal diamond identified as an intersection of future and past directed light-cones and defining a structure analogous to a double pyramid (a convenient shorthand for $CD \times CP_2$ is simply CD).

The interpretation of zero energy states is as counterparts of pairs of initial and final states of physical events in positive energy ontology. CDs form a fractal hierarchy with CDs within CDs. The size scales of CDs come as integer multiples of CP_2 size scale about 10^4 Planck lengths. One can interpret CD as an embedding space correlate for a "spotlight of consciousness" in the sense that the conscious experience of self associated with a given CD is about the region defined by CD. Space-time sheets within CD serve as correlates for selves at space-time level.

Also elementary particles are expected to be accompanied by CDs, and one especially important prediction is that the time scale of the CD associated with electron is .1 seconds, which corresponds to the fundamental 10 Hz bio-rhythm. All elementary particles correspond to macroscopic time scales and u and d quarks would correspond to time scales between 1 ms and .1 seconds.

7.1.2   Cell membrane as super-conductor and a model for EEG

The proposal is that the cell membrane is accompanied by super-conducting dark magnetic flux tubes [K66]. Cooper pairs of electrons, protons, and biologically important fermionic ions would be the carriers of supra currents besides bosonic ions such as Ca^{++} and Mg^{++}. Note that the new exotic nuclear physics suggested by TGD allows to imagine that fermionic nuclei could appear as bosonic variants with essentially the same chemical properties [L10].

Josephson currents through cell membrane have frequency $f = eV/\hbar_{eff}$ so that in this case the energy $E = eV$ identifiable as the energy of electron or proton gained in traversing the cell membrane is a classical quantity whereas Josephson frequency is quantal [K66]. The situation is opposite to this for cyclotron frequencies and energies. Obviously, large values of $\hbar_{eff}$ correspond to low Josephson frequencies. Soliton sequencies associated with the Sine-Gordon equation governing the dynamics for small variations of membrane potential would represent ground states of axonal membranes mathematically, analogous to sequences of mathematical penduli rotating in phase. Nerve pulse generation would mean a perturbation in which one pendulum is kicked [K66].

There are two alternative models for the cell membrane as a Josephson junction [K7].

1. For the conservative option [K7] the cell membrane is a far-from-vacuum extremal and various charged particles experience only the electromagnetic field. The energy scale of excitations is determined by the electric voltage and is given by $E = eV$. Nerve pulse generation would be associated with this kind of membranes. Josephson radiation with harmonics of $f = eV/\hbar_{eff}$ is one signature of super-conductivity.

   One also ends up with an explanation of EEG in this framework [K20]. The function of EEG would be communication of sensory data from cell membrane to the magnetic body and control of biological body via flux sheets traversing through DNA, where genetic expression is activated by the control signals. EEG frequencies are linear combinations of harmonics of Josephson frequencies and of the increments of cyclotron frequencies. Cyclotron transitions can be also accompanied by a spin flip. This model allows one to identify EEG bands. The hierarchy of Planck constants suggest a generalization of EEG and its variants (say EKG) to a fractal hierarchy obtained by scaling EEG. For large enough values of $\hbar$ cyclotron contributions to EEG energies would correspond to energies above thermal threshold as also Josephson frequency (Josephson energy $E = eV_{thr}$, where V_{thr} is the value of resting potential at which nerve pulse is generated is just at the thermal threshold). This would make possible the correlation of EEG with the brain state and also quantum biocontrol by using photons with EEG frequencies.

2. For the non-conservative option [K19] cell membrane is near-to vacuum extremal. The classical Z^0 fields predicted by TGD dominate over em fields, and the voltage must be replaced by a combination of Z^0 and em voltages. By assuming that the Weinberg angle is considerably smaller in this phase than in the standard phase the energies gained by various ions correspond to visible photons. This hypothesis allows one to understand the frequencies for which photoreceptors - which do not directly generate nerve pulses - are most sensitive. Near-vacuum extremal property obviously implies high sensitivity to perturbations making the sensory receptor optimal.

An interesting possibility is that the far-from-, respectively near-to-vacuum extremal options are realized for the neurons of left *resp.* right hemisphere. This option finds support from the observation of Persinger et al [J85] that visible photon emissions are mostly from the right hemisphere. Another possibility is that glial cells as cells which do not generate nerve pulses correspond to near-to vacuum extremals. The identifications do not exclude each other.

7.1.3   Learning to apply the notion of induced field

The geometrization of classical gauge fields and gravitational fields relying on the induction of spinor connection of CP_2 and $M^4 \times CP_2$ metric to the space-time surface is one of the key ideas of TGD and it is useful to get more concrete understanding of the induced fields since this notion will be applied in the sequel.

The basic objection and its resolution

The basic objection against the induced fields is that they reduce the dynamics to that of only 4 field like variables since the 8 embedding space coordinates take the role of field variables and 4 of them are eliminated by general coordinate invariance as field variables. Besides this preferred extremals of Kähler action represent space-time surfaces carrying very restricted kind of patterns of induced gauge fields analogous to Bohr orbits.

Many-sheeted space-time however saves the situation. Each system creates its own field body represented in terms of topological field quanta. If these field bodies have common M^4 projection, a test particle topologically condenses to each of these field body (touches each of them), and the effects of these fields sum up although fields do not interfere as they would do in ordinary field theory.

How could one generate dark photons with large $\hbar$?

The observation which led to the proposal of the effective hierarchy of Planck constants, was that microwaves with frequency of f_h modulated by ELF frequency f_l induce in vertebrate brain effects which could be understood in terms of cyclotron frequencies assignable to quantal cyclotron transitions in an endogenous magnetic field $B_{end} = .2$ Gauss for which cyclotron frequency was equal to ELF frequency: $f_c = f_l$. These effects are possible only if the cyclotron energy is above thermal energy, and this led to the proposal about the hierarchy of Planck constants. '

The key question is how the modulation by ELF frequency could generate dark photons with large $\hbar_{eff}$. A possible answer to this question comes from another question. Topological field quantization forces one to ask what is exactly implied by the amplitude modulation of fields.

The simplest modulation corresponds to a multiplication of rapidly oscillating field with a slowly varying oscillating amplitude so that amplitudes with frequencies $f_h \pm f_l$ result ('h' and 'l' refer to "high" and "low"). The natural thing to do is to develop the two amplitudes with frequencies $f_h \pm f_l$ in Fourier series in time interval $T = 1/f_l$. All harmonics of f_l appear and coefficients of the expansion are proportional to $1/(f_h - (n \pm 1)f_l)$. Maximal amplitudes correspond to $f_h \simeq (n \pm 1)f_l$. This suggests that when this almost-resonant condition is satisfied the generation of dark photons with frequency f_l and energy $\hbar_{eff} f_l$, with $\hbar_{eff} \simeq f_h/f_l$, can take place at a considerable rate. If this argument is correct, one could generate dark photons with given $\hbar_{eff}$ by using modulation satisfying the condition $f_h/f_l = \hbar_{eff}$.

In the case of ELF em fields interacting with brain this is not enough since microwave photons have energies below the thermal threshold E_{th}. Bio-systems however contain photons with energy above thermal threshold - say bio-photons with frequencies f in visible range or infrared Josephson photons generated by cell membrane Josephson currents; the fields associated with MEs ("massless extremals", topological light rays) accompanying these many-photon states can be modulated by the ELF modulated microwaves. Since one can say that a modulation of modulation is also a modulation, the outcome is modulation (f, f_{ELF}) producing dark photons with $\hbar_{eff} \simeq f/f_{ELF}$ with energies about E_{th}.

This mechanism would explain the "scaling law of homeopathy"' [K37] stating that fields with low frequencies f_l are somehow transformed to fields with high frequencies f_h and vice versa. The proposal has been that large $\hbar_{eff}$ photons with $\hbar_{eff} \simeq f_h/f_l$ decay to ordinary photons or vice versa. This transformation has quite concrete description: $\hbar_{eff} = n$ photons correspond to n-furcations of space-time surface made possible by the non-determinism of Kähler action. All n-sheets of the n-furcation would be present and each of them would carry photon with frequency f_l and total energy would be $\hbar_{eff} f_l = f_h$.

How to describe time-varying magnetic fields?

The topological flux quantization for static magnetic fields is easy to understand. The description of time varying magnetic fields in terms of flux quanta is however a non-trivial exercise in thinking in terms of topological field quanta.

Flux quantization implies that the magnetic dipole field decomposes into closed flux tubes with a straight part inside dipole and a portion outside the dipole carrying return flux in roughly opposite direction also arranged to flux tubes.

The basic assumption is that the flux tube structure of dipole field is not lost but is only re-arranged as the dipole field oscillates. As the dipole strength decreases the flux tubes along field lines outside the dipole contract so that eventually the closed flux tubes of dipole field degenerate to those of wormhole magnetic fields [K101] restricted inside the dipole and consisting of parallel flux tube space-time sheets with same M^4 projection and carrying opposite magnetic field strength and having distance of order CP_2 length along CP_2 direction. A charged particle topologically condensing at both sheets experiences the sum of the magnetic fields, which vanishes. As the sign of dipole changes, the flux tubes in the interior of dipole begin to move to the exterior of the dipole. In operational sense this dynamics is approximated well by Maxwell's theory or vice versa.

How are the electric electric fields associated with the time-varying magnetic fields predicted by Faraday law represented? These fields are rotational with flux lines rotating around the magnetic field. In Maxwell's theory one would have single vortex like structure. In TGD this vortex-like structure decomposes into smaller vortices assignable to individual flux tubes just like the rotational flow of super-fluid decomposes into smaller vortices satisfying quantization condition analogous to the quantization of the magnetic flux.

Also the geometro-dynamics for the flux quanta of electric field is possible and in this case magnetic fields induced by time dependent electric fields are assignable to flux quanta. Cell membrane is a good example of this kind of situation. Quite generally, the geometro-dynamics of topological field quanta together with the possibility to have varying overlapping M^4 projections allows to reproduce the smooth dynamics of Maxwell fields.

The appendix of the book gives a summary about basic concepts of TGD with illustrations. There are concept maps about topics related to the contents of the chapter prepared using CMAP realized as html files. Links to all CMAP files can be found at `http://www.tgdtheory.fi/cmaphtml.html` [L35]. Pdf representation of same files serving as a kind of glossary can be found at `http://www.tgdtheory.fi/tgdglossary.pdf` [L36]. The topics relevant to this chapter are given by the following list.

- Geometrization of fields [L49]

- Magnetic body [L52]

- Basic Mechanisms associated with magnetic body [L39]

- Biophotons [L43]

- Bio-anomalies [L41]

- Biophotons [L42]

- ELF effects on brain [L47]

- Quantum antenna hypothesis [L58]

7.2   First article

The first article has the title *Congruence of Energies for Cerebral Photon Emissions, Quantitative EEG Activities and ~ 5 nT Changes in the Proximal Geomagnetic Field Support Spin-based Hypothesis of Consciousness*, which already summarizes the findings.

7.2.1   Findings

In the article [J85] Persinger's group reports simultaneous changes in photon emissions, EEG activity, and alterations of proximal geomagnetic field when a person sitting in dark is imagining white light or not.

According to the article's abstract, "the hypothesis by Hu & Wu that networks of nuclear spins in neural membranes could be modulated by action potentials was explored by measurements of the quantitative changes in photon emissions, electroencephalographic activity, and alterations in the proximal geomagnetic field during successive periods when a subject sitting in the dark imagined white light or did not. During brief periods of imagining white light the power density

of photon emissions from the right hemisphere was about 10^{-11} Wm^{-2} that was congruent with magnetic energy within the volume associated with a diminishment of ~ 7 nT as predicted by the dipole-dipole coupling relation across the neuronal cell membrane. Spectral analyses showed maxima in power from electroencephalographic activity within the parahippocampal region and photon emissions from the right hemisphere with shared phase modulations equivalent to about 20 ms. Beat frequencies (6 Hz) between peak power in photon (17 Hz) and brain (11 Hz) amplitude fluctuations during imagining light were equivalent to energy differences within the visible wavelength that were identical to the intrinsic 8 Hz rhythmic variations of neurons within the parahippocampal gyrus. Several quantitative solutions strongly suggested that spin energies can accommodate the interactions between protons, electrons, and photons and the action potentials associated with intention, consciousness, and entanglement."

The authors interpret the results in terms of entanglement identified as enhanced correlations. Entanglement in this sense does not correspond to quantum entanglement. To my opinion (quantum) coherence would be a more standard manner to interpret the findings. Quantum coherence of course also makes possible quantum entanglement.

Spin flips, whose importance for consciousness has been emphasized by Hu and Wu [J117], would occur between spin triplet and singlet states of pairs of protons belonging to the spin network. The basic finding is that the energy changes are accompanied by changes in EEG power.

Note that spin flips are possible also for cyclotron states proposed to be important for consciousness in TGD approach. In the case of electron the change of the energy in spin flip is in excellent approximation the same as in the transition $n \to n \pm 1$ of cyclotron state characterized by integer n (radial wave functions of electron in constant magnetic field correspond to those of harmonic oscillator). For ions the Lande factor g characterizes the effective nuclear angular momentum and appears in the spin flip energy and also now the frequencies involved are in EEG range.

The correlation of photon emissions with imagination of white light supports the hypothesis that EEG photons are responsible for communications to and control of biological body by magnetic body.

7.2.2 TGD inspired interpretation of the findings

What has been observed is correlation between EEG, emission of visible photons, and weakening of Earth's magnetic field with the change of magnetic energy equal to the energy of radiated photons. There is also evidence that spin flip transitions for protons are involved.

What is the origin of the visible photons?

The basic question concerns the origin of the visible photons.

1. An attractive general hypothesis is that the visible photons result in the transformation of dark EEG photons to ordinary visible photons. In TGD based model EEG (and its predicted fractal variants) correspond to dark photons with large *effective* value of $\hbar$ - call it $\hbar_{eff}$ - and energy $E = h_{eff} f$ in infrared or visible range and perhaps even in UV. Also bio-photons would result from these large $\hbar$ "dark" photons as they decay to bunches of ordinary photons. The wavelengths of dark photons with given energy are scaled by $\hbar_{eff}/\hbar$ predicted to be integer. The transformation of EEG photons to ordinary visible photons could explain the correlation between EEG and visible photon emission reported by Persinger's group. This kind of process would generate also bio-photons.

2. The mechanism providing energy for dark photons (in particular EEG photons) would provide it also for the visible photons. According to the authors, the energy would come from the Earth's magnetic field which I as inhabitant of many-sheeted space-time take liberty to translate to "measured magnetic field". What is interesting is that magnetic body would serve as a provided of metabolic energy. It is interesting to notice that in TGD based cosmology matter is created from the dark energy identified as Kähler magnetic energy assignable to magnetic flux tubes.

3. Authors conclude that the energy liberated per action potential is $E = eV_{rest}$. In TGD framework it could correspond to either a photon of Josephson radiation or the energy liberated when an electron traverses the cell membrane. What is troublesome is that this energy

corresponds to IR photon just above thermal threshold rather than visible photon. The non-conservative model for the cell membrane mentioned above (applying to photo-receptor cells at least) could explain why visible photons rather than infrared photons with energy $E = eV_{rest}$ correspond to photons of the Josephson radiation.

4. The model based on the observation of Hu and Wu [J116] suggesting that action potentials affect a spin network of protons (possibly at opposite ends of lipid of two lipid layers making cell membrane) looks like a totally different explanation from what would come first in mind in TGD framework. Could the spin network proposal of Hu and Wu be integrated to the picture of living matter provided by TGD? This is the question to be considered next.

The spin network hypothesis of Hu and Wu from TGD point of view

The hypothesis of Hu and Wu [J116] states that nuclear spin networks of nuclei associated with the cell membrane are relevant for consciousness in the sense that action potential induces modulations of the coupling parameters describing the magnetic interaction between neighboring spins of the spin network.

1. A direct calculation using the value of proton magnetic moment gives that the magnetic field created by proton at distance defined by cell membrane thickness of 10 nm is 3 nT. There are also other factors involved, and the estimate of Hu is that the field is about 5 nT.

2. The crucial observation is that the classical spin-spin interaction energy for two protons at distance $d = 10$ nm defined by cell membrane thickness and given by $E_{s-s} = -\mu \cdot B$, where B is the dipole field created by proton, corresponds to a frequency of the order 10^{-14} eV and thus is in EEG range. This can be seen by a direct calculation by assuming that proton creates a dipole field with Lande factor of proton.

   The frequencies assignable to the energies of neighboring interacting proton spins at distance d are in EEG range also when the effects of the environment are taken into account. For instance, the Hamiltonian for a rotationally symmetric nearest neighbor spin-spin interaction characterized in terms of so called J-factor, predicts in the case of protons frequency differences ΔE between singlet and triplet states varying in the range 5-25 Hz.

   For heavier nuclei these interaction energies scale down like $1/A^2$, A the mass number, so that a naive conclusion would be that the frequencies tend to be below 5 Hz scale. Proton would therefore be in a completely unique position. That EEG frequencies result in case of proton suggest that cell membrane thickness is not 10 nm by a pure accident (not that p-adic length scale hypothesis fixes assigns it to the p-adic length scale $L(k = 151)$, where $k = 151$ characterize Gaussian Mersenne prime.

The fact that the frequencies for energy differences of singlets and triplets are in EEG range is highly relevant also from TGD point view since this energy range makes it possible for EEG frequencies to induce spin flips.

1. In TGD framework fermionic spin and fermion numbers in various modes of second quantized induced spinor field (1 or 0) are predicted to serve as correlates for Boolean cognition [K16] so that there are good reasons to expect that also spin flips are important. One might even think that protonic and even nuclear spins could be utilized to build Boolean representations.

2. The basic objection against the proposal of Hu and Wu is same as that against the findings of Blackman and others: quantum coherence is not possible since the energy differences corresponding to (say) frequency of 5 Hz is about 12 orders of magnitude below thermal threshold. Trom the basic relation $E = h_{eff}f$ it is clear that the objection can be circumvented for large values of effective Planck constant, which can take raise the energies involved to those of IR or perhaps even visible photons.

3. Authors conclude that the energy emitted per single action potential is $E = eV_{rest}$ which corresponds to IR photon just at the thermal threshold. It is however visible photons which are emitted. Why not photons with the Josephson energy $E = eV_{rest}$ just at the thermal threshold?

If the photons would result when electron or proton traverses cell membrane and liberates potential energy as a photon or if the emitted IR photon could be interpreted as a photon of Josephson radiation this would be the case. TGD allows also to imagine that the cell membranes in question correspond to the non-conservative option for the model of cell membrane as Josephson junction for which V_{rest} contains Z^0 potential as a dominating contribution and gives rise to Josephson photons with energies in visible range.

If one takes the proposal of Hu and Wu seriously, the visible photons would have different origin, and one must perhaps give up the assumption that the estimate of authors forces the identification of basic energy quantum emitted in the process considered as $E = eV_{rest}$.

Authors state that the energy associated with visible photon emission should be equivalent to the energy emitted in the emission of photons. What can one conclude from this?

1. An attractive possibility would be "dark" spin network formed by spin-coupled protons, whose members are associated with the lipids of the two lipid layers with lipids. The number of the lipids per cell membrane would be roughly $N_l = r^2/d^2$, with lipids thickness estimated to be $d \sim .1$ nm. For $r \sim 10^{-4}$ m corresponding to a relatively large neuron this would give $N_l = 10^{14}$.

   This number would give also the maximum number of spin pairs participating in phase transition and an estimate for the value of $\hbar_{eff}$ from $N_l \Delta E_{s-s} = E_{ph}$ as

   $$N_l = \frac{E_{ph}}{E_{s-s}} = \frac{f_{ph}}{f_{s-s}} \quad .$$

   Suppose that all dipoles make a simultaneous spin flip with energy change $\Delta E = hf$, $f_{s-s} = 5$ Hz generating an energy of $E_{ph} = 1eV$ corresponding to a frequency of 2.4×10^{14} Hz. This requires $N_l \sim .5 \times 10^{14}$. It is encouraging that the rough estimates are consistent with each other.

2. That all protonic spin pairs make a simultaneous spin flip between singlet and triplet states of neighboring pairs looks like a phase transition. This suggests strongly macroscopic quantum coherence. What looks extremely strange is that a single visible photon should be emitted in the process since the entire magnetized region would behave like single spin! In standard physics this is not possible. TGD however leads to a possible realization of this kind of process as a mechanism of psychokinesis [L28].

   The hierarchy of effective Planck constants could resolve the paradox. If one has $\hbar_{eff}/\hbar \simeq E_{ph}/\Delta E \simeq .5 \times 10^{14}$, the emitted photon would be large $\hbar$ dark photon with frequency 5 Hz and the energy of visible photon and geometrically would corresponds to a n-furcation of space-time with $n = \hbar_{eff}/\hbar$ sheets each carrying single 5 Hz photon. Each dipole pair emits ELF photon but they combine to single dark ELF photon with the energy of single photon.

It seems that it is not natural to assign the photon emission to cyclotron transitions ionic cyclotron B-E condensates or to the transitions associated with the cell membrane Josephson junctions. Also the model based on the observation of Hu and Wu is very attractive. This does not add a completely new element to TGD. One can find a nice connection with one of the TGD inspired basic ideas about genetic code, namely the dark realization of genetic code as sequences of dark protons.

1. About 7 years ago I constructed a model for dark nuclei identifying them as strings of dark nucleons [L10, K37]. The model of dark nucleon yielded a compete surprise: the states of the nucleon were in 1-1 correspondence with DNA, RNA, tRNA, and amino-acids and vertebrate genetic code could be understood in a simple manner. This led to the vision that dark proton sequences allow a virtual world realization of genetic code making possible a kind of R&D department developing and testing various genetic alternatives. The genetic discoveries are however useful only if they can be used. This requires a generalization of transcription process allowing to transcribe DNA and RNA and perhaps even tRNA, and amino-acids to their dark counterparts and vice versa. This requires that dark nucleon sequences have

same size scale as ordinary DNA, RNA, and amino-acids and that they could accompany the biomolecules.

This fixes the size scale of dark proton to be of the order of the volume defined by the length L corresponding to single nucleotide in nucleotide sequence. The value of Planck constant would be of the order $\hbar_{eff}/\hbar \sim L/r_p \simeq 2.3 \times 10^5$, $r_p = \hbar/m_p \simeq 1.3 \times 10^{-15}$ m and $L \simeq .3$ nm.

2. At the same time I also constructed a model of DNA and cell membrane acting as a topological quantum computer [K23]. DNA nucleotides would be connected to lipids of the inner lipid layer of the cell membrane by magnetic flux tubes, whose braiding would define the topological quantum computer programs. The braids would continue from the outer lipid layers to the membranes of other cells and in this manner bind the cells to a kind of network. The strands could have at their ends molecules containing phosphates to make possible transfer of metabolic energy to the system.

3. Dark protons could be generated in the ionization of OH group to OH^- as proton drops to dark space-time sheet and possibly becomes a part of dark proton sequences.

   (a) The basic process would be formation of dark water in this manner and the rich spectrum of anomalies of water could be understood in terms of temperature dependence fraction of dark protons [K19].

   (b) OH groups are also associated with the hydrophilic ends of lipids such as fatty acids, glycerolipids, and phospholipids, which are the basic structural element of cell membranes. In phospholipids OH is associated with phosphate. In the DNA strand the phosphates contain O^- identifiable as OH^- resulting when proton of H drops to dark space-time sheet and possibly becomes part of dark proton sequence.

   (c) Also carbohydrates, in particular sugars, which are basic building brick of metabolism and defined the sugar backbone of DNA and RNA, contain a large number of OH groups. The model of DNA as topological quantum computer led to a proposal that magnetic flux tubes have OH or OH^- groups as their ends. These observations would allow magnetic flux tubes have dark protons at either or both ends. According to the earlier proposal [K23] magnetic flux tubes to have OH and $O =$ at their ends. Earlier picture need not to be modified if the cell membrane carries dark double DNA strand connected to the ordinary DNA double strand inside nucleus. Similar connections would be natural also between DNA and amino-acids and their dark counterparts possibly associated with the cell membrane and reconnection of the color magnetic flux tubes could allow to build and manipulate these connections.

4. This would predict that single DNA codon, which corresponds to a length of .33 nm along DNA strand is connected to single lipid by magnetic flux tube or three color magnetic flux tubes to corresponding proton consisting of 3 quarks. This seems to be consistent with the width of single lipid in lipid bilayer if one takes seriously the illustration of the Wikipedia article. Note that in the earlier model single nucleotide was assumed to be connected by a magnetic flux tube to *single lipid*.

5. A further natural working hypothesis is that the proton pairs assignable to the OH^- groups at the hydrophilic ends of opposite lipid layers can also be connected by triplets of (color) magnetic flux tubes giving rise to the dipole-dipole interaction. This connection need not be permanent and could disappear or appear by the reconnection of the magnetic flux tubes. This could correspond to the transiotion to singlet state for proton pairs and would require energy. The working hypothesis of [K23] indeed is that during topological quantum computation the connection is split so that the cell is isolated from external world. The connection would be restored as the computation halts. Photon emission would therefore be seen as a signature of topological quantum computation.

The fact that the proton cyclotron frequency 300 Hz in $B_{end} = .2$ Gauss is the only cyclotron frequency above EEG range, one can ask whether biologically important dark ions form cyclotron

Bose-Einstein condensates (possibly also Cooper pairs if fermions), dark protons form a cell membrane spin network, and dark electrons arrange to dark Cooper pairs making cell membrane a super-conductor. This would provide a unified picture about the role of various particle in TGD inspired vision about living matter.

Correlation of photon emissions with the weakening of the Earth's magnetic field

Authors say *During brief periods of imagining white light the power density of photon emissions from the right hemisphere was about 10^{-11} Wm^{-2} that was congruent with magnetic energy within the volume associated with a diminishment of ~ 7 nT as predicted by the dipole-dipole coupling relation across the neuronal cell membrane.*

The experiment is to some extent a replication of earlier experiment of [J77] in which it was observed that visible photon emissions mainly from the right hemisphere is accompanied by a weakening of the horizontal component of the Earth's magnetic field. Decreases over 10 to 15 s of 15 nT and 5 nT at 0.25 m and 1 m from the right side of the head of the subject person were associated with the same magnitude of energy (10^{-11} J) that was associated with the net increase in photon emissions during that period. This energy - assuming each action potential is associated with energy of $eV_{rest} = 1.9 \times 10^{-20}$ J - would be the equivalent of the activity of about 1 billion neurons.

1. If I have understood correctly, the weakening of the magnetic field outside the head of the subject person would be due to magnetic energy change associated with the spin flips taking place in the cell membrane and absorbing the needed energy from this magnetic field. This would obviously represent a new kind of metabolic activity: magnetic field would provide the needed metabolic energy instead of ATP-ADP process. That magnetic body could directly use its magnetic energy to control biological processes, would mean quite a dramatic modification of the usual view about metabolism.

2. The nuclear magnetization disappears for a moment in a transition from spin triplet to spin singlet state, which then spontaneously decay to triplet state again. The excitation of singlet state requires energy so that the magnetic field outside should weaken if it pays the energy bill. The contribution of magnetic dipoles to the horizontal magnetic field component measured outside the head of the subject person disappears and if the direction of dipole magnetization correlates with the direction of the magnetic field the strength of the magnetic field is reduced. The correlation would guarantee that the magnetic fields from different pairs of dipoles do not interfere to zero. Some kind of ordering of the orientations of neurons perhaps induced by the layered structure of cortex and of the almost collinearity of the myelinated axons of white matter is required.

3. Spin-flip transition from triplet to singlet state would change the contribution of magnetic dipoles to the net magnetic field and thus affect the net magnetic field experienced by a test particle. Could this explain the reduction of B_E by factor about 1.8×10^{-4}? At distance of order .1 meter the dipole field created by proton is very small: by a factor 10^{-21} weaker than the 9 nT field created at distance of $d = 10$ nm. The fields of neurons each containing a contribution of about 10^{14} protons sum up and the estimate is that there are 10^9 active neurons. The resulting net factor of 10^{23} could make possible reduction by 9 nT.

4. Triplet-to-singlet spin flip transition taking its energy from the magnetic field is the interpretation suggested by the experiments. The return to the ground state would liberate this energy as large $\hbar_{eff}$ quanta with energies of visible photons transforming later to ordinary visible photons. Therefore the radiated energy could indeed be magnetic energy also in TGD. Of course, also metabolism might drive particles directly to the excited cyclotron states and is expected provide the energy needed to regenerate the magnetic fields since the energy of visible photons is lost.

5. In TGD Universe the correlation of the photon emission with changes (about 7 nT) in the measured magnetic field identified as the Earth's magnetic field B_E having nominal value of $.5 \times 10^{-4}$ T does not force to assign dark photons with the magnetic flux tubes of the Earth's magnetic field.

(a) One can of question the assignment of 7 nT weakening to B_E as a Maxwellian description not applying in TGD framework. The changes of the horizontal component of the magnetic field are detected outside the head of the subject person is it possible to assign this change to any particular magnetic field? How to distinguish between magnetic fields associated with different space-time sheets? TGD predicts that test particles "feel" their sum if these magnetic space-time sheet have projection in the same region of Minkowski space.

The possibility to move the flux tubes in such a manner that only the flux quanta of one particular component of the many-sheeted magnetic field contribute to the projection, would allow to analyze the field into these components. Note that un Maxwell's theory this is not possible. The change in the measured magnetic field could be induced by a flux tube carrying 7 nT field assignable to the proton spin network and having a projection to the same M^4 volume as a flux tube of the Earth's magnetic field or the endogenous magnetic field has. Therefore it might not be easy to distinguish between changes of B_E and B_{end}.

(b) The experimental findings of Blackman et al [J46] about the effects of ELF frequencies on vertebrate brain however encourages an interpretation in terms of cyclotron frequencies for magnetic field in "dark" endogenous magnetic field $B_{end} \simeq 2B_E/5$ (this predicts that Ca^{++} cyclotron frequency is 15 Hz, which is not far from 17 Hz). It is of course possible that the flux tubes of the Earth's magnetic field thicken inside the brain so that the strength of the magnetic field is reduced accordingly.

Can one understand the ELF frequencies involved?

Authors state: *Spectral analyses showed maxima in power from electroencephalographic activity within the parahippocampal region and photon emissions from the right hemisphere with shared phase modulations equivalent to about 20 ms.*

The time scale of 20 ms appears also in the experiments of articles 2 and 3 in which rotating and frequency modulated magnetic fields where applied. This time scale corresponds to 50 Hz frequency, which has been found to have biological effects [J146]. The cyclotron frequency of Lithium (bosonic ion) for $B_{end} = .2$ Gauss equals to 50.1 Hz (see the appendix of appendix of [K13]).

Authors continue : *Beat frequencies (6 Hz) between peak power in photon (17 Hz) and brain (11 Hz) amplitude fluctuations during imagining light were equivalent to energy differences within the visible wavelength that were identical to the intrinsic 8 Hz rhythmic variations of neurons within the parahippocampal gyrus.*

Can one understand the ELF frequencies involved? In TGD framework [K13] cyclotron states of electrons, protons, and of ions are possible [K13].

1. Ca^{++} is one important bosonic ion able to form cyclotron Bose-Einstein condensates and the 17 Hz frequency for the power of photon fluctuations could correspond to $f(Ca^{++}) = 15$ Hz: note that the strength of the endogenous magnetic field is expected to be under homeostatic control and thus vary in some range.

2. 11 Hz frequency is perhaps too far from alpha frequency 10 Hz but rather near to cyclotron frequency 11.4 Hz for Mn^{++} or 10.8 Hz of Fe^{++} in the field $B_{end} = .2$ Gauss (see the appendix of appendix of [K13]).

3. The superposition of effects on test charges caused by MEs associated with 17 Hz and 11 Hz frequencies would give 6 Hz beat frequency. Note that K^+ and Cl^- (fermionic ions) have cyclotron frequencies 7.5 Hz and 8.5 Hz and their Cooper pairs might relate to parahippocampal 8 Hz frequency.

7.3 Second article

Second article has the title *Demonstration of Entanglement of Pure Photon Emissions at Two Locations That Share Specific Configurations of Magnetic Fields: Implications for Translocation of Consciousness.*

In the article [J86] the group reports an excess correlation between "pure" photon emissions at two locations separated by few meters that share specific correlations of frequency modulated magnetic fields. The photon emissions were from chemical reactions.

According to the article's abstract, "the experimental demonstration of non-locality for photon emissions has become relevant because bio-photons are coupled to conscious activity and cognition. The experimental condition that produces doubling of photon emissions from two loci during simultaneous chemical reactions when exposed to a sequence of circular rotating magnetic fields with differential phase and group angular velocities was applied to photons from LEDs (light-emitting diodes). A significant but weaker enhancement of photon emissions as measured by photomultiplier tubes occurred when the two LEDs were activated simultaneously within two loci separated by several meters. The effect suggests that under optimal conditions photons emitted from two, magnetic field congruent, loci become macroscopically entangled and that the two loci display properties of a single space. Implications for the transposition of consciousness over large distances are considered."

What was observed was enhanced visible photon emission from LEDs subject to the same magnetic stimulation as the cell culture dishes (neurons) in the earlier experiment [J37]. The size of the effect was however smaller. If the effect is real, the presence of organic matter (the cell culture dishes) is not absolutely necessary for the effect although it enhances it. The conclusion of the authors is that photons are carriers of consciousness. TGD inspired interpretation is that the experiment provides support for the identification of magnetic flux tubes as generators of macroscopic quantum coherence.

7.3.1 Experimental arrangement and results

The article describes first earlier similar experiment [J37] using instead of LEDs chemical reactions occurring in cell culture dishes (neurons) and leading to a doubling of photon emissions serving as a signature for coherence - or entanglement as authors express it. LEDs were motivated by the hypothesis that photon field can be equated with consciousness, and to test this the cell culture dishes were replaced with LEDs. A weaker but significant enhancement of LED emissions is indeed reported.

In the following I shall consider mostly the earlier experiment [J37] involving cell culture dishes which is identical to the recent one except for the mentioned replacement.

1. The distance between the cell culture dishes was a few meters as was also the distance of the solenoids from the sample located circularly around it. If I have understood correctly, the circular arrangements of solenoids were in parallel planes around the cell culture dishes (neurons) and the solenoids were directed radially to the dishes: otherwise it would not be possible to achieve a rotating magnetic field.

2. Each set of eight solenoids in circular arrangement around the cell culture dish received identical patterns of piecewise constant magnetic fields generated by potentials having 8 different values: the duration of single constant piece was 1 ms. Each solenoid created a magnetic field, whose lines emanating from the end of the solenoid were directed to the center of the cell culture dish.

3. Figure 1 of [J86] describes the shapes of the AD (accelerating angular velocity, decreasing "phase" modulation) and DI (decelerating angular velocity, increasing "phase" modulation). AD configuration was represented for 8 minutes and followed by DI configuration induced the effect and it occurred immediately after the initiation of DI phase.

Consider now a more detailed description of the AD and DI phases of magnetic stimulation.

1. During AD phase the accelerated rotation of the magnetic field was achieved by creating a magnetic pulse of duration 20,18, 16,..., $T_n = 20 - 2n$, ... ms to subsequent solenoids so that only single solenoid contributed to the net magnetic field at any moment. This series was repeated for every rotation of 2π. During AD phase the frequency modulation was slowed down meaning the frequency decreased and also this process was same for every rotation of 2π. The optimal duration of AD phase was about 4-5 minutes.

2. During DI phase decelerated rotation was achieved by in increasing the subsequent durations by 2 ms so that a series of pulses with durations 18 ,20, 22,...,$T_n = 20 + 2n,...$ ms was obtained. During this period frequency modulation was increased.

3. What "frequency modulation of phase" precisely means? Pictures of AD and DI temporal patterns of voltages (equivalently magnetic fields) feeded to the solenoids inducing a series of values of magnetic field are given Fig. 2 of [J86].

   A more detailed description can be found from the earlier article by Persinger's group [J37]. The voltage range [-5 V, 5V] was discretized to 8 pieces and the possible discretized voltages in this range are represented by 8 bits. The bit patterns were selected so that they were "physiologically patterned". The value of the magnetic field inside solenoid for n:th bit was proportional to V_n. The duration of each voltage was 1 ms - basic frequency of brain synchrony.

   During AD pattern a) with decreasing frequency and during DI pattern b) with increasing frequency was used. The numbers of points which composed each pattern were 859 (duration was 859 ms) for AD and 230 (duration of 230 ms) for DI. Only a part of the pattern could be represented since the duration of single 2π rotation was 104 ms, which corresponds to 10 Hz, a fundamental bio-rhythm (Unless there was scaling of the bit duration).

4. Within the center of the 8-solenoid configuration the value of the magnetic field averages to 1 μT. A natural assumption that this magnetic field contributes to the net effective value of the endogenous magnetic field B_{end} inducing small variations of B_{end} in turn modulating cyclotron frequencies.

   The modulated cyclotron frequency should be higher that frequency of modulation and thus higher than 1 kHz. For B_{end} this leaves only electron with cyclotron frequency $f_c = 6 \times 10^5$ Hz under consideration. The effect would be on electron Cooper pairs in the case of cell culture dishes or electrons in the case of LEDs. Electrons are indeed essential also for the function of LED.

5. The frequencies $f_n = 1/T_n$ defined by the durations of magnetic field vary during AD phase between 50 Hz and and 157 Hz. During DI phase the frequencies vary between 50 Hz and 30 Hz. In [J146] it is reported that 50 Hz frequencies have biological effects. As already noticed, 50.1 Hz corresponds to cyclotron frequency for Lithium (bosonic ion) for $B_{end} = .2$ Gauss.

7.3.2 Reconnection of magnetic flux tubes as a mechanism generating macroscopic quantum coherence

A doubling of the rate of emissions of visible photons immediately after the AD phase in the earlier experiment [J37] and weaker enhancement in the recent experiment using LEDs instead of cell culture disches, is interpreted as a signature of entanglement. Quantum coherence is perhaps a more appropriate manner to express the findings of the two experiments although quantum coherence makes possible also quantum entanglement. To my opinion the experiments provide support for the basic prediction of TGD inspired quantum biology that magnetic flux tubes are generators of macroscopic quantum coherence.

What seems necessary is that some flux tubes emanating from the solenoids must reconnect to form flux tubes connecting the two cell culture dishes or LEDs: reconnection is indeed one of the fundamental processes in TGD inspired theory of living matter. Without reconnection the flux tubes of the two magnetic fields remain disjoint and cannot induce macroscopic quantum coherence. The reconnection can occur only if the temporal and spatial patterns of the rotating and modulated magnetic fields are identical. These flux tube connections would induce quantum coherence by effectively binding the two systems to single system.

The doubling of the photon emission rate in the earlier experiment involving cell culture can be understood by the well-known rule that in incoherent emission the total rate is N times the individual rate, and in coherent emission N^2 times the individual rate: now N equals to 2. Also destructive interference becomes possible when the summed amplitudes are in opposite phases. This would reduce the rate below the predicted based on incoherence.

Also the enhancement of the photon emission rate from LEDs in a similar arrangement supports the view that macroscopic quantum coherence generated by the magnetic field patterns is relevant and implies that the amplitudes describing the emission of photons from the two LEDs add coherently with some probability so that constructive or possibly also destructive interference occurs. To make this statement more precise, one would need a detailed quantum model for LEDs.

7.3.3 Why AD followed by DI is needed to induce enhanced photon emissions?

Why should AD period followed by DI period be most effective in inducing photon emissions? Why the flux quanta (flux tubes) do not induce any effects, when the angular velocity is constant and frequency is absent (constant magnetic field)?

1. Accelerated rotation during AD period corresponds at quantum level to an application of magnetic flux tubes from directions $\phi_n = n \times 2\pi/8$ such that the duration of the pulse is reduced in discrete steps. The process should generate frequencies coming as harmonics of $f_n = 1/T_n$. The patterns of magnetic field consisting of periods of constant magnetic field lasting 1 ms and fixed for AD and DI to be "physiologically patterned" determines the Fourier decomposition. The duration of 1 ms brings in harmonics of kHz resonance frequency.

2. The variation of the duration of the magnetic field makes it possible to scan a wide range of resonance frequencies of the cell culture. The process would be like tuning a radio. At special frequencies resonant coupling to the frequency of magnetic field and to the frequency defined by the duration of magnetic field becomes possible and enhanced dark photon emissions take place. If the fundamental frequency were not varied, the effect would occur only for very special pulse durations.

3. Why the visible photons were observed only during the beginning of DI phase? If the emitted photons were dark having very long wave length but energy of visible photon, they would not have been detected during AD phase. The decay of dark photons after the beginning of DI phase to bunches of ordinary photons could explain the observed enhanced emissions of visible photons.

7.3.4 Why the magnetic pulses from a given direction arrived with frequency of 10 Hz?

The magnetic pulses arriving from a given direction to the cell culture dish/LED came with a frequency of 10 Hz. That a fundamental biorhythm is in question, cannot be an accident. In TGD framework 10 Hz frequency corresponds to the secondary p-adic time scale assignable to electron and defines the size scale of causal diamond assigned with electron. This conforms with the assumption that electronic Cooper pairs are fundamental for consciousness serving also as carriers of super-current through cell membrane. In fact, all elementary particles correspond in zero energy ontology to macroscopic time scales via the secondary p-adic time scales associated with them and for quarks the time scales correspond to frequencies of order 10 ms.

7.4 Third article

Third article has the title *Experimental Demonstration of Potential Entanglement of Brain Activity over 300 Km for Pairs of Subjects Sharing the Same Circular Rotating, Angular Accelerating Magnetic Fields: Verification by s_LORETA, QEEG Measurements.*

In the third article [J87] the group reports excess correlation of brain activity of individual subjects separated by 300 km and sharing the same circular rotating, angular accelerating magnetic fields.

According to the article's abstract, "in order to test the presence of excess correlation, or entanglement, pairs of subjects separated by 300 km were either exposed or not exposed to specific configurations of circular magnetic fields with changing angular velocities that dissociated the phase and group components. When one person in the pair was exposed to sound pulses but not

to light flash frequencies within the classical electroencephalographic band, there were discrete changes in power within the cerebral space of the other person even though they were not aware of the stimulus times and separated by 300 km. The intra-cerebral changes that only occurred if the magnetic fields were activated around the two cerebrums simultaneously were discrete and involved about single, punctate volumes of about 0.13 cc (125 mm^3). The potential energy from the applied magnetic field within this volume was calculated to be about 6×10^{-14} J and with an average brain power frequency of 10 Hz would result in 6×10^{-13} W. Assuming $\pi \cdot 10^{-2}$ m^2 for the surface area of the cerebrum, this is equivalent to $\sim 2 \cdot 10^{-11}$ Wm^{-2}. This power density is the same order of magnitude as that associated with photon emission during cognition. Given the average of 6×10^6 neurons per 125 mm^3, the induced energy is equivalent to about 10^{-20} J per neuron. This value can be considered a quantum of universal energy and would be congruent with a condition that could promote non-locality."

7.4.1 Experimental arrangement and results

If I have understood correctly, the experimental arrangement was roughly following.

1. Two individual subjects were involved. The second subject was 300 km away. The other subject received stimuli at various frequencies of sound or flashes of light while the first person was unaware of these stimuli. Both members of the pair were exposed to a rotating, circular magnetic field whose frequency modulation would vary with rotation angle. This guarantees that the phase and group velocities of the magnetic field varied and were different.

2. It seems safe to assume that the magnetic field pattern used to stimulate brains of subject persons was identical with that applied in the second experiment.

Authors report a correlation between individual subjects in the sense that there were discrete changes in EEG power within the cerebral space of the second person even if he/she was not aware of the stimulus. The effect occurred only if the phase and group velocities assignable to the magnetic field were different. Authors interpret this as entanglement identified as excess correlation if the fields were activated around cerebrum simultaneously and were discrete and involved about single punctuate volumes of about 125 mm^3. Entanglement in this sense need not correspond to quantum entanglement although it could make it possible.

Authors introduce what they call quantum universal energy $E = 10^{-20}$ J, and estimate the that this is the induced energy per neuron transferred from the magnetic field to energy of EEG. In particle physicist's units this gives $E = 6.24 \times 10^{-2}$ eV. This would naturally correspond to energy gained by electron or proton in the resting potential E_{rest}, which is above $E_{min} = 6.15 \times 10^{-2}$ eV. Note that threshold potential for nerve pulse generation corresponds to energy $E_{thr} = 5.5 \times 10^{-2}$ eV. On the other hand, also the first experiment and predecessor of the second experiment involved visible photon emissions which suggests that also visible photons were emitted and they came from the transitions of the proton spin network associated with cell membrane proposed by Wu and Hu [J116].

7.4.2 TGD based interpretation

TGD interpretation should rely on the notion of magnetic body and a model for neuronal membrane as a super-conductor - at least electronic but possibly also ionic super-conductor), cyclotron Bose-Einstein condensed of biologically important ions, and the spin network of dark protons associated with the cell membrane discussed in TGD based model for the outcome of the experiment described in the first article.

1. The flux tubes of the rotating magnetic field would connect the subject persons into a single coherent unit reacting to the stimuli posed to second subject like a single unit. TGD assigns to the magnetic bodies large effective value of Planck constant so that photons with energies of order E would correspond to much longer wavelengths essential for the coherence in scales of the order of a few wave lengths.

2. The wave length $\lambda = 300$ km could correspond to the Planck constant $\hbar_{eff} \simeq \lambda/\lambda_0 = 1.5 \times 10^{10} \times \hbar$, where one has $\lambda_0 = c/E\hbar \simeq 20$ μm is the wavelength of photon with "quantum universal energy". This energy is in IR region just around thermal threshold. The corresponding period and frequency are $T = c/\lambda = 1$ ms and $f = 1$ kHz, which correspond to fundamental time scales for cell membrane with 1 ms defining the time scale of nerve pulse and 1 kHz defining an important resonance frequency in brain associated with the generation of coherence. Probably this is not an accident. The authors indeed mention that the effect is maximal at distance of 300 km.

Concerning the detailed interpretation of the experiment there are several options. First, TGD suggests two alternative models for cell membrane as Josephson junction involving currents of electron Cooper pairs and possibly also bosonic ions or Cooper pairs of fermionic ions. For the conservative option the cell membrane would be far-from- vacuum extremal carrying strong induced Kähler field. For the non-conservative option the cell membrane would be near-to-vacuum extremal making it maximally sensitive to sensory input. Secondly, the universal quantum suggests emission of dark IR photons, whereas the emission of visible photons associated with cognition suggests visible photons.

1. The "quantum universal energy" $E = eV_{rest} = 6.24 \times 10^{-2}$ eV would naturally correspond to the energy gained by electron or proton in a membrane potential slightly above the threshold potential. Also the conservative option for cell membrane as Josephson junction would predict Josephson radiation emitted at multiples of Josephson frequency $E = eV_{rest}$ or $E = eE_{thr}$.

2. The non-conservative option for the cell membrane as Josephson junction predicts that the emitted photons have visible energies. This option might be realized for photoreceptors in retina, which react to the sensory stimulus by variation of membrane potential instead of nerve pulse. The correlation of cognition with the emission of visible photons also allows one to consider the possibility that some neurons are near-to-vacuum extremals (also glial cells as cells which do not generate nerve pulses could be such). Since visible photon emissions are mostly from the right hemisphere, one can ask whether the emissions from the left hemisphere are in IR region and those from right hemisphere in visible region and whether the different ground states of neurons as far-from- respectively near-to- vacuum extremals could distinguish between right and left hemisphere.

3. How does the spin network model based on dark proton strings relate to this? Since the photons have biological functions, the energies of all kinds of EEG photons should be in the same region of spectrum: visible or IR for a given hemisphere. For near-to-vacuum extremals the argument of Hu and Wu would be modified by replacing ordinary magnetic field with a combination of Z^0 magnetic field and ordinary magnetic field. This would imply that the energy scale would increase just as it does when Z^0 electric field dominates over em electric field. Therefore also the photons emitted by spin network at the right hemisphere would be dark EEG photons with energies of visible photons.

4. An alternative interpretation encouraged by the photon emission associated with cognition is that λ_0 corresponds to the energy of visible photon resulting in the transformation of dark ELF photon produced in the triplet-to-singlet transition of proton pair associated with the cell membrane as described in the interpretation of the first experiment. For a photon with energy 1.77 eV at the red end of visible spectrum this would give $\hbar_{eff} = 4.3 \times 10^{11}$. Interestingly, Cyril Smith [J147] reports on the basis of his own experimentation that the transformation of low energy photons to high energy photons and vice versa takes place for frequency ratio $f_h/f_l = 2 \times 10^{11}$: the interpretation would be also in this case in terms of $\hbar_{eff}$ [K37].

7.5 Conclusions

The results of the experiments of Persinger et al can be understood in the framework of TGD and the findings allow to develop a more precise view about the role of dark electrons, protons, and ions in TGD inspired quantum biology.

1. The identification of the magnetic flux quanta connecting two systems as generators of macroscopic quantum coherence finds experimental support.

2. The proposal of Hu and Wu about proton spin networks associated with cell membrane has a TGD counterpart in terms of dark proton strings allowing interpretation as dark DNA. The spin-paired protons are assigned to the hydro-philic ends of the two lipids in the layers of the cell membrane and the dark proton strings define an analog of DNA double strand. The model of Wu and Hu is subject to the same objections as the model for cyclotron Bose-Einstein condensates and is circumvented by introducing the hierarchy of effective Planck constants.

3. The fact that photon emissions are detected only from the right hemisphere suggests that both options for the cell membrane as Josephson junction are realized: far-from-vacuum extremal option for the neurons of the left hemisphere with emissions in infrared and near-to vacuum extremal for the neurons of the right hemisphere.

To sum up, the resulting framework allows an overall view about the roles of both dark electrons, dark protons, and dark ions in quantum biology according to TGD.

Chapter 8

Are dark photons behind biophotons?

8.1 Introduction

I have written already earlier about bio-photons [K106] and proposed that bio-photons result when dark photons with large value $\hbar_{eff}$ of effective Planck constant and large wavelength transform to ordinary photons with the same energy. The recent progress in understanding the implications of basic vision behind TGD inspired theory of consciousness [L33] [L33] served as a motivation for a complementary treatment from different perspective.

The recent progress in understanding the implications of basic vision behind TGD inspired theory of consciousness [L33] [L33] served as an additional motivation for a complementary treatment.

The anatomy of quantum jump in zero energy ontology (ZEO) allows one to understand basic aspects of sensory and cognitive processing in the brain without ever mentioning the brain. Sensory perception - motor action cycle with motor action interpreted as time-reversed sensory perception directly reflects the fact that state function reductions occur as sequences to the same boundary of causal diamond (CD) (which itself or rather, quantum superposition of CDs, changes in the process such that either the upper or lower boundaries of all CDs involved are localized at the same light-cone boundary). The first reduction of sequence corresponds to genuine state function reduction and the next induce changes only at the second boundary giving rise to experience flow of time and arrow of time.

Also the abstraction and de-abstraction processes in various scales which are essential for the neural processing emerge already at the level of quantum jump. The formation of associations is one aspect of abstraction since it combines different manners to experience the same object. Negentropic entanglement of two or more mental images (CDs) gives rise to rules in which superposed n-particle states correspond to instances of the rule. Tensor product formation generating negentropic entanglement between new mental images and earlier ones generates longer sequences of memory mental images and gives rise to negentropy gain generating experience of understanding, recognition, something which has positive emotional coloring. Quantum superposition of perceptively equivalent zero energy states in given resolution gives rise to averaging. Increasing the abstraction level means poorer resolution so that the insignificant details are not perceived.

Various memory representations should be approximately invariant under the sequence of quantum jumps. Negentropic entanglement gives rise to this kind of stabilization. The assumption that self model is a negentropically entangled system which does not change in state function reduction, leads to a problem. If the conscious information about this kind of sub-self corresponds to change of negentropy in quantum jump, it seems impossible to get this information. Quite generally, if moment of consciousness corresponds to quantum jump and thus change, how it is possible to carry conscious information about quantum state? Interaction free measurement however allows to circumvent the problem: non-destructive reading of memories and future plans becomes possible in arbitrary good approximation.

This memory reading mechanism can be formulated for both photons and photons and these two

reading mechanisms could correspond to visual memories as imagination and auditory memories as internal speech. Therefore dark photons decaying to bio-photons could be crucial element of imagination and the notion bio-phonon could also make sense and even follow as a prediction.

The observation that bio-photons seem to be associated only with the right hemisphere [J85] [L32] suggests that at least some parts of the right hemisphere prefer dark photons and are thus specialized to visual imagination: spatial relationships are the speciality of the right hemisphere. Some parts ofthe left hemisphere at least might prefer dark phonons: left hemisphere is indeed the verbal hemisphere specialized to linear linguistic cognition.

8.1.1   Basic facts about bio-photons

Alexander Gurwitsch discovered bio-photons as early as 1923 and called the phenomenon "mitotic radiation". Fritz Popp is one of those who have continued the pioneering work with bio-photons [I39, I88]. Also Roeland van Wijk [J92] shoud be mentioned as one of the many people involved. Recently the possible fundamental role of bio-photons in neuroscience has been realized.

To get a first quantitative grasp of bio-photons one can look at `http://en.wikipedia.org/wiki/Biophotons` [I1]. Ultraweak emissions of visible and also UV light from living matter. Spectrum looks continuous. Intensity (power per unit area) is 10^{-13} to 10^{-10} W/m^2. The intensity of solar radiation is 1.361 kW/m^2 and stronger by 13-16 orders of magnitude. The intensity of bio-photons is however much above the intensity of thermal radiation at energies of visible and UV photons.

In order to obtain a more biological perspective one can look for the intensity in the natural length and time scales of neuron. 2 eV is the energy of red visible photon. Using the relationship $J = 6.4 \times 10^{28}$ eV one obtains that if all bio-photons were photons with energy of 2 eV, there would be about 3.2 bio-photons per area of μm^2 characterizing cell nucleus during period of 1 ms defining characteristic time scale of neuronal firing. This raises the question whether bio-photons might be relevant for neural firing.

Chemi-oxidation via oxidative stress by reactive oxygen species (ROS) and/or catalysis by enzymes (peroxidase, oxygenase) has been suggested as a source of bio-photons [I1, I54]. The excitation of biomolecule to triplet (spin 1) state would decay via the emission of bio-photons.

Evidence has been given that bio-photons represent coherent radiation [I53, I27]. For instance, the distribution for bio-photon number for given energy is nearer to Poissonian distribution characterizing coherent state of photons (technically a state, which is an eigenstate of annihilation operator for photon of given energy and quantum analog of classical state in which it makes sense to assign classical field to the state). The coherence time from photon counts is much longer than the estimate 10^{-13} seconds based on standard sources. Time scale of at least second is nearer to reality. Also delayed luminescence of bio-photons [I27] as a respose to a stimulation of system by visible photons reflects long range temporal correlations and not expected for incoherent radiation. Instead of exponential decay hyperbolic power low type decay takes place. The underlying reason is not well-understood.

The coherence is not easy to understand if chemi-oxidation is the source of bio-photons although it could quite well correlate with the production of bio-photons. The coherence and empirical findings made already by Gurwitsch have inspired the proposal that bio-photons could play an important role in control and communications in living matter. The attitudes of mainstream are very negative to proposals of this kind as the Wikipedia article [I1] illustrates. Recently the situation have been changing and reports supporting the existence of non-chemical communications between cell cultures having no physical contact are emerging [I16].

One can raise a long list of questions about bio-photons.

1. What is the actual nature of bio-photons? If bio-photons are not primary entities (contrary to what is usually believed), what is behind bio-photons? Could bio-photons be decay products of something more fundamental and perhaps new from the perspective of recent day physics? If bio-photons are fundamental entities responsible for control and communication, the extreme weakness of their intensity becomes a problem. The idea about bio-photons as leakage of more fundamental entities could allow even metabolic role for the these entities.

2. How bio-photons are produced? The proposed mechanism based on oxidative stress does not explain coherence nor the reported communication and control function.

3. How do bio-photons or more fundamental entities relate to biology in general and specifically to metabolism, to neuroscience, to certain findings of Gariaev's group [I52], to Becker's DC currents [J42] and the related TGD inspired model discussed in [L27]? Could bio-photons relate to vision and imagination? Bischof [J45] and Bokkon et al [J118, J78, J51, J79, J50] have made several proposals in this respect. What is behind the correlation between EEG and bio-photons (for which multiple sources of evidence exist - [J36, J88, J85] - or that between the changes in bio-photon emission in meditative [J67] and qigong practices [J76, J95, J102, J96]? What about remote mental interactions, which are natural and ubiquitous if TGD-inspired biology is accepted: could bio-photons or more fundamental entities provide a control and communication tool?

The following considerations are inspired by a collection of mostly recent articles collected through Pubmed and the Qigong and Energy Medicine Database (`http://www.qigonginstitute.org/html/database.php`, [J21]). The purpose is to build a more detailed view about bio-photons relying on ideas represented already earlier [K41, K106].

The basic vision involves some new elements: bio-photons are decay results of dark photons, which are the fundamental objects. Dark photons play a key role in non-destructive reading of sensory/cognitive/memory representations by interaction free measurements. Besides dark photons and also dark phonons could be involved in interaction free meaurements and could be behind imagination resp. internal speech. Hence the notion of biophonons deserves a serious consideration. Dark photons and maybe also dark phonons would be generated by the memory reading mechanism automatically as a kind of echo and could yield virtual sensory input allowing to test whether sensory representation is realistic. Also copies of memories would be produced automatically by the echo mechanism: this could explain after-images and serve as a basic mechanism of learning. Dark photons could also serve communication and control purposes and define metabolic energy, making possible remote metabolism by what I have called quantum credit card mechanism. The energy range of biophotons corresponds to visible and UV range so that they are optimal for biochemical control by inducing molecular transitions.

8.1.2 Basic ideas of TGD based model of bio-photons

The following list summarizes the key TGD inspired ideas about bio-photons.

1. *Identification of elementary particles microscopically.*

   Quantum antenna hypothesis suggests that bio-photons are associated with topological light rays - "massless extremals" (MEs, topological light rays [K56]). Biophotons - in fact, all elementary particles - are identified as pairs of wormhole contacts with wormhole contacts connecting two space-time sheets in CP_2 directions. The two space-time sheets would be most naturally ME and magnetic flux quantum (tube or sheet). These details do not matter much for applications.

2. *Identification of bio-photons as decay products of dark photons.*

   In TGD Universe bio-photons would be ordinary photons resulting from the transformation of dark large $\hbar_{eff} = n \times \hbar$ low frequency (f_l) photons to ordinary photons with high frequency (f_h). In the original form I proposed (f_l, f_h) pairing as what I called scaling law of homeopathy [K37], and later realized the connection with the hypothesis about hierarchy of Planck constants. This transition would transform low frequency dark photons with E= $h_{eff} \times f_l$ to ordinary photons with E= $h \times f_h$ ("l" is for "low" and "h" is for "high"). The outcome could be observed as bio-photons.

   Any system having field body with parts having large $\hbar_{eff}$ can generate dark photons in turn decaying to bio-photons or dark photons with smaller value of $\hbar_{eff}$. Decay cascade decreasing $\hbar_{eff}$ down to $\hbar$ is the most general option and the integers n in $\hbar_{eff}(k)/\hbar = n(k)$ are factors of $n(1)$. This is a strong number theoretical prediction. The longest possible decay sequence to ordinary photons would factorize the integer $n = \hbar_{eff}/\hbar$ so that this kind of process might also have number theoretical meaning.

   The low intensity of bio-photons suggests that the rate for the transformation of ordinary to dark is very low and/or that the density of charged particles (say ions of cyclotron BE

condensate) generating dark photons is very low. Given a quantitative model for the mechanism one could estimate the rate for the transformation of ordinary photons to bio-photons. Gariaev's experiment [I52] yielding radio wave photons (interpreted as dark photons) from incoming laser light beam irradiating DNA sample could help to estimate the transformation rates as function of h: the most naive guess inspired by scaling argument is $1/h_{eff}$ dependence for given photon energy. DNA would induce energy conserving transformation of ordinary laser photons to long wave length dark photons with the same energy. A possible mechanism is modulation of the beam by radio wave frequency.

The crucial parameter is the magnitude for the $f_l \to f_h$ transition amplitude. Dimensional analysis suggests that the rate $\Gamma(f_l \to f_h)$ is proportional to f_l. This would give very slow rate for ELF frequencies so that the intensity of bio-photons would be very low l for a given intensity of dark photons.

The intensity of dark photons could be rather high. Gariaev reported the transformation of laser light to radio waves in scattering from DNA in rather wide range of frequencies [I52]. These photons had biological effects on remote target (stimulation of growth of potatoes). If radio frequency photons are dark photons with visible energies they could have provided metabolic energy for high enough intensity. The role of controller is also possible. Dark photons could be also used to read memory representation in non-destructive manner by interaction free measurements so that dark photons would be fundamental from the point of view of cognition.

The value of not only h_{gr} but also that of h_{eff} at magnetic flux tubes could be proportional to the mass of charged particle populating the flux tube in question. Flux tubes would distill the molecules to separate flux tubes. Cyclotron energy scale would be universal and does not depend on the mass of charged particle: therefore bio-photons would have universal energy spectrum in the range of molecular excitation energies.

3. *Possible connection with negentropic entanglement.*

   The connection of dark photons with negentropic entanglement is not well understood but highly suggestive. One can imagine at least three reasons for the connection, which are not necessarily exclusive.

   (a) If the braiding (geometric entanglement!) of magnetic flux tubes carrying dark matter and dark photons (!) serves as a correlate for negentropic entanglement, braided collections of flux tubes define negentropically entangled systems serving as negentropy sources . This fits nicely with DNA as topological quantum computer vision [?] and with the vision about various representations (sensory, motor, memory, ..) [L33]).

   (b) Dark photon with $\hbar_{eff} = n \times \hbar$ with frequency f_l can be said to contain n ordinary photons with frequency f_l. Could these analogs of ordinary photons be negentropically entangled?

   (c) An alternative view is that dark photons are necessary for generating quantum coherence and negentropic entanglement in long length scales. This option is consistent with the first two options.

   Note: Topologically dark photons correspond to the n sheets of n-fold covering of space-time sheet assignable to n-furcation reflecting the failure of the strict determinism of Kähler action for preferred extremals. One might even ask whether dark photon with energy E could be seen as space-time correlate of Bose-Einstein condensate of photons with energy E/n!

4. *Some signatures of bio-photons in TGD Universe.*

   The simultaneous presence of frequencies f_h and f_l is the basic signature of the proposed mechanism. Cyril Smith [J147] has done a lot of work with this kind of connection and claims that $f_l \leftrightarrow f_h$ transformations (interpreted as transformations between dark and bio-photons in TGD framework) occur in living matter. His interpretation is completely different. Smith mentions the frequency ratio $f_h/f_l = 2 \times 10^{11}$ as very special one. For $\hbar_{eff}/hbar = 2 \times 10^{11}$

radiation with $l_l = 2.56$ kHz would correspond visible photon with $\lambda = .6$ μm at the red end of the spectrum.

Assuming that bio-photons indeed appear in TGD Universe, the first predicted signature is a correlation between fluctuations in EEG power and the ultraweak emission of visible photons from brain identified as particular kind of bio-photons. This kind of correlation has been observed [J36] but visible photons emerge from right hemisphere [J85].

(a) Could this mean that right brain and left hemisphere emit dark photons in different energy ranges: one possibility is that left hemisphere emits infrared photons above the thermal energy. The photons would have energies above the Josephson energy $E_J = 2eV_{rest} = .12$ eV in case of Cooper pairs of electrons. Here $V_{rest} \simeq .06$ V denotes the membrane resting potential are possible infrared analogs of bio-photons.

(b) The idea that dark photons correspond to imagination and dark phonons to internal speech in turn would suggest that left brain as brain hemisphere responsible for internal speech operates with dark phonons rather than dark photons. Right hemisphere being specialized to spatial thinking would favor dark photons.

Second signature are long range temporal correlations reflecting the origin of bio-photons. These correlations are observed for bio-photons as delayed luminescence [I27] and the sequel presents a model for the correlations based on dark photons explaining hyperbolic decay law and suggesting a totally unexpected connection with zeros of Riemann zeta.

8.1.3   Are biophonons also predicted?

It came as a surprise that a general model for the non-destructive reading of memory mental images and their time reversals (interpreted as predictions of the future based on interaction free measurement) in principle allows the use of not only dark photons, but also *dark phonons* in the reading process. The mechanisms of imagination and internal speech could emerge from the general structure of quantum jump and model for self representation based on negentropic entanglement.

The identification of bio-photons as decay products of dark photons suggests strongly that bio-phonons also result as decay products of dark phonons. Internal speech could be one manifestation of the transformation of dark phonons to ordinary ones. This transformation could also appear as a dissipative leakage phenomenon.

As a pleasant surprise came the realization that there is a poorly understood phenomenon of this kind known as Taos hum [I102]. The patient suffering from it hears an unpleasant humming sound reflecting the properties of the acoustic environment but which does not generate any response in microphones. Nevertheless neurophysiological correlates for hearing the Taos hum are observed.

Taos hum is experienced only after and before sunset. The electric "static" (electrical noise in shortwave radio receivers) beginning after sunset and believed to have a biological origin has been proposed to at least correlate with this phenomenon. A natural interpretation would be that when vision is not a possible communication tool anymore, dark photons or dark phonons propagating along ME-flux tube pairs are used for communications. Since living matter is full of electrets dark photons or phonons can give rise to the static.

Several options can be considered: dark signal could propagate from the source to receiver as dark photons or phonons along ME-magnetic flux tube pair, continue by travelling along ME-flux tube pair parallel to the auditory pathway down to the ear as dark photons or phonons and transform then to ordinary phonons generating the experience. The most conservative option consistent with the earlier proposal that the distinction between right and left hemispheres relates to the wave length range of dark photons (bio-photons in left hemisphere would be in infrared) [L32].

It seems that Taos hum is experienced in a pathological situation: a possible interpretation is that the leakage of dark phonons to bio-phonons is too strong and leads to the experience. Also the electromagnetic component of the patient's immune system could fail and negative energy dark photon signals could suck metabolic energy from the patient.

I will consider a slightly modified briefer version of a model that I developed for Taos hum for more than a decade ago as evidence for the notion of magnetic body [K41] (sensory magnetic canvas was the term that I used at that time) . In this model Taos hum was interpreted as a

phenomenon analogous to microwave hearing. At the end I will consider variants of the model involving dark photons and/or dark photons.

The appendix of the book gives a summary about basic concepts of TGD with illustrations. There are concept maps about topics related to the contents of the chapter prepared using CMAP realized as html files. Links to all CMAP files can be found at `http://www.tgdtheory.fi/cmaphtml.html` [L35]. Pdf representation of same files serving as a kind of glossary can be found at `http://www.tgdtheory.fi/tgdglossary.pdf` [L36].

- Biophotons [L43]

- Magnetic body [L52]

- Bio-anomalies [L41]

- DC currents of Becker [L46]

- ELF effects on brain [L42]

- Quantum antenna hypothesis [L58]

- Microtubules [L53]

8.2 Bio-photons in TGD Universe

I have discussed already earlier the identification of bio-photons in TGD framework [K10, K106].

8.2.1 The origin of bio-photons in standard physics framework

The are several proposals for the source of bio-photons: for instance cell membrane [I35], DNA [I53], mitochondria [I46], linear molecules [I29], microtubules are proposed as sources of bio-photons. The existence of several sources conforms with the universality of production mechanism.

1. Biophotons seem to be emitted under stress [I98]. It has been proposed that bio-photons arise as a product of redox reactions of free radicals [I1, I54]. The hypothesis is motivated by the correlation between bio-photon counts and doses of reactive oxygen and nitrogen species but does not explain in any obvious manner the coherence of bio-photons. The proposed production mechanism is that a biomolecule is excited to a triplet state (spin 1) and releases photon as it returns to the ground state. Laser like behavior would be required in order to achieve the coherence. The correlation of bio-photon production with ROS can however have alternative explanations.

2. A model for bio-photon production based on non-linear polarizable double layers obeying Maxwell's ED: cell membrane is proposed [J50]. Destructive interference between incoming and reflected wave leaving a wave confined inside double layered structure.

8.2.2 The origin of bio-photons in TGD Universe

Dark photons decaying to bio-photons could be produced by many systems - even non-living systems. Therefore the production mechanism of bio-photons would be universal and there would be several dominating production mechanisms for bio-photons. One test for this is to check whether water and quartz crystals produce bio-photons (the claimed health effects of quartz crystal might be real and relate to dark photons).

In the framework of standard biology one would try to identify biochemical mechanisms for the production of bio-photons. The coherence of bio-photons however suggests that something totally new is involved. Just the assumption that something genuinely new is involved of course sounds rather outlandish unless one has a concrete proposal for what this new is and unless this something new is able to solve other puzzles.

Do dark photons give rise to biophotons?

The basic philosophy in what follows will be as following. In computer world decomposition to hardware and software is very useful. In biology this division could mean that biochemistry describes dynamical hardware and also the mechanisms modifying it. Electromagnetic fields in TGD sense, dark photons, magnetic body, topological quantum computation, communications and control by dark photons would correspond to software. If this division is real, one might have rather satisfactory description of the software without even mentioning biochemistry. "Biology is governed by symbolic dynamics" is other manner to state the idea: to predict the behavior of priest all that one needs to know that he/she is a priest. One could never predict the behavior of priest from biochemistry and Newton's laws but single word "priest" associated with his person allows this. The basic justification for this separation between software and hardware (biochemistry) would come from the identification in terms of dark matter having now direct interactions with ordinary matter (in the sense that particles with different value of $\hbar_{eff}$ cannot appear in interaction vertices.

1. In TGD framework the counterpart of confinement inside double layered structure in polarizable media proposed as a model for bio-photons [J50] is confinement of photons inside topological light rays (MEs) acting like wave guides. Mechanism can be said to be gravitational since MEs are not only extremely non-linear structure but as space-time quanta also gravitationally non-trivial. The deviations of TGD from Maxwell's electrodynamics (MED) are important and come from induced field concept implying also topological field quantization. For instance, MEs are analogous to wave guides and have no counterpart in MED. MEs can carry non-vanishing light-like currents not possible in MED. MEs mediate precisely targeted signals propagating with light velocity without changes in their shape, to only single direction. Therefore MEs are ideal for communication and control. Topological field quantization makes space-time topology in various scales a key player also in biology. This leads to the notion of magnetic body and also the notion of electric flux quanta such as cell membrane.

2. In TGD Universe the large value of $\hbar_{eff}$ provides a general explanation for macroscopic quantum coherence. This allows several sources of bio-photons resulting when dark photon transforms to ordinary photon of same energy.

   - Dark photons could be absorbed and emitted in cyclotron transitions at magnetic flux tubes. Dark photons could be Josephson photons from a Josephson junction formed by the lipid layers of cell membrane. The minimal energy for the Josephson photon assignable to electronic Cooper pair is $E = 2eV_{rest} = .12$ eV for electronic Cooper pair and $V_{rest} = .06$ eV and is above thermal threshold. More generally, the spectrum of dark photons would be a combination of cyclotron spectrum and Josephson spectrum assignable to cell membrane [K20]. Frequencies would come as sums of harmonics of cyclotron frequency for a given bosonic ion or Cooper pair of fermionic ions and harmonics Josephson frequency.

   - The variation of the membrane potential induces a modulation of Josephson photon frequencies $f_J = ZeV$. This suggests that frequency modulation defines the fundamental information representation. This brings in mind whale's song - maybe mathematically very similar to human speech (as hearing in as slowed down version reveals) - in various time scales!

   - Huping Hu has observed that dipole magnetic interaction between protons with distance of 10 nm corresponds to energy scale in EEG frequency scale [J116] [L32]. Large $\hbar_{eff}$ could raise the energy to visible range. The cyclotron transitions assignable to the pairs of dark protons forming analogs of Cooper pairs could generate dark photons with EEG frequency and cytochrome oxidase could catalyse the energy metabolism providing them energy.

One can raise several questions about dark photons and bio-photons.

1. How are dark photons generated? Gariaev's experiments [I52] suggest that at least DNA induces transformation of ordinary photons to dark photons with much lower frequency. Could amplitude modulation of f_h signal by f_l signal provide a mechanism producing $\hbar_{eff} = f_h/f_l$ dark photons decaying to bunches of ordinary f_l photons or to ordinary f_h photons? Resonance condition requires integer valued frequency ratio and in principle this could serve as a test. In many experiments, say the pioneering experiments of Blackman and others (see for instance [J46]), this kind of modulation is involved. If this mechanism really works it provides a tool for producing dark photons: this has an obvious technological potential.

2. How would reactive oxygen species induce $\hbar_{eff} \to \hbar$ transitions inducing a loss of coherence? The process should be the inverse for the generation of dark photons. Analog of induced emission: presence of ordinary photons of same energy in state would increase the rate for the transition $\hbar_{eff} \to \hbar$. What is the reverse of amplitude modulation? Small ripples in a slowly varying wave. Amplitude modulation with frequency much higher than modulated frequency. Are these two descriptions equivalent?

3. What is the connection with quantum antenna hypothesis [K56]? Pairs of MEs and magnetic flux tubes giving rise to structures parallel to linear structures populating biosystems (axons, microtubules, DNA, linear molecules, etc) could be involved. Larger space-time sheet would induce a modulation by lower frequency defined by its scale. A hierarchy of amplitude modulations would be the outcome.

Has the decay of dark photons to visible photons observed in astrophysical scales?

There is an interesting news providing new light to the puzzles of dark matter in New Scientist.

It has been found that Universe is too bright. There are too many high energy UV photons in the spectrum. The model calculations suggest also that this too high brightness has emerged lately, and was not present in the early universe. The intergalactic space contains more neutral hydrogen and thus also more ionized hydrogen as thought previously and it was hoped that the ionized hydrogen could explain the too high brightness. It is now however clear that 5 times more ionized hydrogen would be required than theory allows accepting the experimental data.

The question is whether dark matter could explain the anomaly.

1. The usual dark matter candidates have by definition extremely weak interactions - not only with ordinary matter and also with dark matter. Therefore it is not easy to explain the finding in terms of ordinary dark matter. The idea about dark matter as remnant from the early cosmology does not fit naturally with the finding that the surplus UV radiation does not seem to be present in the early Universe.

2. In TGD dark matter is ordinary matter with large $h_{eff} = n \times h$ and has just the ordinary interactions with itself but no direct interactions with visible matter. Thus these interactions produce dark radiation with visible and UV energies but with probably much lower frequencies (from $E = h_{eff}f$). The energy preserving transformations of dark photons to ordinary ones are an obvious candidate for explaining the surprlus UV light.

3. These transitions are fundamental in TGD inspired model of quantum biology. Biophotons are in visible and UV range and identified as decay products of dark photons in living matter. The fact that the surplus has appeared recently would conform with the idea that higher levels of dark matter hierarchy have also appeared lately. Could the appearance of UV photons relate to the generation of dark matter responsible for the evolution of life? And could the surplus ionization of hydrogen also relate to this? Ionization is indeed one of the basic characteristics of living matter and makes possible charge separation [L38], which is also a crucial element of TGD inspired quantum biology [K64]

8.2.3 Biophotons, dissipation, and de-coherence

1. By above proposal the yield of bio-photons would be a leakage process. The transformation of dark photons to ordinary or dark photons with smaller $\hbar_{eff}$ means reduction of coherence length of order wave length by the ratio of final and initial effective Planck constants. The

process leading to visible photons leads to a coherence length which is fraction of micron. Therefore also dissipative effect is in question. The ordered energy of dark photon BE condensate transforms to less ordered energy of ordinary photons.

The process is expected to reflect the long scale coherence of dark photons. This could resolve the basic objection against the observation of delayed luminescence for which time scale should be of order 10^{-13} seconds for standard value of $\hbar$. Scaling of $\hbar$ to $\hbar_{eff}$ can increase this time scale even to seconds if not longer time scales.

In the simplest mode the intensity of bio-photons is proportional to the intensity of dark photons proportional to the modulus squared for dark photon complex order parameter assignable to a coherent state of dark photons. Also other than coherent states are possible: for instance, Popp et al have suggested so called squeezed states [I38].

2. Cancer could be understood as a disorder in which $\hbar_{eff}$ of part of magnetic body is reduced to smaller value and eventually to its ordinary value of $\hbar$ so that long range coherence is lost. If dark photons have energy of visible photons, basic coherent units have size of cell and one obtains "selfish cells" [I89].

3. Redox reactions, ROS and RNS induce loss of coherence by inducing process reducing $\hbar_{eff}$ and production of bio-photons: perhaps by the inverse of amplitude modulation which might generate dark photons. These reactions could have also a useful role in hardware development. Kind of etching of 4-D brain as a representation of self (modification of synaptic connections for instance) might be the basic function and necessarily involves dissipation.

8.2.4 What is the origin of the hyperbolic decay law?

The basic question concerns the origin of the hyperbolic decay law. It is not actually clear whether this law as anything to do with genuine decay or whether it reflects the behavior of complex order parameter of dark photons as a function of time. The latter interpretation is supported by the following argument.

The intensity decays slowly being in the first approximation of form $I(t) = I(0)/(1 + \lambda t)$: also hyperbolic waves of form $I_0 sin(log(1 + (t/t_0))$ have been reported. The most general form for the intensity is

$$I(t) = I(0) \times exp(\lambda u) \ , \tag{8.2.1}$$

where $\lambda 1 + iy$ is complex parameter and $u = log(1 + \lambda t)$ is the analog of time coordinate defined as logarithm of the shifted and normalized dimensionless time coordinate $T = (t + t_0)/t_0$. Fractal power law $I \propto T^\alpha$ approaching for large values of t to $I(t) = t^\alpha$ would be in question.

In zero energy ontology (ZEO) this kind of behavior can be related to Lorentz invariance.

1. The boundary of CD corresponds to light-cone boundary with light-like coordinate. For irreducible representations of Lorentz group the wave functions at light-cone boundary $t = r$ ($c = 1$ in the units used) behave as r^α. The appearance of this coordinate might be due to the fact that dark photons travelling with light-velocity are involved.

2. For hyperboloids $t^2 - r^2 = a_0^2$ one would have wave functions behaving as

$$A_y(t) = A_0 \times u^s \ , \ s = -1/2 + iy \ , \ u = (\frac{t^2 - a_0^2}{a_0^2})^{1/2} \ . \tag{8.2.2}$$

The intensity would be of the form

$$I_y = \frac{A_0^2}{u} \tag{8.2.3}$$

approaching the hyperbolic form for $t >> a_0$. For $a_0 = 0$ one obtains exact power law behavior $I \propto t^{-1}$.

3. Oscillatory behavior is obtained if one has superposition of two waves of this kind with different values of y:

$$A \quad = \quad cos(\phi)A_{y_1} + sin(\phi)A_{y_2} \tag{8.2.4}$$

giving

$$I \quad = \quad \frac{1 + sin(\phi_1 + \phi_2) \times cos[(y_1 - y_2)log(u)]}{u} \tag{8.2.5}$$

approaching hyperbolic decay law for $t >> a_0$ and diverging for $t = a_0$. Linear combinations $\sum a_n A_{y_n}$ are also possible.

What is intriguing that the form of the complex parameter s is same as for the zeros of Riemann zeta.

1. There are several reasons to believe that the zeros of Riemann zeta might play fundamental role as "scaling momenta" in TGD framework [K74]. For instance, if the spectrum of wave vectors associated with the zeros of zeta is discrete and consists of logarithms of integers so that the zeros of Zeta define quasilattice, Riemann hypothesis holds true [K74]. Furthermore, discrete spectrum for the zeros is strongly favored by number theoretical considerations since it gives hopes about p-adic algebraic continuation of the integral by reducing it to sum for both zeros of zeta and for the Fourier transform.

2. The quantization of spectrum for the distribution defined by zeros of Zeta means that the spectrum of "momenta" is integer valued in suitable units. In the recent case the momenta correspond to values of the radial coordinate r so that only the integer values $r = nr_0$ are possible. The interpretation would be in terms of discretization of the radial coordinate r and also of time. This is just what number theoretic vision suggests and the notion of p-adic manifold (see appendix of the book) requires both at real and p-adic side. Below it will be found that bio-photons could play a fundamental role in non-destructive reading of memories by interaction free measurement.

3. This argument would suggest that hyperbolic scaling law at light-cone boundary actually corresponds to a distribution

$$A(u) = \sum_y A_y(u) \ , \ \ u = \frac{t}{t_0} \ \ .$$

localized to the values $u = t/t_0 = r/r_0 = n$. This implies automatically infinite number of interefence terms in the intensity $I(u) = |A(u)|^2$ and the comparison of $I(t/t_0)$ with the experimentally determined intensity of bio-photons serves as a killer test for the proposal since only one parameter - t_0 determining the scale - appears in the model.

8.3 How could dark photons and phonons relate to consciousness?

One of the basic objections against the identification of moment of consciousness as quantum jump is that contents of consciousness corresponds always to change. How it is possible to code anything about the states of the world if this is the case? For instance, how conscious entity can construct a self model which by definition should correspond to something which is approximately invariant in quantum jump sequences? Negentropically entangled subsystems indeed can be parts of the state approximately invariant under dynamics dictated by Negentropy Maximization Principle (NMP) [K49] .

The manner to circumvent the objection comes from the notion of interaction free measurement: the conscious information about invariant part of system, say self model, could be obtained by interaction free measurement, which involves state function which leads the incoming photons to interaction free state. This information would be obtained as sequences of bits and might be correspond to declarative, verbal memories rather than direct sensory experiences.

8.3.1 What does bomb testing have to do with cognition and consciousness?

Dark photons decaying to bio-photons could be involved with the basic cognitive processes like memory recall involving interaction free measurement. At the ideal limit the photon which interacts with a subsystem representing qubit of memory mental image suffers state function reduction to a path at which it does not interact with the memory system in the usual sense. Hence memory mental image is not affected at all at this limit. The following model for memory recall is discussed in the article A Vision about Quantum Jump as a Universal Cognitive Process.

1. The bomb testing problem of Elitzur and Vaidman gives a nice concrete description of what happens in interaction free measurement, see `http://en.wikipedia.org/wiki/ElitzurVaidman_bomb-testing_problem` [B2] for illustration of the system considered.

   The challenge is to find whether the bomb is dud or not. Bomb explodes if it receives photon with given energy. The simplest test would explode all bombs. Interaction free measurement allows to make test by destroying only small number of bombs and at idealized limit no bombs are destroyed.

   The system involves four lenses and two detectors C and D. In the first lense the incoming photon beam splits to reflected and transmitted beams: the path travelled by transmitted beam contains the bomb.

   (a) The bomb absorbs photon with a probability which tells the fraction of photon beam going to the path at which bomb is (is transmitted through the lense). The other possibility is that this measurement process creates a state in which photon travels along the other path (is reflected). This photon goes through a lense and ends up to detector C or D through lense.

   (b) If the bomb is dud, photon travels through both paths and interference at the lense leads the photon to detector D. If C detects photon we know that the bomb was not a dud without exploding it. If D detects the photon, it was either dud or not and we can repeat the experiment as long as bomb explodes, or C detects photon and stop if the detector continues to be D (dud). This arrangement can be refined so that at the ideal limit no explosions take place and all.

2. The measurement of bomb property is interaction free experiment in the sense that state function reduction performed by absorber/bomb can eliminate the interaction in the sense that photon travels along the path not containing the bomb. One might say that state function reduction is an interaction which can eliminates the usual interaction with photon beam. State function reduction performed by bomb can change the history of photon so it travels along the path not containing the bomb.

This picture is only metaphorical representation of something much more general.

1. In TGD framework the photon paths branching at lenses correspond to branching 3-surfaces analogous to branching strings in string model and photon wave splits to sum of waves travelling along the two paths.

2. Bomb could be of course replaced with any two-state system absorbing photons in one state but not in the other state, say atom. Now one would test in which state the atom is gaining one bit of information in the optimal situation. Two-state atom could thus represent bit and one could in principle read the bit sequence formed by atoms (say in row) by this method without any photon absorption so that the row of atoms would remain in the original state.

One can imagine several applications if the information to be read in interaction free manner can be interpreted as bit sequences represented as states of two-state system. Lasers in ground states and its excited state would be analogous many particle quantum system. In TGD framework the analog of laser consisting of two space-time sheets with different sizes and different zero point kinetic energies would be the analogous system.

For instance, a model of memory recall with memories realized as negentropically entangled states such that each state represents a qubit can be considered.

1. Reading of a particular qubit of memory means sending of negative energy photon signal to the past, which can be absorbed in the reading process. The problem is however that the memory representation is changed in this process since two state system returns to the ground state. This could be seen as analog of no-cloning theorem (the read thoughts define the clone). Interaction free measurement could help to overcome the problem partially. Memory would not be affected at all at the limit so that no-cloning theorem would be circumvented at this limit.

2. A possible problem is that the analogs of detectors C and D for a given qubit are in geometric past and one must be able to decide whether it was C or D that absorbed the negative energy photon! Direct conscious experience should tell whether the detector C or D fired: could this experience correspond to visual quale black/white and more generally to a pair of complementary colors?

3. Zero Energy Ontology (ZEO) means that zero energy states appear have both imbedding space arrows of time and these arrows appear alternately. This dichotomy would correspond to sensory representation-motor action dichotomy and would suggest that there is no fundamental difference between memory recall and future prediction by self model and they different only the direction of the signal.

Since photon absorption is the basic process, the conscious experience about the qubit pattern could be visual sensation or even some other kind of sensory qualia induced by the absorption of photons the level of neurons. The model for the lipids of cell membrane as pixels of a sensory screen suggests that neuronal/cell membranes could serve defined digital self model at the length scale of neurons. This would suggest that primordial cognitive processes and memory correspond to vision and imagination and that speech, internal speech, and language have developed much later and characterize the human brain.

This idea finds some support from the fact that in some altered states of consciousness one can see one's thoughts: I have personally experienced this kind of state and one of the big realizations during this state was just the realization that at some level we think in terms of pictures rather than words at some deeper non-conscious-to-us level, and that there is a translation mapping words to pictures. Maybe at least visual imagination is conscious at some level of self hierarchy.

8.3.2 Memory recall as an interaction free measurement?

One can imagine several applications if the information to be read in interaction free manner can be interpreted as bit sequences represented as states of two-state system. Lasers in ground states and its excited state would be analogous to many particle quantum system. In TGD framework the analog of laser consisting of two space-time sheets with different sizes and different zero point kinetic energies would be the analogous system.

For instance, a model of memory recall with memories realized as negentropically entangled states such that each state represents a qubit can be considered. The model applies also to the reading of future plans (memories on reversed time direction).

1. Reading of a particular qubit of memory means sending of negative energy photon signal to the past, which can be absorbed in the reading process. The problem is however that the memory representation is changed in this process since two state system returns to the ground state. This could be seen as analog of no-cloning theorem (the read thoughts define the clone). Interaction free measurement could help to overcome the problem partially. Memory would not be affected at all at the limit so that no-cloning theorem would be circumvented at this limit.

2. A possible problem is that the analogs of detectors C and D for a given qubit are in geometric past and one must be able to decide whether it was C or D that absorbed the negative energy photon! Direct conscious experience should tell whether the detector C or D fired: could this experience correspond to visual quale black/white and more generally to a pair of complementary colors?

3. ZEO means that zero energy states appear have both imbedding space arrows of time and these arrows appear alternately. This dichotomy would correspond to sensory representation-motor action dichotomy and would suggest that there is no fundamental difference between memory recall and future prediction by self model and they differ only by the time direction of the signals involved.

4. Since photon absorption is the basic process, the conscious experience about the qubit pattern at neuronal level could be a visual sensation or even some other kind of sensory qualia induced by the absorption of photons. The model for the lipids of cell membrane as pixels of a sensory screen suggests that neuronal/cell membranes could define digital self model at the length scale of neurons.

Some comments are in order.

1. To avoid misunderstandings it should be emphasized that TGD based view about memory is not the same as the standard view. In ZEO brain is four-dimensional and in principle memories can be negentropically entangled memories in geometric past. It is possible to build almost complete copies of memories (no-cloning theorem prevents complete copies) by memory recall, and learning would correspond to a generation of large enough number of copies of the memory mental image. Memory recall could be seen as a negative energy signal inducing the interaction free measurement of memory qubits. Dark photons with EEG frequencies (say in theta band characterizing hippocampus) but having energies of visible photons could be involved with the memory recall. Correlation between EEG and bio-photons supports this view.

2. If the systems taking the role of the detectors C and D in interaction free measurement are analogous to population reversed lasers, their return to the ground state could automatically generate virtual sensory input propagating to the sensory organs and allowing to check whether it is consistent with the actual sensory input. The generation of the feedback signal takes some time expected however to be much shorter than that for a typical neuronal activity.

   Since the signals would propagate with light velocity, the virtual sensory input could travel practically instantaneously from the brain to sensory organs and possibly also vice versa. Libet's experiments on passive aspects of consciousness [J71] in fact demonstrate a time delay which is fraction of second having interpretation in terms of time to propagate to a layer of magnetic body of size scale of Earth and back: these delays are consistent with the fact that the chronon of sensory experience is about .1 seconds. The propagation of photon signals in both directions would make possible construction of sensory representation in time scale much shorter than that of neural activity. This mechanism could also explain generation of after images.

3. Photons can be replaced with phonons or quanta of any other wave motion with constant propagation velocity (no dispersion of signal) in a given reference frame. This suggests that imagination and internal speech correspond to the two reading mechanisms of memories.

8.3.3 Why vision and hearing are so fundamental for cognition?

The interaction free measurement is formulated in terms of photons. It can be however formulated also for sound waves using phonon detectors and acoustic waves traversing through two different paths. Quantum coherence is required but the hierarchy of Planck constants makes sense also for phonons by the basic equation $E = hf$.

In TGD framework there are good reasons to believe that sound waves are not only something emerging at the level of condensed matter but correspond to oscillations of string like objects at

4-D space-time surface. These strings connect the wormhole contacts assignable to the light-like orbits of partonic 2-surfaces. Partonic 2-surfaces can be assigned with elementary particles but also to 2-surfaces with arbitrarily large size scale. The outer boundary of any physical object would correspond to a partonic 2-surface. String world sheets carry fermion fields localized at them (right-handed neutrino is an exception in that it is de-localized at entire space-time surface). The fact that strings always connect two partonic 2-surfaces corresponds to the fundamental two-particle character of sound waves. Sound would be as fundamental phenomenon as photons and other massless bosons.

This encourages to ask whether photon (more generally gauge boson: TGD suggests that scaled up copies of gluons and weak bosons behaving like massless particles even in cell length scale are possible) and photon absorption could define fundamental conscious representations of information realized in terms of interaction free measurements for negentropically entangled states remaining unchanged under state function reduction in good approximation.

Photons would correspond to "seeing" but at neuronal level rather than at the level of retina - and imagination. Phonons would correspond to hearing at neuronal level and internal speech which is also essential for cognition. Both internal speech and imagination could be understood at fundamental aspects of cognition. Dark photons with energies of visible photons (decaying to what is interpreted as bio-photons) and dark phonons would be behind imagination and internal speech. I have already earlier proposed that the lipid layers of neuronal membranes (and maybe also ordinary cell membranes) can be regarded as pixels of a sensory map representing neuronal qualia [K32]. These pixels could serve as the counterparts of the detectors C and D appearing in interaction free measurement. The evidence for the importance of bio-photons (in TGD framework dark photons decay to bio-photons in energy conserving manner) in biology and neuroscience is emerging, see for instance the experiments of Persinger's group [J85, J86, J87]. I have discussed these findings from TGD point of view in [L32]. One can speculate about direct translation between the words of language and visual pre-images. Something like this one might expect.

Biophotons seem to be associated only with the right hemisphere [J85]. This suggests that right hemisphere or some parts of it prefer dark photons being thus specialized to visual imagination in accordance witht the fact that spatial relationships are the speciality of right hemisphere. Could this mean that left hemisphere or some pats of it prefer dark phonons? Left hemisphere indeed is the verbal hemisphere specialized to linear linguistic cognition and produces also internal speech.

8.3.4 Dark photons, after images, and mechanism of learning

After images are generated when one stares to bright light source for some time. Anyone can observe how the after images develop. After images drift gradually downwards suggesting that they are indeed generated at the retina and their source drifts downwards in gravitational field. After image also reappears periodically and can change their color in each re-appearance.

It has been suggested that bio-photons could be responsible for the generation of after images. In TGD framework the after images would be generated by dark photons decaying to bio-photons.

1. Delayed luminescence has been proposed as explanation. The light absorbed by retina from intense light-source emitted partially as bio-photons could define the secondary source. This is a possible mechanism since retina is sensitive to even single photon. One can however ask what is the real mechanism behind delayed luminescence.

2. Consciousness theoretic explanation based on the model fo sensory receptor as an analog of capacitor which suffers di-electric breakdown. There is some recovery time. Looking into bright light-source generates visual sensation but requires a long recovery time. The image is regenerated after the recovery. Visual mental images define conscious entities (selves) and just as we do they also would have sleep-awake cycle). Where the sensory input comes or do bio-photons resulting in the decay of dark photon BE condensates generate it. Why the periodic appearance and why the gradual change of color? Could it be that the photons rotate in a large loop identifiable as a closed magnetic flux tube? Does the time constant (length of loop) for a visual receptor depend on the peak frequency for which it is sensitive.

3. Or is a generation of copies of visual memory in question? Magnetic body or brain generates a virtual sensory input as dark photons transforming to bio-photons at retina. Internal

speech involves similar echo like effect and also piece of music is recalled repeatedly. Could delayed luminescence provide a mechanism of memory storage: the repetition of the stimulus increases the probability of memory recall in TGD based model of long term memory as a communication with the geometric past?

As a matter fact, delayed luminescence could be seen to reflect the presence of a deeper level cognitive mechanism rather than vice versa. The periodic appearance of after images could be a process in which retina receives periodically a virtual sensory input - perhaps from magnetic body via brain - and generates as a response nerve pulse pattern, and perhaps also dark photons generating a memory mental image which is negentropically entangled with the earlier memory representation. In this process memories representing the after image are read and the interaction free measurement involved with the process excites laser like systems which then generate radiative response defining the virtual sensory input, which then generates genuine sensory input. One could speak of a repeated echo. Why the color of the after image changes could be understood if the decay of the laser like states generates photons with several energies.

Similar echo generating mechanism for dark phonons instead of photons could explain why during sleep and also during wake-up state some word of internal speech repeats itself.

8.3.5 Realization of memory representations in terms of braided flux tubes

The obvious question is how various representations (sensory - , memory -,...) - "Akashic records" - are realized as negentropically entangled states?

Magnetic body should be the seat of memories in some sense.

1. I have already earlier proposed this kind of realization based on the observation that braiding in time direction generates space-like braiding [K23]. Dancers on the parquette with their feet connected to the wall by threads illustrates the idea. When dancers move at the parquette their world lines define a time-like braiding in 3-dimensional space-time assignable to the floor. Also the threads connecting the dancers to the wall get braided - or entangled - as one might also say. There is clearly a duality between time-like and space-like braidings: the running topological quantum computer program coded by braiding in time direction is stored as space-like braiding defining memory representation of what happened. Note that same mechanism realizes also predictions and future plans as time reversed topological quantum computer programs in ZEO. CDs in various scales contain this kind of programs and their memory representations.

2. I have also proposed that the geometric entanglement - braiding - of flux tubes defines a space-time correlate for quantum entanglement. In the case of topological quantum computation it would be naturally described by probabilities, which are rational numbers (or perhaps even algebraic numbers in some algebraic extension of p-adic numbers characterizing together value of the p-adic prime the evolutionary level of the system). Hence the notion of number theoretic negentropy makes sense and one obtains a connection with topological quantum computation.

3. The representation of memories in terms of space-like braiding of magnetic flux tubes connecting various systems would be universal, and not restricted to DNA-cell membrane system in which the flux tubes would connect DNA nucleotides [K23, K93] or codons (this seems to be the more plausible option [L32]) with the lipids. One could indeed speak about Akashic records (http://en.wikipedia.org/wiki/Akashic_records).

4. The time reversals or these representations defined by the zero energy states of opposite arrow of the imbedding space time would define a representation for future predictions/ plans in ZEO. For instance, the development of a seed to a full-grown organism could be coded in this manner in time scale where CD has time scale of order of the lifetime of the organism. Already Burr found evidence that the radiation field assignable to the seed has the same shape as the plant [I30, I81] or animal (salamander in his experiments). This energy

field would naturally correspond to the magnetic body containing dark photon Bose-Einstein condensates. The Akashic records and their time reversal would naturally correspond to the morphic fields of Sheldrake [I96, I97]: memories and future plans in time scales longer than than duration of life cycle for an individual member of species would be possibles. Every scientist of course agrees that the societies are busily predicting and planning their futures but find very difficult to accept the idea that this could have some concrete quantum physical correlate.

8.3.6 How to construct and read conscious hologram?

There is also another question to be answered. How the vision about brain as a conscious hologram is realized in the proposed conceptual framework?

The idea about living system as a hologram has strong empirical basis. One of the most dramatic demonstrations of the hologram like character of brain was the discovery of Pietch [J137] that salamander's brain can be sliced to pieces and shuffled like a deck of cards and put together. When the resulting stuff is returned to the head of the salamander, it recovers! This extreme robustness is very strong support for the non-local hologram like storage of biological information. Ironically, Pietch tried to demonstrate that the theory of Karl Pribram [J138, J139] about brain as a hologram is wrong!

In TGD framework one can go even further and ask whether this robustness actually demonstrates that various representations (sensory - , cognitive - , memory - ...) are realized at the long magnetic flux loops and sheets of the magnetic body rather than brain: one of the most disptable ideas of TGDi based quantum biology.

The notion of conscious hologram [K10] is one of the key ideas of TGD inspired theory of consciousness. Hitherto I have not been however able to find a really convincing concrete proposal for how brain could be a hologram in TGD Universe. The reading of memory - and other representations by interaction free measurement however leads to a natural proposal for what the hologram might be.

1. Certainly the formation of the hologram must closely relate to the vision about universal Akashic records realized in terms of braided flux tubes and their non-destructive reading by interaction free measurement. Oversimplifying, tor a given bit of the representation the photons scattered without interaction would kick either of the two detectors C and D associated with it to an excited state (see `http://en.wikipedia.org/wiki/ElitzurVaidman_bomb_tester`). This process is very much like absorption of photons by a photosensitive plate defining an ordinary hologram.

2. The lipids of the cell membrane are good candidates as something in 1-1 correspondence with the basic units of this hologram (note the analogy with computer screen - also a liquid crystal!). If one irradiates the laser like system formed by the detectors not only by the radiation scattered from the quantum Akashic records but by its superposition with the reference wave of same frequency, one obtains a good candidate for a hologram. It would be defined by the excited quantum state consisting of laser systems analogous to the detectors C and D. Any piece of the system should give and approximate representation of the memory and robustness of the representation is achieved.

3. In semiclassical treatment the probability that a given laser like detector is excited must be proportional to the modulus squared of the net field amplitude, which is a superposition of reference wave and scattered wave Also just. as in the case of ordinary holograms, the irradiation of the laser like system by the negative energy counterpart of the reference wave (its phase conjugate emitted in a state resulting in state function reduction to the opposite boundary of CD) effectively generates the conjugate of the scattered wave since only those parts of the system can return to the ground state with considerable probability for which the probability to go to excited state is high enough. Note that this implies that magnetic body contains geometric representations of the perceptive field as indeed assumed [K41, K42]. This is however not quite the classical hologram. Rather, the total number of absorbed negative energy phase conjugate photons for given pixel defines the "real" picture. A given point

of the hologram corresponds to an ensemble of laser like detectors so that a statistically deterministic response is obtained as an ensemble average.

How to realize this concretely?

1. The lipids of cell membrane could serve as pixels of sensory representations [K32] defining conscious holograms. Each pixel should contain large number of laser like "detectors" so that statistical determinism would be achieved.

2. The basic structural element would be pair C and D of detectors such that either of them absorbs photon in an interaction free measurement so that a value of bit is defined. Universality serves as a strong constraint as one tries to guess what C and D could be.

   (a) The lipids at the two lipid layers of cell membrane could be in 1-1 correspondence with C and D. This option is not however universal.

   (b) It is however quite possible that the magnetic fields involved are what I have called wormhole magnetic fields [K101], which carry monopole flux and and involve two space-time sheets carrying opposite net fluxes. As a matter of fact, all elementary particles correspond to flux quanta of wormhole magnetic fields. In this case the two sheets would naturally correspond to detectors C and D and in the simplest situation they would have same Minkowski space projection. Universality of both detectors and holograms is achieved.

3. The cyclotron Bose-Einstein condensates for charged particles at magnetic flux tubes assignable to lipids are good candidates for the laser like systems if they contain cyclotron Bose-Einstein condensates. There are however several options since the magnetic flux tubes are closed and there are several manners to realize this.

   (a) DNA as topological quantum computer vision [K23] and the view about cell membrane as a sensory receptor communicating data to the magnetic body in turn sending control signals via DNA suggest the following. Magnetic flux loops have a part connecting DNA with nuclear or cell membrane (this would be the analog for the dipole of the dipole magnetic field) and part which is long - even with size scale of Earth and corresponds to the magnetic field created by the DNA-cell membrane system. This picture applies both to the flux tubes of ordinary magnetic field and to the flux tubes of the wormhole magnetic field.

   (b) An assumption in accordance with the general role of magnetic body is that Akashic records reside at the short portions of flux tubes connecting lipids with DNA codons: their braiding would define basic example about universal representations in living matter. The laser like detectors would reside at the long portions of the flux tubes connecting cell membrane and DNA. If wormhole magnetic fields are in question, the detectors C and D could correspond to the two parallel flux tubes carrying opposite monopole fluxes.

   (c) Universality suggest that this picture allows many alternative realizations. In principle, the relative motion of any system (partonic 2-surfaces with light-like orbits) connected by flux tubes could give rise to Akashic records. The lipids of axonal membrane are excellent candidates for the pixels and the flux tubes connecting the lipids to microtubuli [J12] would also define Akashic records with long parts of the flux tubes serving as the laser like system. The maximization of the memory capacity would also explain why the neural pathways to brain tend to maximize their lengths by connecting right side of the body to left hemisphere and vice versa.

4. What remains still open is how to integrate the Josephson junctions defined by the lipid layers of the cell membrane to this picture.

8.3.7 Some critical questions

There are two basic objections against quantum theories of consciousness. How it is possible to have conscious information about invariant under quantum jumps if only change is experienced continuously? The outcome of state function reduction in standard quantum theory is random: how can one understand freedom of choice and intentional behaviour in terms of state function reduction? NMP and the possibility of negentropic entanglement (see fig. `http://www.tgdtheory.fi/appfigures/cat.jpg` or fig. 21 in the appendix of this book) imply that TGD based quantum theory is not equivalent with the standard one, and this allows to circumvent the objections.

There are however two further questions, which I cannot answer yet. Can one really assume that the notion of interaction free measurement continues to make sense in TGD framework? Could NMP allow to make this notion exact or make it impossible? Could the invariants or at least their existence be experienced directly without interaction free measurement?

The experiments carried out to test whether 40 Hz thalamocortical resonance is correlate for conscious experience suggests that the resonance is present only when a new pattern is discovered, not when it has become a memory. The TGD inspired interpretation would be that the resonances accompanies negentropy gain and quantum jump is necessary for a conscious experience. However, the reports about higher states of consciousness suggest that the invariants can be experienced directly when all thoughts (interaction free measurements) are eliminated. This experience cannot be however communicated: one understands does not know what one understands. Therefore also the original vision that negentropic entanglement corresponds to a conscious experience - experience of pure understanding, which is not communicable - and in apparent contradiction with the basic hypothesis about quantum jump, would be correct after all! Only the identification of the hierarchy of quantum jumps as self hierarchy would be wrong.

8.4 Taos hum as evidence for biophonons?

Taos hum is an experimentally well-established anomalous phenomenon which has escaped rational explanations (in the article [I102] a thorough review about nocturnal taos hum is given and the following representation relies on this article). Very concisely, taos hum seems is apparently a subjective experience without identifiable objective counterpart, and could therefore correspond to dark photons and/or phonons eventually transforming to ordinary sound and generating the experience. In the following basic facts about taos hum are summarized and some alternative TGD inspired explanations of taos hum are considered besides the original explanation as microwave hearing.

8.4.1 Basic facts

Taos hum is perceived in and around Taos, New Mexico but similar phenomena are experienced also in Northern America and Northern Europe. The hum is mostly heard during night time. Most people experience the hum as irritating and it causes nocturnal disturbances. From the tests based on psychophysical matching the frequency range of the hum has been deduced to be 40-80 Hz and whereas amplitude is around 60 dB. The hum is a regional phenomenon. The hum does not usually appear between sunrise and sunset. The pitch and intensity of the hum varies inside house and finds the largest magnifications on lower floors. Rooms modify the hum by adding distinctive harmonics to it. The pitch of the hum changes when one moves from outer wall to the interior rooms. Hallways and small alcoves raise the pitch considerably. The wavelengths involved vary between 3.9-7.8 meters for 40-80 Hz frequency range which suggests that resonance effects could be involved. It has been however impossible to identify any acoustic origin for the phenomenon. The presence of effectively acoustic effects suggests that a gigantic amplification by the physical (and magnetic!) body of the patient is involved.

Hum can involve also an experience about whirling or roaring wind, kind of vortex although nothing moves around, and coming from all directions. Also a strange amplification of distant sounds can be experienced. White light in the horizon in the direction where hum comes from can be also perceived. Experiences analogous to hum have been reported also in past, even in antique ('Aeolian wind'), but nowadays the number of victims of the hum has increased, which

suggests a connection with the emergence of electronics and computers. The direction which hum is experienced to come from seems to be random.

The hum can be accompanied by irritating tactile sensations and neuralgic pain. The unfortunate individual who suffers of extreme HUM disturbances, seems to be controlled by very fundamental and autonomic response-reflexes when in it grips. Such sufferers may behave in semiconscious modes, modelling behavioral patterns seen only in animals. Typically the victim tends to get underground believing that this allows to get him rid of the hum. The victims of hum indeed tend to wake up with the realization that they have very strong and painful muscle tenure.

An important hint as regards to mechanism of hum is the fact that the temporal patterns of the shortwave radio static detectable by shortwave receivers correlate strongly with those associated with the hum. It is also known that the static has a biological origin: the warbling sounds characterizing the static resemble those produced by plants and galvanic skin response sensors. And most importantly, the statics is present during night time.

All attempts to detect the hum instrumentally and to identify its source have failed. This has inspired various kinds of conspiracy theories about the nature of the phenomenon, for instance, the proposal the strong ELF power feed by submarine radars alone could explain the phenomenon.

8.4.2 Phenomena possibly related to taos hum

It is appropriate to discuss first some phenomena possibly related to the taos hum before considering the model for the phenomenon itself.

Microwave hearing

Microwave hearing [I43] is a phenomenon in which microwaves generate an audible sensation. There is evidence that microwave hearing does not involve ears as receivers of the primary signal [I68] and that the sensation of hearing could result as back-projection from cortex to ears.

This, and the correlation with microwave static suggest that taos hum could be a particular case of microwave hearing. The model of sensory representations implies that brain acts as a sending microwave antenna: a natural implication is that brain can act also as a receiving microwave antenna. The size of the brain hemisphere corresponds to a microwave frequency of order 3 GHz and smaller structures inside brain correspond to higher radio frequencies.

If primary sensory organs are the seats of the sensory qualia and back-projections cannot induce physical pain, the presence of the painful tactile sensations means that microwaves - assuming that they underlie Taos hum - also must interact also with the sensory receptors at the skin.

Physiophonic effect

Physiophonic effect is a phenomenon accidentally discovered by Antonio Meucci in 1842, in which vocal signals are electrically transmitted directly into the neurology of listeners [I102] . Physiophonic sound can be often amplified to an enormous volume. A possible interpretation is as externally stimulated internal sound but one can of course wonder whether the transduction to sound is necessary.

Since the body (especially collagen network) is liquid crystal allowing piezoelectric effect in which mechanical vibrations are transformed to electric signal, external sounds could be transformed to electric fields. On course, LC property implies that also genuine sound is generated so that both ELF em fields and ELF sounds can act as amplified signals. One can ask whether strong back-projection to the ears is generated so that sound percept results. This would imply oto-acoustic sounds directly detectable by microphones not found in the case of taos hum.

Microwave static and taos hum

It is known that the temporal patterns of the shortwave static detectable by shortwave receivers correlate strongly with those associated with the hum. It is also known that the static has a biological origin: the warbling sounds characterizing the static resemble those produced by plants and galvanic skin response sensors. And most importantly, the fact that the static is present during night time would explain why hum is experienced at night time.

8.4.3   Possible ingredients for the model for taos hum

The facts about the role of the musculature, shortwave radio noise, and the role of acoustic environment combined with the model of microwave hearing based on the notion of dark photons [K39] pose strong constraints on the model of taos hum.

Taos hum as sensitivity to external biological control signals

Magnetic bodies control biological body by sending control commands to brain and body where they are transformed to nerve pulse patterns and various physiological waves. Also the lower levels of self hierarchy should control the respective levels of the hierarchy, in particular muscle cells, in a similar manner. In the case of hum patient the normal control signal could be replaced by a control signal from some external biological source, say plants, and would be responsible for the muscular vibrations amplified to the hum. In the worst situation the behavior of hum patients reduces to simple reflex actions: these reflex actions would be initiated by fake control signals.

The fact that the taos hum begins after the sunset would conform with the interpretation as sucking of metabolic energy with energy quanta in visible and UV range. The loss of metabolic energy could explain why the experiences of patients are so unpleasant. Since motor action is based on negative energy signals affecting directly neuronal membranes by the same mechanisms as ordinary motor actions the signals would also induce reflex actions.

The situation could be due to the failure of the em (or rather, electro-weak) immune system of the patient. In order to understand what is involved a brief discussion of model of motor control based on charge entanglement induced by W MEs is necessary: a detailed model is discussed in [K37, K39] .

1. The exotic ionization of dark matter induced by W MEs generates dark plasma oscillations inducing electric fields which by many-sheeted variant of the Faraday law induce electric fields also at the space-time sheets where ordinary matter resides. Various ionic waves, in particular Ca^{2+} waves and nerve pulse are examples of the physiological responses resulting in this manner.

2. Dark plasma frequency corresponds to a microwave photon with energy above the thermal threshold and the system must be able to provide dark photons with this energy to generate plasma oscillation patterns serving as control commands.

The electro-weak immune system could fail in the following manner.

1. In the healthy situation em immune system takes care that the body is tuned to the personal dark plasma frequencies and does not respond to control commands from alien magnetic bodies associated with, say, plants.

2. In an un-healthy situation persons plasma oscillation frequencies are tuned to some frequencies in the microwave static and microwave static provides the energy needed to generate plasma wave patterns and thus to realize control commands from the alien magnetic bodies. The plasmoids would induce microwave hearing and generalized motor actions at cellular level exhausting the personal metabolic sources and leading to the painful experiences and fatigue.

Taos hum and microwave hearing

The identification of the audible sensation associated with taos hum in terms of microwave hearing could explain the failure of the attempts to identify the source for taos hum. Amplitude modulation by ELF frequencies naturally associated with motor control would give rise to sensation of sound.

Concerning the model for microwave hearing, a good guideline is that the effect is expected to be possible as quantum effect only if the energies of the microwave photons are above the thermal threshold. This would require dark microwave photons for which 5 GHz photons have energy above thermal threshold (6 cm wavelength). Same applies to other effects caused by dark microwave photons.

Microwave hearing itself would rely on hearing of dark microwave photons at visible and UV frequencies. These dark microwave photons could accompany the microwave signal automatically or could be generated by cells via a phase transition increasing the value of Planck constant.

Taos hum and microwave seeing

The de-coherence of microwave photons to ordinary photons would produce the biological effects. This could explain also the reported perception of white light as resulting from the de-coherence of the microwave photons at the upper end of the spectrum: 1 mm microwave wavelength would correspond to 2.5 eV photon energy.

The de-coherence of dark microwave static to ordinary visible photons could make possible microwave vision during night time. This could explain why the static emerges after the sunset. Plants could also generate negative energy dark microwave photons with energies in the frequency bands of visible photons involved with photosynthesis to satisfy their metabolic needs when they do not receive sunlight. One can of course wonder whether the quartz in the rock heated during day-time could generate dark microwave photons during night-time serving as a metabolic source.

Taos hum as a failure of the electromagnetic immune system

Taos hum starts immediately after the sunrise and stops after the sunset and seems to have a biological origin. The magnetic bodies of (say) plant cells could send dark energy photons at microwave frequencies above 5 GHz: one reason is that they become visible in this manner.

Negative energy W MEs in the same frequency range and responsible for quantum bio-control in the time scale of microwaves could be involved. Due to the failure of the electro-weak immune system the surrounding biosphere could induce generalized motor actions and these would exhaust the metabolic energy resources of the victim. This would explain why the hum is intolerable and the extreme fatigue caused by it.

The radio noise generated by computers and other sources of radio waves should not cause troubles if these radio waves correspond to ordinary photons. If not, then the microwaves in question could provide the energy needed to realize alien control commands based on ELF modulation.

An explanation for 40-80 Hz modulation

The model of biological evolution and evolution of nervous system based on dark matter hierarchy [K20] leads to sa detailed identification of the values of Planck constant associated with EEG identified as of dark Josephson radiation with energies in visible and UV range and EEG frequencies. This level is involved with all life forms capable of genetic expression, in particular plants. Therefore the ELF modulation of microwave frequencies could be due to the control commands from the levels of the magnetic body normally meant to control the genetic expression of say plants. The modulation of the microwaves with EEG frequencies, in particular with the frequencies in the $37 - 44$ Hz thalamo-cortical resonance band, could force the patient to stay awake by not allowing the dominant EEG frequencies to drop down to theta and delta region of EEG as occurs during sleep.

Is stochastic resonance involved?

One could also ask whether the microwave static of victims of taos hum is anomalously amplified by some mechanism so that control commands from alien magnetic bodies can be realized. The transduction of weak microwave signals to mechanical oscillations by piezo-electric body liquid crystals, and the amplification of this signal in the presence of a metabolic energy feed to the musculature, could lead to this kind of situation.

Stochastic resonance with white noise generated by body provides one possible amplification mechanism. Micro-wave frequency would correspond to the amplified frequency. If so, one could perhaps understand why only some persons experience the hum and why the effect is strong at night time. White noise would be generated by body. White noise induces jumps between the states of the 2-state system with an average frequency f_K (Kramers frequency) which depends on the autocorrelation function of the white noise and the properties of the 2-state system [K69]. If the Kramers frequency satisfies $f_R = 2f$, where f is the frequency of the signal, a resonant amplification occurs. The dependence $f_K \propto exp(-\Delta V/D)$, where $\Delta V > 0$ is the height of the potential barrier separating the states of the 2-state system, implies and exponential sensitivity of f_K on $1/D$, where D is the intensity of the white noise. Hence the failure of the em immune

system could be due to the too intense white noise produced by the body of the victim or due a too low height of the the potential barrier.

Are electronic systems involved with the hum?

The fact that the number of victims of hum has rapidly increased during the era of radio communications and computers and suggests that both radio noise and computers might be actively involved with the hum. Also ELF noise from electronic systems might be important if these systems generate dark ELF photons.

Electronic instruments generate also frequencies in the range $40 - 80$ Hz, in particular the 50 Hz frequency associated with the household electricity. Also submarine radars generate very strong ELF signals. The liquid crystal character of human body implies that besides weak sound signals also these ELF signals can contribute to the signal amplified by musculature. If these signals correspond to the lowest level of dark matter hierarchy, they should not have biological effects but whether this is the case is not all clear.

The strong coupling between magnetic flux tube structures associated the with computer networks and sensory canvases might be created by the magnetic reconnection process during night time when the shape of the flux tube structures changes. Also whole-daily use of a computer could generate magnetic mirror bridges between the computer and user's musculature and allow computer to feed fake control signals to muscles.

8.4.4 How TGD approach could explain taos hum?

The original explanation for taos hum was as analog of microwave hearing.

1. According to the original explanation, taos hum could be understood in terms of this kind of Josephson radiation or more general radiation at microwave and also higher frequencies generated by living matter during night-time and possibly providing some organisms with an active "vision". The emission of negative energy dark photons could also make it possible for plants to suck metabolic energy from environment in the absence of solar radiation. This radiation would propagate along magnetic flux tube - ME pairs. Microwave hearing or its analog at higher frequencies would generate the experience of hearing. The question is what exactly happens in in microwave hearing or its analog.

2. The estimated wave length λ for sounds assignable to taos hum are in the range 4-8 meters: this estimate might comes from the correlation with the acoustic environment. Probably it comes simply from the formula $\lambda = c_s/f$, where $c_s = 3 \times 10^3$ m/s denotes sound velocity in air and f is the frequency 40-80 Hz assignable to the auditory experience on basis of neurophysiological correlates. This estimate must be taken with a big grain of salt.

   If the primary signal is dark photon signal $f_l = 40 - 80$ Hz and if one takes the wavelength estimate seriously, one obtains the estimate $f_h = c/\lambda \simeq .05 - .1$ GHz. Unfortunately this frequency range is below the microwave frequencies varying in the range .3-300 GHz but scaling down of wavelength estimate by less than an order of magnitude would improve the situation. Thermal energy at room temperature corresponds roughly to 2.5×10^3 GHz so that the energies would be below the thermal energy at physiological temperatures. This cannot be however used as a serious objection against interpretation as microwave hearing since the wavelength estimate is based on the effective assumption that signal corresponds to 40-80 Hz ordinary sound wave.

The TGD based model for EEG [K20] is based on dark Josephson radiation generated by cell membrane Josephson junctions in the energy range of visible and UV light and covering a wide frequency range. The model explains bio-photons and EEG as manifestations of one and same basic phenomenon: dark photons and the recent observations support this identification [J85]. This motivates a more radical explanation of taos hum.

1. The auditory information is presumably coded to modulations of carrier wave with frequency f_h by frequency $f_l = 40 - 80$ Hz, which is in EEG range and could be assigned with the

    magnetic interaction energy of dark protons assignable to the opposite sides the cell membrane [J116] [L32]. Dark photon wave length would be of the order of the radius of Earth and the only reasonable explanation for the claimed correlation with the acoustics of the environment is that magnetic body provides a representation of biological body and environment as indeed proposed (magnetic sensory canvas hypothesis [K41]).

2. Since Josephson frequency characterizes the cell membrane frequency scale, one might expect that the dark photons signal has the same frequency. In this case the wave length would be of the order $\lambda = c/f \sim .1$ mm, size scale of large neuron rather than the naive estimate $\lambda = 4 - 8$ meters.

3. The dark photon signal would be generated by an amplitude modulation of a carrier wave at Josephson frequency $f_h = 2eV \sim 5 \times 10^{12}$ Hz (for electronic Cooper pairs) by frequency $f_l = 40 - 80$ Hz. According to the conjecture proposed earlier [L32], this would generate dark photons with $\hbar_{eff} = f_h/f_l \sim 1.2 \times 10^{11}$ near the thermal threshold. It is highly interesting, Cyril Smith reports that the frequency ratio $f_h/f_l = 2 \times 10^{11}$ is involved with the transformation of high frequency signal to low frequency signal [J147].

4. This picture would conform with the original idea that left brain utilizes frequencies not smaller than Josephson frequency assignable to cell membrane and right brain hemisphere visible and UV frequencies. In TGD framework this difference would be due the fact that cell membrane can appear in two ground states [K32]. The state realized in right hemisphere near to the vacuum extremal with Josephson frequencies in visible and UV range and the state realized in left hemisphere far from vacuum extremals and Josephson frequencies derivable from membrane potential.

    One should also understand how dark photon signal transforms to dark phonon signals and how this signal transforms to ordinary sound generating the taos hum experience. Two options can be considered: for the first option only dark photons are involved, for the second option both dark photons and phonons are involved.

1. Living body - cell membrane is an electret - and thus transforms electric signals to sound waves and vice versa. The minimum option is that signal propagates as dark photons and transforms to dark phonons of same energy at cell membrane level. One can consider also second possibility: dark photons continue to propagate along ME-flux tube pair parallel to the axonal membrane.

2. Dark phonons in the high frequency optical branch of the spectrum (/photons) would propagate as oscillations assignable to axonal membrane (/ME - flux tube pair parallel to it) to ear. Dark phonons/photons would generate virtual auditory percept by transforming to ordinary phonons at ear.

3. Both the variants of the model could explain the basic findings about taos hum, in particular the fact that it creates a subjective experience without any objective counterpart.

    One can ask why taos hum is not accompanied by its visual counterpart involving dark photons with visible photon energies. In fact, the persons suffering from taos hum occasionally report experiences of white light in the direction of sound. The mechanism could be essentially the same as for taos hum except that the right brain hemisphere is a better candidate for the receiver now if one takes TGD inspired view about cell membrane seriously.

8.5 Dark photons in biology and neuroscience

In this section I want to add some details to the general vision about dark photons as deeper level behind bio-photons. What is certainly unusual that I will barely mention biochemistry. My knowledge about the comlexities of biochemistry is not the reason for the neglect. The reason is that if hardware-software dichotomy in biology corresponds to the matter-dark matter dichotomy, the biochemistry separates neatly from the physics of dark matter for the software. It is a physical fact that dark matter dominates over ordinary matter in cosmic scales and is present everywhere

so that it is not so surprising if dark matter would play a key role in biology. Recently the futile searches for WIMP (weakly interacting massive particle) with expected properties have forced particle physicists to ask whether dark matter could be much more than single WIMP, maybe a new phase of matter or even hierarchy phases as TGD suggests.

My basic defense for the notions of magnetic body and dark photons (also other dark particles) is that they follow from the basic TGD and allow to explain phenomena very difficult to understand in the standard biochemistry framework - consider only the correlation between EEG and bio-photons, coherence of bio-photons, and delayed luminescence.

8.5.1 General vision

I have already explained the basic ideas about bio-photons as decay products of dark photons. In the following I try to develop a general vision about the role of dark photons in living matter.

1. Pulse patterns or temporal polarization patterns travelling along MEs are ideal for communications and control because of precise targeting, absence of dispersion and maximal possible signal velocity.

2. Resonance frequencies for dark photons could be an essential element in their interactions with biomatter. The most important of these interactions would be the generation of negentropic entanglement between new representations of mental images and already existing corresponding representations. For instance, for cyclotron Bose-Einstein condensates the magnetic fields at the ends of the sender and receiver must be equal in good accuracy. Password mechanism is suggestive: several resonance frequencies would define the letters of the password. Among other things this could lead to a selective remote activation of gene expression if dark photons represent codons of the genetic code [K120].

The vision of Hawkins about fundamental algorithm [J115] might find realization in TGD framework in terms of the basic anatomy of quantum jump in zero energy ontology (ZEO) [L33]. The basic idea is that conscious information processing consists of pairs formed by sensory perceptions (involving the recognition of the objects of the perceptive field) and by motor action. Sensory perception and motor action are related by time reversal and correspond to state function reductions at opposite boundaries of CD. These processes can combine to complex program like structures via generalization of lock and key mechanism in which fitting of the key to lock corresponds to recognition.

Lock and key mechanism is a well-known mechanism of bio-catalysis, and allows a far reaching generalization. Dark photons could provide a very general non-local realization of this mechanism.

1. Lock and key mechanism allows to imagine biochemical programs consisting from reactions proceeding in fixed order. The idea is same as in a familiar game of children. At each step player gets a key of a room containing a new key and the task is to find the room. After visiting many rooms the successful player eventually has the key to the room containing the treasure. In computer languages like LISP the same idea is realized: program is represented as a collection memory location containing two addresses: the address of memory location and the address of the next memory location. Associative memory recall could rely on the same mechanism.

2. Lock and key mechanism can be realized in several manners. The most concrete manner is as a chemical reaction in which reactants have complementary surface geometries fitting like lock and key. Keys could be replaced with passwords. The password could be represented as a collection of resonance frequencies. Also a pulse sequence or a more general temporal field pattern such as a sequence of magnetic fields with discrete valued strength and duration (Persinger has found that this kind of sequences are "physiologically effective" [J85, J87]. Temporal polarization patterns are also possible and are suggested by Gariaev's group [I52].

   For frequency coding, a given step in the process would activate a collection of frequencies activating the next step of the program and magnetic flux tube connections along which signals propagate would allow to achieve highly selective activation.

3. The decomposition of quantum jump to state function reductions at opposite boundaries of CD explaining the sensory-motor dichotomy at the level of brain could be realized also at molecular level and define basically a pair of addresses/passwords. Sensory perception with recognition of the objects of the perceptive field would correspond to the fitting of the key to lock. The frequencies of future directed positive energy signals would serve as a password inducing a motor action generating a collection of frequencies of past directed negative energy signals serving as a password for the next step of reaction.

8.5.2 Dark photons and biology

A lot of experimental data about the role of bio-photons in biology exist [I39, I88, I80]. Coherence [I53] and closely related delayed luminescence [I27] are the basic poorly understood aspects of bio-photons. Already Gurwitsch demonstrated that mitogenetic radiation makes possible communication between cell cultures.

1. Passwords realized as frequency patters could be at work also at the level of genome and rely on use of portions of DNA sequences as pairs of addresses. One could imagine a representation of DNA sequences in terms of frequency patterns of em fields.

2. Password mechanism realized in terms of frequencies for dark photons could allow interaction between remote genomes. One can imagine remote DNA replication, remote transcription and translation [K37]. If one accepts dark DNA [L10, K37] similar processes involving dark DNA and ordinary DNA can be imagined. I have discussed the role of dark DNA in making possible kind of R&D department allowing to test new variants of genes in the virtual world of dark DNA, RNA, tRNA and dark amino-acids. Peter Gariaev's findings suggest the possibility of remote DNA replication and remote activation of gene expression [K120].

3. The mechanism for the generation of sensory -, memory -, and cognitive representations as negentropically entangled zero energy states getting new tensor factors during quantum jump sequence is extremely general. Same can be said about the interaction free measurement as a mechanism for nondestructive reading of these representations. This suggests that they are realized already at the biomolecular level so that also conscious intelligence is present already at nanolevel. What we call molecular machines would be conscious entities and swarm intelligence as a mechanistic algorithm would be replaced by self-organization of conscious entities able to co-operate thanks to the presence of collective levels of consciousness made possible by the magnetic bodies and flux tube reconnections generating larger quantum coherent structures.

4. One can imagine new mechanisms of metabolism based on dark photons. Dark photons could take the role of sunlight and provide energy for electrons in electron transport cycle appearing in both cell respiration and photosynthesis. The effect of visible laser light on skin might involve this kind of mechanism. Negative energy dark photons emitted by electrons would make possible remote metabolism (quantum credit card mechanism).

5. The possibility to transform ordinary photons to dark photons is what one should understand. The findings of Peter Gariaev [I52] can be explained in TGD framework if DNA transforms laser photons to dark photons with frequencies of radio waves extending at least to kHz. Somehow DNA is able to induce the phase transition changing the value of $\hbar_{eff}$: amplitude modulation by radiofrequencies is a good candidate for mechanism in the case that the frequency ratio equals to integer valued ratio $\hbar_{eff}/\hbar$.

8.5.3 Dark photons and brain

The role of dark photons in imagination and for memories has been already discussed. Dark photons could also have a role in vision.

1. In TGD inspired theory of consciousness sensory qualia are assigned with sensory receptor. These primary sensory mental images are negentropically entangled with the mental images at brain and magnetic body (decomposition of perceptive field to objects). Qualia would

represent the colors of perceptive map. This assumption can be justified by very general arguments such as general coordinate invariance implying holography but is not absolutely necessary. Mental images at the magnetic body could be also involved with the entanglement sequence giving higher abstractions about the sensory input. The basic objection (phantom leg) can be circumvented if one accepts the vision about 4-D brain and TGD view about memory. The pain could be also real but erroneously assigned with the non-existing leg.

2. The notion of sensory window is almost two decades old notion [K56]. In its recent version dark photons propagate along MEs associated with magnetic flux tubes parallel to neural pathways, perhaps both from and to sensory organs. Experimental evidence for the propagation of bio-photons signal between nerve ends [J165] provide support for this idea. Stimulation of other end by light induces bio-photon emission at the other end. What would happen that dark photons are generated a the first end and propagate to other end along MEs and decay to ordinary photons.

3. Seeing without brain (see http://www.sciencedaily.com/releases/2013/02/130227183311.htm) - or more precisely without neuronal connections to brain - is now known to be possible [J33]. Does this mean that dark photons mediate information to brain or that retina plus spine "see" and that the geometric aspects of vision are realized also at the level of retina?

4. Dark photons from magnetic body or brain or both to retina transforming there to ordinary photons could provide feedback allowing to transform visual input to stardardized visual mental images. The proposed mechanism would require that retina produces seeds for induced transformation to ordinary photons. Retina is indeed known to generate bio-photons [J73]. Same mechanism could of course generate photons at the visual cortex so that visual mental images could be generated also there. Dissipation would be also now an unavoidable aspect of the process.

5. This picture would make possible similar representations also for the other sensory modalities. For instance, people learn to "see" via tactile sensation and also by hearing.

Correlations between bio-photons, EEG, and neural activity

The recent experimental understanding about correlations between emission of bio-photons and neural activity of the brain is thoroughly discussed in [J88].

1. *In vivo* experiments of Kobayashi et al [J84] demonstrate that the spontaneous ultraweak photon emission from a rat brain correlates with cerebral energy metabolism, EEG activity, cerebral blood flow and oxidative stress. Van Wijk et al [J92] have demonstrated significant correlations between fluctuations of alpha wave portion of EEG and bio-photon emission. It has been also demonstrated that neuronal axons can conduct photon signals [J165]. Thus there is a lot of evidence that bio-photons or something behind them are real and could serve communication purposes. Bischof has proposed that visual consciousness is a property of bio-photon field itself [J45]: this kind of conjecture is problematic philosophically and a weaker hypothesis about the correlation with visual consciousness and/or visual imagination looks more natural.

2. The article takes as granted that bio-photons are produced by biochemical processes related to reactive oxygen and nitrogen species (ROS and RNS). There is a strong correlation with oxidative metabolism of mitochondria. If f bio-photons are not fundamental entities, this correlation does not mean that these processes would directly produce bio-photons.

   One can however invent several objections against this mechanism.

   (a) Too short de-coherence time is the basic objection - Tegmark's estimate for the de-coherence time of bio-photons is $\tau \sim 10^{-13}$ seconds. The estimate is rough and gives coherence time increasing with temperature but certainly the lacking 10 orders of magnitude are a real problem and would require that generation of ROSs and RNSs is a highly coordinated mechanism. There are indeed indications that free radicals and their derivatives are necessary for synaptic processes and ordinary brain functions. If

magnetic body controls metabolism the underlying quantum coherence could imply the required high spatial and temporal coordination.

(b) Delayed luminescence is difficult to understand if only biochemistry is behind bio-photons.

(c) A further problem is the extreme weakness of bio-photon flux - at least in the vicinity of organism where the measurements are made. The argument of authors is that the strong absorption of bio-photons in living matter is the reason for this.

Despite these difficulties the authors suggest that bio-photons define a new kind of fast signalling accompanying electric signalling (nerve pulses and waves propagating along axonal membranes) and consider a quantum model for the interaction of bio-photons with microtubules. As a matter of fact, the idea about microtubules as quantum antennae represents one of the first applications of the notion of "massless extremal" (ME) to biology in [K56].

I have already described the basic deviations of TGD based model from this picture. Dark photons relevant to biology make themselves visible by transforming to bio-photons by energy conserving manner: this gives rise to frequency pairs (f_h, f_l) with $f_h/f_l = \hbar_{eff}/\hbar = n$. The other member of the pair would reveal itself classically as low frequency classical radiation and second pair as higher frequency photon. The pairing of EEG with bio-photons could be understood in terms of this pairing. The findings of Cyril Smith [J147] would have interpretation of this pairing allowing also other than EEG frequencies as dark photon frequencies. Also the findings of Peter Gariaev [I52] suggest that also radio wave frequencies can appear as dark photon frequencies.

According to [J88] the evidence for the correlation between neural electrical activity of neurons and bio-photon emissions is however poor. Situation might improve in future but one can ask whether it could be possible to understand the poor correlation.

1. If the transformation of dark photons at EEG frequencies to ordinary photons gives rise to bio-photons, it might be possible to understand the poor correlation. Neuronal activity would modulate membrane potential and the therefore the frequency $f_J = eV/h_{eff}$ of Josephson radiation but not Josephson current determining its magnitude. Note that f_J can be also outside the EEG range and TGD suggests a hierarchy of scaled up variants of EEG.

2. Neural events would have time scale of order milliseconds much shorter than the time scale of EEG so that the frequency modulation caused by them would not be visible in the time scale T_{EEG} of EEG frequencies considered. Only the slow modulations of membrane potential in time scales longer than T_{EEG} would be visible as a slow variation of corresponding bio-photon energy. The testable prediction is that the time variation of the frequency spectrum of bio-photons directly reflects that of EEG spectrum.

Biophotons and vision

Bischof [J45] was probably the first one to propose that bio-photons might relate directly to vision. The following list of articles by Bokkon et al illustrates the development of ideas about the connection between bio-photons and vision. I have included a comparison with TGD based views, which have developed during last two decades and are discussed in chapters of various online books [K56, K41, K106].

- *Phosphene phenomenon: a new concept* [J50].

  It is proposed that the visual sensation of phosphenes (induced by mechanical, electrical, magnetic situli, ionizing radiation, etc..) is due to bio-photon emission inside neurons. Also an interference model concerning the mechanism of interaction between living organisms and electromagnetic fields is proposed. Authors suggests that the biological nonlinearly polarizable double layer allows destructive interference of incoming and reflected waves outside the double layer. As a consequence, in the inside constructive interference would take place at the same time. The proposal is that the interference patterns may play an important role in biological self organization and in biological functions.

The authors investigate the boundary conditions necessary for explaining these non-linear optical effects in terms of the phase conjugation, and claim that there are solutions of the Maxwell equations which satisfy destructive interference of bio-photons. Necessary provisions are nonlinearly polarizable optically active double layers of distances which are small compared to the wavelength of light. In addition, they have to be able to move into the nodal planes of the impinging waves within a small time interval compared to the coherence time. The claim is that the conditions are likely fulfilled in the optically dense, but ordered and optically excited, highly polarizable living matter.

In TGD framework phosphenes could result via a transformation of dark photons to bio-photons. The propose interference model is needed to channel the electromagnetic fields inside cells and axons. In TGD framework the nonlinear modification of Maxwell's equations resulting from the fact that gauge potentials as primary dynamical variables are replaced with imbedding space coordinates, implies topological field quantization manifesting structures like massless extremals (MEs), magnetic flux quanta (sheets and tubes) and electric flux quanta realized as space-time quanta. Hence precisely targeted beams of dark photons become possible.

- *Picture representation during REM dreams: a redox molecular hypothesis* [J118].

  The proposal is that the visible photons in retina are converted to neural signals, which in V1 are are converted into synchronized bio-photon signals inside the neutrons by neurocellular radical reactions in retinotopically organized V1 mitochondrial CCO-rich (CCO is a shorthand for cytochrome oxidase) visual areas.

  The TGD counterpart for this would be the conversion of the neural signals to dark photon signals to the magnetic body with ROS and RNS reactions inducing a small leakage to bio-photons. One can also imagine that dark photons are generated at regina and travel along visual pathway so that the communications to magnetic body would be much faster. The feedback as dark photons from magnetic body to brain to retina would generate virtual visual input which in wake-up state would be compared with the actual input. During REM dreams only the virtual sensory input would be present. In retina dark photon input would generate bio-photon emission and this kind of emission is observed [J73]. One can wonder whether the dark photon emission from retina reflected from target could give rise to a "lamp" making possible "active" seeing under some circumstances.

  Cytochrome oxidase (CCO) enzyme is integral membrane protein permanently associated with the cell membrane and coded by mitochondrial DNA, and thus directly related to energy metabolism catalysing the reduction of oxygen to water in respiration and therefore something very primordial biologically. In TGD inspired model CCO would be needed for generating metabolic energy needed to generate dark photons. This would suggest that CCO rich regions are present also in other sensory areas. An interesting question is whether CCO rich regions are present both in left and right hemisphere. There is evidence that bio-photons are emitted considerably only in right hemisphere [J85]. Could this mean that the energy range for dark photons from left hemisphere is different or that dark phonons/biophonons effectively replace dark photons/bio-photons?

- *Visual perception and imagery: a new molecular hypothesis* [J78].

  The authors describe the basic hypothesis that neural signals from retina generate synchronized bio-photon signals by radical and non-radical processes in retinotopically organized visual areas and that these bio-photon signals provide intrinsic pictures in retinotopically organized mitochondria-rich visual areas.

  It is also proposed that long term visual memory corresponds to epigenetic information regulated by free radicals and redox processes. There is indeed evidence that reactive oxygen species and related haem pathway components as possible epigenetic modifiers in neurobehavioural pathology [J106].

  The TGD counterpart of this hypothesis is that dark photons generate representations of visual field at brain and possibly also at various layers of magnetic body with different degrees of abstraction. For dark EEG photons the layers would have size of order Earth

radius suggesting a connection with Schumann resonance and magnetosphere as a higher level in the predicted self hierarchy.

Epigenetic modifications and changes of synaptic connections would correspond in TGD framework to behavioral changes, not genuine conscious memories. The idea that ROS and RNS could perform this "carving" process analogous to the modification of computer hardware (now represented by biochemistry), is attractive. In TGD Universe genuine declarative memories would be however realized in terms of representations based on negentropic entanglement (see fig. `http://www.tgdtheory.fi/appfigures/cat.jpg` or fig. 21 in the appendix of this book) and read by interaction free measurement using dark photons and possibly also dark photons.

- *Estimation of the number of bio-photons involved in the visual perception of a single-object image: bio-photon intensity can be considerably higher inside cells than outside* [J78].

Authors consider two objections against biological role of bio-photons. First, bio-photons are a mere byproduct of cellular metabolism. Secondly, the extreme weakness of bio-photon flux does not support the idea that they might have biological significance. Authors however argue that bio-photon production is a controlled process and among other things gives rise to the above mentioned synaptic and epigenetic modifications. Authors also argue that the density of bio-photons inside cells is considerably higher than outside and consider a mechanism in which em fields are confined inside bilayered structures.

In TGD framework bio-photons are replaced by dark photons propagating along MEs. Their intensity can be much higher and bio-photons would represent a small leakage resulting from the transformation of dark photons to bio-photons. Unfortunately one cannot say much about the rate of this process: p-adic length scale hypothesis however probably fixes it to be inversely proportional to the secondary p-adic time scale (.1 seconds for M_{127} characterising electron) and hierarchy of Planck constants suggests that the rate behaves like $\hbar/\hbar_{eff}$. The strong correlation with metabolism can be understood since the generation of dark photons requires metabolic energy. An interesting question is what happens at other sensory areas: are CCO rich regions present also there?

- *Visible light induced ocular delayed bioluminescence as a possible origin of negative after image* [J79].

The motivation of the article is the experimental proof of the existence of spontaneous ultra-weak photon emission and visible light induced delayed ultraweak photon emission from in vitro freshly isolated rat's whole eye, lens, vitreous humor and retina [J73]. Authors propose that the photobiophysical source of negative afterimage can also occur within the eye by delayed bioluminescent photons. When one stares at a colored (or white) image for few seconds, external photons can induce excited electronic states within different parts of the eye that is followed by a delayed re-emission of absorbed photons for several seconds. Finally, these reemitted photons can be absorbed by non-bleached photoreceptors that produce a negative after image.

In TGD framework one could understand the emission of bio-photons from retina as a leakage phenomenon. After images and delayed luminescence in general could be seen as a kind of echo resulting when dark photons travel to brain, maybe also magnetic body and return back after exciting laser like system which returns to it ground state by secondary emission. After images perhaps assignable to dark photons could give build up copies of memory representations. This could also apply to dark phonons: examples about this would be a repetition of single world or simple piece of music occurring during wake-up state and in sleep mentation.

Interaction free measurement allowing to get conscious information from various memory representation requires for each bit two detectors, call them C and D, and the value of bit determines which of them detects photon. If the systems taking the role of the detectors C and D in interaction free measurement are analogous to population reversed lasers, their return to the ground state could automatically generate virtual sensory input propagating to the sensory organs and allowing to check whether it is consistent with the actual sensory

input. The generation of the feedback signal takes some time expected to be much shorter than that for a typical neuronal activity.

Since the signals would propagate with light velocity, the virtual sensory input could travel practically instantaneously from the brain to sensory organs and possibly also vice versa. Libet's experiments on passive aspects of consciousness [J71] in fact demonstrate a time delay which is fraction of second having interpretation in terms of time to propagate to a layer of magnetic body of size scale of Earth and back: these delays are consistent with the fact that the chronon of sensory experience is about .1 seconds. The propagation of photon signals in both directions would make possible construction of sensory representation in time scale much shorter than that of neural activity.

As special case this mechanism would explain after images. After images would be sensory echoes resulting when the sensory signal travels to magnetic body and back to sensory organs, maybe several times. The time scale for negative after images is seconds and in principle this allows to get some idea about the slow time scales involved with the process and maybe also about the size scales of largest layers of the magnetic body involved.

8.5.4   Dark photons, meditative states, and Qigong practices

Various experiments demonstrate that meditation tends to reduce bio-photon emission [J67, J124]. The interpretation would be that for some reason meditation reduces the leakage of large $\hbar$ photons to ordinary ones. How meditation could help to achieve this reduction?

If the generation of ROS generates bio-photons by the proposed mechanism with the ordinary photon generated in ROS serving as a seed inducing the transformation of dark photons of same energy to bio-photons then reduction ROS would explain the correlation. The life style of meditator might explain why the generation of ROS is reduced. If dark photons are involved with non-destructive reading of memories and future plans (time reversed memories), and if the absorption of dark photons by laser like systems followed by a return to ground state leads to an emission of also ordinary photons then cognitive processes would generate bio-photons. In meditative practices the basic goal is to calm mind by getting rid of thoughts so that this mechanism would not produce photons anymore.

The effects of Qigong practices on bio-photon emission has been also studied. Examples are changes of bio-photon emission and temperature of human hand during Qigong [J76], the effects of mental concentration on bio-photon emission [J95], temperature and bio-photon changes of the middle finger during Qigong and light imagery tasks [J102], and comparison of bioenergy and physiological markers in qigong and acupuncture research has been carried out [J96].

Quite generally, the hands of qi healer are expected to emit bio-photons. If Qi healer generates a flux of dark photons, some fraction of them dissipates to bio-photons, so that an increase of bio-photons could be the outcome.

8.6   Dark photons and remote mental interactions

Remote mental interactions are the same interactions that relate magnetic body and biological body. Now biological body is not the "personal one" but that of target and can be also inanimate in which case the presence of codes are not expected.

1. Flux tubes serve as correlates of attention. Attention would therefore be always involved with remote mental interactions - also those between various layers magnetic body and parts of biological body manifesting themselves in the biology of TGD Universe. Dark photons propagating along ME-flux tube pair serve as correlates of communication and control. "Motor actions" of magnetic body serve as tools of bio-control too. Also the reading of memory representations would involved dark photons and could therefore be involved with telepathy as mind reading.

2. Dark photons would accompany various remote mental interactions and the unavoidable leakage as bio-photons could be a signature of these interactions. For instance, healer generates low frequency dark photons along flux tubes creating the connection to the patient and part

of these photons leak out in the process. Dark photons are expected to leak from the hands of healer as bio-photons.

3. Could simultaneous changes in bio-photon emissions from healer and healee take place and be also detected? Identical values of f_l and f_h for healer and healee would serve as as a signature. In principle testable aspect of darkness is the integer aluedness of $\hbar_{eff}/\hbar= f_h/f_l$. From quantum coherence criterion the distance roughly $L \leq c/f_l$ allows to guess upper bound for the value of f_l. The additional signature would be the identical temporal patterns of dark photons correlation functions at both ends. This would be the analog of long range temporal correlations in delayed luminescence.

4. Dark photons could be seen as universal mechanism of remote viewing. Do various sensory modalities involve separate frequency bands f_h or is the frequency band determined solely by distance? This question relevant also for brain. Second relevant question is the role of magnetic bodies. The model for the findings of Willian Tiller about intentional imprinting of electric devices [J153, J154, J155] requires that magnetic bodies serve as relay stations in this process. Both healers and healee's magnetic bodies and even those assignable to levels of collective consciousness could be involved (healing by prayer).

Chapter 9

About concrete realization of remote metabolism

9.1 Introduction

The idea of "remote metabolism" (or quantum credit card, as I have also called it) emerged more than a decade ago - and zero energy ontology (ZEO) provides the justification for it. The idea is that the system needing energy sends negative energy to a system able to receive the negative energy and make a transition to a lower energy state. This kind of mechanism would be ideal for biology, where rapid reactions to a changing environment are essential for survival. Originally this article was intended to summarize a more detailed model of remote metabolism but the article expanded to a considerably more detailed view about TGD inspired biology than the earlier vision.

9.1.1 Short glossary about the basic concepts of TGD

The model involves several new physics elements. It is good to begin with a little glossary to get a rough view about basic ideas of TGD and TGD inspired biology. The following list explains briefly the notions relevant to the ontology of TGD Universe.

- The notion of ***many-sheeted space-time*** (see fig. `http://www.tgdtheory.fi/appfigures/manysheeted.jpg` or fig. 9 in the appendix of this book) distinguishes between TGD and special and general relativities. In TGD framework space-times are regarded as a 4-D surfaces in certain 8-D space $M^4 \times CP_2$ obtained from empty Minkowski space M^4 by adding four small dimensions. The study of field equations characterizing space-time surfaces as "orbits" of 3-surfaces (3-D generalization of strings) forces the conclusion that the topology of space-time is non-trivial in all length scales. Many-sheeted space-time consists of space-time sheets in various length scales with smaller sheet being glued to the larger ones by wormhole contacts (see fig. `http://www.tgdtheory.fi/appfigures/wormholecontact.jpg` or fig. 10 in the appendix of this book) identified as building bricks of elementary particles. The sizes of wormhole contacts vary but are at least about CP_2 size (about 10^4 Planck lengths) and thus extremely small for ordinary elementary particles.

- The notion of many-sheeted space-time forces the replacement of reductionism with ***fractality***. This is the basic motivation for applying TGD in, say, biology. The most radical prediction is the existence of scaled variants of physics of strong and weak interactions in various length scales, and biology is especially interesting in this respect. Fractality reflects itself as various length scale hierarchies.

  1. ***p-Adic physics*** as a physics of cognition and intention and the fusion of p-adic physics with real number based physics are new elements. p-Adic mass calculations lead to the ***p-adic length scale hypothesis*** stating that preferred p-adic length scales correspond to primes p near powers of two: $p \simeq 2^k$, k positive integer. Mersenne primes M_k of form $2^k - 1$, and Gaussian Mersennes $M_{k,G}$ of form $(1+i)^k - 1$ (k some prime in both cases)

are especially favored with biologically interesting length scale range [10 nm, 2.5 μm] containing as many as four electron Compton scales assignable to Gaussian Mersennes, which could be seen as a number theoretic miracle.

2. **Dark matter hierarchy** realized in terms of a hierarchy of values of effective Planck constant as integers using $\hbar$ as a unit. Large value of h_{eff} makes possible macroscopic quantum coherence crucial in living matter. For instance, it allows dark ELF photons with energies above thermal energy ($E = h_{eff}f$).

- **Topological field quantization**. This distinguishes between TGD and Maxwell's electrodynamics. TGD leads to a geometrization of the notion of classical field. Both weak, electromagnetic, and gluon fields are known once the space-time surface as a solution of field equations is known. This implies an enormous reduction in the number of degrees of freedom but the many-sheeted space-time brings in additional degrees of freedom allowing to avoid conflicts with known experimental facts about fields.

  Topological field quantization means that fields are replaced by quanta of space-time. For instance, constant magnetic field decomposes into space-time surfaces of finite size representing flux tubes or sheets. Field configurations are like Bohr orbits carrying very specific "archetypal" field patterns. Radiation fields corresponds to so called topological light rays or massless extremals (MEs), magnetic fields correspond to magnetic flux quanta (flux tubes and sheets) having as primordial representatives "cosmic strings", electric fields correspond to electric flux quanta (say cell membrane), and elementary particles have so called CP_2 type vacuum extremals as basic building bricks.

- **Field body** and **magnetic body**. These notions follow from topological field quantization. In TGD Universe a physical system has a corresponding field identity - field body or magnetic body - in the sense that a given topological field quantum corresponds to a particular source (or several of them - say in the case of flux tube connecting two systems). In Maxwell's electrodynamics one cannot achieve this kind of identification since the fields created by different sources superpose. Superposition is replaced with a set theoretic union implying that only the *effects* of the fields assignable to different sources on test particle superpose.

  Field body and magnetic body bring in new degrees of freedom highly relevant in TGD inspired quantum biology. Magnetic body has hierarchical onion-like structure reflecting corresponding structure for the system with which it is associated. One can also speak of **dark magnetic body** corresponding to the value of effective Planck constant $h_{eff}/h = n$. Dark space-time surface can be regarded as an analog of n-sheeted Riemann surface - an n-furcation of space-time surface occurring because of the extremely non-linear dynamics of Kähler action.

- **Magnetic body as an intentional agent using biological body as a sensory receptor and motor instrument** is an attractive identification but one should be cautious. One could argue that magnetic body and biological body together form the natural intentional unit - kind of "super-body" - and that in remote metabolism energy is transferred between biological and magnetic body parts. Note however that personal magnetic body has a hierarchical onion-like layered structure and that several magnetic bodies can use the same biological body making possible remote mental interactions such as hypnosis [L34].

- **Magnetic flux tubes and sheets** serve as "body parts" of the magnetic body, and one can speak about magnetic motor actions. Besides concrete motion of flux quanta analogous to ordinary motor activity, basic motor motor actions include the contraction of magnetic flux tubes by a phase transition reducing Planck constant, and the change in thickness of the magnetic flux tube changing the value of magnetic field and thus the cyclotron frequency. Reconnections of the flux tubes allow to magnetic bodies to get in contact and temporal variations of magnetic fields inducing motor actions of magnetic bodies favor the formation of reconnections. Flux tube connections at molecular level bring a completely new element to biochemistry. Flux tube connection serves as a space-time correlate for attention in TGD inspire theory of consciousness. ATP-ADP process could have interpretation in terms of reconnection.

- **Cyclotron Bose-Einstein condensates** of various charged particles can accompany magnetic bodies. Cyclotron energy $E_c = hZeB/m$ is much below thermal energy at physiological temperatures and magnetic fields possible in living matter. In the transition $h \to h_{eff}$ E_c is scaled up by a fractor $h_{eff}/h = n$ and for sufficiently high value of h_{eff} cyclotron energy can be above thermal energy $E = h_{eff}ZeB/m$. The observations of Blackman about quantum like effects of radiation at harmonic of Ca^{++} cyclotron frequency could be used as motivation for introducing the hierarchy of Planck constants. The proposal is that cyclotron Bose-Einstein condensates associated with DNA and cell membrane - perhaps cell membrane proteins - play a key role in biology.

- **Massless extremals (MEs)/topological light rays** are extremals of the Kähler action replacing radiation fields in Maxwell's theory. Laser beam serves as a good analogy for ME. MEs are tubular space-time surfaces carrying classical fields propagating with light velocity. Since the waves propagate in single direction only there is no dispersion and MEs make possible precisely targeted communications without loss of information. Linear superposition is possible in the direction of ME. Both electromagnetic, weak, color and gravitational fields are present as induced fields. MEs can carry light-like currents and can be charged: in Maxwell's theory this is not possible. For charged MEs polarization has a longitudinal component. Tesla's scalar waves are obvious analogs for charged MEs. Charged MEs can however serve as correlates also for charged particles like electron.

- **Josephson junctions** are junctions between two super-conductors, say, parallel wires or analogs of capacitor plates carrying supra currents. **Josephson current** is generated when there is a phase difference $\Delta\Phi(t) = \int ZeV \, dt/h$ between the two super-conductors involved. Josephson current is of the form $J = J_0 sin(\Delta\Phi(t))$. For constant voltage V the current is oscillating with **Josephson frequency** $f_J = ZeV/h$. The frequency for cell membrane is rather high for the ordinary value of Planck constant but $h \to h_{eff}$ scales it down so that even ELF frequencies are possible. The charge carriers of Josephson current are in accelerated motion and expected to radiate. The radiation is quantum process analogous to emission of photon by an atom and occurs with quantized energies coming as harmonics of Josephson energy ZeV having interpretation as electrostatic energy gained by the charge carrier "freely falling" through the junction. Charged particle can jump to the other side of cell membrane by absorbing positive energy Josephson photon or sending negative energy Josephson photon. This would define the basic mechanism of charge transfer for ionic pumps.

  In TGD inspired biology Josephson junctions are associated with electric flux quanta of which cell membrane carrying extremely strong electric field represents the basic example. In low length scale resolution one can regard the entire cell membrane as a Josephson junction. In improved length scale resolution cell membrane proteins are natural candidates for Josephson junctions and might define quantum counterparts for channels and pumps. The conjecture is that superconductors and Josephson junctions form a length scale hierarchy. The levels of this hierarchy can communicate by exchange of Josephson photons if the values of h_{eff} and Josephson energies were the same for them.

- The recent view about **negentropic entanglement** forced by Negentropy Maximization Principle (NMP) [K49] is very simple and leads to a connection between negentropic entanglement (see fig. `http://www.tgdtheory.fi/appfigures/cat.jpg` or fig. 21 in the appendix of this book), dark matter hierarchy, p-adic physics, and quantum criticality. NMP holds true only in the intersection of realities and p-adicities - that is, applies in the situations in which density matrix for a system and its complement is multiple of identity matrix resulting in general quantum measurement identified as a measurement of the density matrix. Negentropic entanglement is always maximal entanglement so that the density matrix is proportional to unit matrix and corresponds to a value of effective Planck constant equal to the integer $\hbar_{eff} = n\hbar$ telling the number of the entangled states. The p-adic prime assignable to the system corresponds to the largest prime power factor of n. n has interpretation as the number of sheets of multi-sheeted covering defining n-furcation of space-time sheet and the n-furcation is manifestation of quantum criticality implying n-sheeted covering property. Negentropic entanglement is a prerequisite for an experience defining abstraction as a rule having as instances the state pairs appearing in the entangled state. Note that the state

pairs are not unique since any unitary transformation acting in the same manner to the two entangled state basis is allowed.

- In *zero energy ontology* (ZEO) physical states are pairs of positive and negative energy parts having opposite net quantum numbers and identifiable as counterparts of initial and final states of physical event in ordinary positive energy ontology. Positive and negative energy parts of the zero energy state are at the opposite boundaries of **causal diamond** (CD) defined as a double-pyramid-like intersection of future and past directed light-cones of Minkowski space.

  There is a fractal hierarchy of CDs within CDs (and perhaps also overlapping with each other). The sizes of CDs (definable by the temporal distance between its tips) come as integer multiples of CP_2 time T_{CP_2} and the fundamental time scale $T = .1$ s of biology corresponds to $T = nT_{CP_2}$, $n = M_{127} = 2^{127} - 1$. This time scale corresponds to the secondary p-adic time scale assignable to electron and is macroscopic. As a matter of fact, all elementary particles correspond to macroscopic time scales: this predicts a direct connection between elementary particle physics and macroscopic physics.

  In TGD inspired theory of consciousness CD defines what might be called a spot-light of consciousness in the sense that the contents of conscious experiences associated with given CD are about the space-time sheets in the imbedding space region spanned by CD. Physical states are superpositions of pairs of positive and negative energy parts at opposite boundaries of causal diamond (CD) defined as double-pyramid-like intersection of future and past directed light-cones of Minkowski space. The conserved quantum numbers of positive and negative energy parts are opposite. Zero energy state is actually a superposition of zero energy states associated with CDs of different size scale characterized by integer. Time evolution with respect to subjective time is a sequence of state function reductions at opposite boundaries of CDs involving localization of that boundary and state function reduction at it but necessarily forcing the de-localization of the opposite boundary. During this process CDs in the superposition tend to increase in size, and this gives rise to the experienced flow and arrow of time. The pairs of state reductions at opposite boundaries correspond to sensory percept followed by motor action as reaction at the level of the brain. Phase conjugate laser beam would represent a standard example of negative energy photons.

  Negative energy signals would have several functions: realization of intentional action initiating neural activity in geometric past would explain Libet's well-known findings, memory as communication with geometric past with time reflection in time direction defining "seeing" in time direction, and remote metabolism.

9.1.2   Plan of the chapter

The model of remote metabolism and the vision behind it is applied to biology. It is shown that the basic notions of the theory of Ling about cell metabolism inspired by various anomalies have natural counterparts in TGD based model relying on the notion of magnetic body. Remote metabolism can be considered as a universal mechanism of metabolism with magnetic body of ATP, or system containing it, carrying the metabolic energy required by the biological user. In particular, the role of ATP is discussed in Ling's theory and from the point of view of TGD-inspired theory of consciousness.

It is easy to imagine new technologies relying on negative energy signals propagating to the geometric past and ZEO justifies these speculations. Remote metabolism could make possible a new kind of energy technology. The discoveries of Tesla made more than a century ago plus various free energy anomalies provide excellent material for developing these ideas, and one ends up with a concrete proposal for how dark photons and dark matter could be produced in capacitor-like systems analogous to cell membranes and acting as Josephson junctions and how energy could be extracted from "large" magnetic bodies.

The model identifies Josephson frequency with the subharmonic of the frequency characterizing the periodicity of a periodic voltage perturbation assumed to correspond to cyclotron frequency in biological applications. Together with quantization conditions for charge and effective Planck

constant it leads to precise quantitative predictions for capacitor-like systems acting as dark capacitors. Also a relationship between the magnetic field at magnetic body of the system and the voltage of the capacitor-like Josephson junction emerges.

The predictions allow new quantitative insights about biological evolution as emergence of Josephson junctions realized as capacitor-like systems both at the level of cell, DNA and proteins, and brain. h_{eff} can be related to Josephson frequency and cyclotron frequency and thus to measurable parameters. h_{eff} serves as a kind of intelligence quotient and its maximization requires the maximization of both the voltage and area of the membrane-like capacitor system involved. This is what has happened during evolution. Indeed, the internal cell membranes, cortical layers and DNA double strand in chromosomes are strongly folded, and the value of membrane electric field is roughly twice the value of the electric field for which di-electric breakdown occurs in air. Even 40 Hz thalamocortical resonance frequency can be understood in the framework of the model.

The claimed properties of Tesla's "cold electricity" suggest interpretation in terms of dark matter in TGD sense. This leads to a proposal that a transition to dark phase occurs when the value of voltage equals the rest mass of charged particle involved. This criterion is generalizes to the case of cell membrane and relates the values of h_{eff}, p-adic prime p, and threshold potential for various charged particles to each other. The idea that nerve pulse corresponds to the breakdown of super-conductivity as a transition from dark to ordinary phase receives additional support. The resulting picture conforms surprisingly well with the earlier speculations involving dark matter and p-adically scaled variants of weak and color interactions in biologically relevant length scales. An extremely simple mechanism producing ATP involving only the kicking of two protonic Cooper pairs through the cell membrane by Josephson photon as a basic step is proposed is proposed. Also the proposal that neutrino Cooper pairs making sense in TGD framework but not not in standard model could be highly relevant not only for cognition but also metabolism finds support.

The appendix of the book gives a summary about basic concepts of TGD with illustrations. There are concept maps about topics related to the contents of the chapter prepared using CMAP realized as html files. Links to all CMAP files can be found at `http://www.tgdtheory.fi/cmaphtml.html` [L35]. Pdf representation of same files serving as a kind of glossary can be found at `http://www.tgdtheory.fi/tgdglossary.pdf` [L36]. The topics relevant to this chapter are given by the following list.

- Magnetic body [L52]

- Basic Mechanisms associated with magnetic body

- Bio-anomalies [L41] [L39]

- Pollack's observations [L57]

- Biophotons [L43]

- Cell membrane anomalies [L44]

- Pollack's observations [L56]

- Quantum antenna hypothesis [L58]

- Quantum gravity and biology [L60]

- Quantum metabolism [L61]

- Water memory and homeopathy [L70]

- Bio-catalysis from primitive immune system

9.2 Quantum credit card

The receiving system serving as energy storage would be analogous to a population reversed laser and one can imagine at least two new physics options for the laser like system.

9.2.1   Two realizations for the "population inverted laser"

The two options could be realized for ordinary matter at biological body and for dark matter at the magnetic body respectively.

1. One possibility is provided by zero point kinetic energy depending on the size scale of the space-time sheets $E \sim \hbar^2\pi^2/2mL^2(k)$, where $L(k)$ is the p-adic length scale given by p-adic length scale hypothesis stating that p-adic primes $p \simeq 2^k$, k integer are favored. m refers to the mass of the particle transferred between space-time sheets as the laser like system is excited or de-excited. I have considered the identification for a hierarchy of metabolic energy quanta in terms of p-adic length scales comings as square roots of powers of two and defining a hierarchy transition energies which are not identifiable as ordinary molecular transition energies [K7]. The ordinary metabolic energy quantum whose nominal value can be taken as .5 eV belongs to this hierarchy and corresponds to proton for atomic p-adic length scale $L(139)$ or to electron Cooper pair with p-adic length scale $L(149)$. From $m_p/2m_e \simeq 2^{10}$ and from the ratio of p-adic mass scales $2^{(149-139)/2} = 2^5$ it follows that zero point kinetic energies are approximately the same. This option makes sense for visible matter and also for dark matter: the zero point kinetic energies are same since $L(k,\hbar_{eff}) = (\hbar_{eff}/\hbar)L(k,\hbar)$ is very natural assumption. $\hbar_{eff} = n\hbar$ is the effective value of Planck constant. This hierarchy most naturally holds true for ordinary matter and I have discussed unidentified spectral lines from outer space as a possible evidence for the existence of this hierarchy.

2. Second option would be natural in dark matter sector for dark matter residing at the magnetic body of a given system serving as the energy storage of the system. The cyclotron Bose-Einstein condensates of bosonic ions or Cooper pairs of fermionic ions would define the analog of population reversed laser. TGD inspired nuclear physics allows also to have bosonic counterparts of fermionic ions behaving chemically in the same manner as their fermionic counterparts [L10]. The excitation energy would be defined by cyclotron energy $E_= h_{eff}f_c$, $f_c = qB/4\pi m$: here q and m are the charge and mass of the charged particle in question. If the value of $\hbar_{eff}$ is large enough, cyclotron energies are above thermal energy. For ordinary value of Planck constant they are typically very small.

The realization of quantum credit card for the latter option relies on reconnection of the magnetic flux tubes of the system extracting the energy and those associated with the energy storage. The energy storage could be higher onion-like layer of the personal magnetic body of the system or even some other magnetic body. The reconnection is possible only if the magnetic field strengths of reconnecting flux tubes are identical. Therefore the system needing energy should be able to tune the field strength on the receiving flux tubes by varying their thickness (conservation of magnetic flux guarantees that field strength behaves as inverse of the cross-sectional area of the flux tube). The reconnection gives rise to a formation of a flux tube between two systems and the system needing energy can send negative energy received by the excited cyclotron BE condensate.

This mechanism can also be behind the binding of molecules to corresponding receptors allowing the molecule to recognize the presence of the receptor after which the contraction of the flux tube by a phase transition reducing $\hbar_{eff}$ would bring the molecule to the receptor. Also water memory and homeopathic healing - and also immune system - would rely on the same mechanism. This mechanism appears also in the model of hypnosis as a kind of hijacking of parts of brain of the subject by hypnotist and in the general model of remote mental interactions.

9.2.2   Support for quantum credit card mechanism

There is some empirical support for the credit card mechanism.

1. Photons of phase conjugate laser light behaves like negative energy photons in the sense that second law holds true in the reversed direction of geometric time which must be distinguished from experienced time.

2. Popp has identified a process equivalent to "sucking of energy" in living matter, interpreting it as an extraction of energy in the form of bio-photons [I90]. Extraction mechanism allows interpretation in terms of sending of negative energy photons, which can also be dark. In

TGD Universe bio-photons would result as dark photons decay in energy conserving manner to ordinary photons [K112]. The decay rate could be very small so that the intensity of dark photons could be quite high.

3. Sleighdogs [I92] can run for several days without eating and no signatures of ordinary metabolism have been found. This phenomenon cannot of course be specific to sleigh dogs. Remote metabolism could explain the phenomenon as an extraction of metabolic energy from non-standard sources in absence of standard sources - say from the magnetic body associated with the collective formed by the dogs.

4. Yan Xin Qigong practitioners report that in so called Bigu state there is no need to eat solid food at all for days, weeks, months or even years. Western science is beginning to take Bigu state (`http://www.scribd.com/doc/40483378/Bigu-by-R-Roy`) seriously [I19] and the first national conference on Bigu state was held at the Pennsylvania State University in 2000, with presenters such as as Rustum Roy, founding director of Penn State's Materials Research Laboratory and Hans Peter Duerr, former director of the Max Planck Institute.

One could argue that these individuals live by utilizing dark light as metabolic energy. Does living matter use quantum credit routinely or only in special situations when ATP-ADP mechanism is not available or the neural processing of incoming information leading to the decision about motor action is too slow? Quantum credit card mechanism allows also to initiate the neural activities preceding motor action in the geometric past and Libet's experiments indeed give support for this. Intentional action could be also seen as a top-down process in reverse time direction in which neural activity would be the last step.

One could also raise a more heretical question: could metabolic energy be always received by quantum credit card mechanism? Could the mysterious "high energy phosphate bond" actually reflect the fact that the metabolic energy is extracted from the magnetic body of ATP or some system containing it? Could energy reservoirs be filled by sending dark photon radiation exciting cyclotron states (EEG would be only one example of dark photons)? Or could ATP$\rightarrow$ ADP fill energy reservoirs at magnetic body?

The best manner to test this is by studying cells under metabolic deprivation. Ling [I74] has argued that ionic pumps and channels do not actually exist and the experimental support for this was his experimental finding that cells continue to function under metabolic deprivation. This could be also interpreted as support for the hypothesis that the ionic currents flowing through cell membrane are supra currents so that dissipation is very low and pumping is un-necessary. My own argument [K13] runs as follows:

> "One can also wonder how metabolism is able to provide the needed energy to this continual construction of pumps and channels and also do the pumping. For instance, sodium pump alone is estimated to take 45-50 per cent of the cell's metabolic energy supply. Ling has studied the viability of the notion of the ionic pump experimentally [I74] by exposing cell to a cocktail of metabolic poisons and depriving it from oxygen: this should stop the metabolic activities of the cell and also stop the pumping. Rather remarkably, nothing happened to the concentration gradients! Presumably this is also the case for the membrane potential, so that the notion of metabolically driven electrostatic pumps seems to fail. Of course, some metabolism is needed to keep the equilibrium but the mechanism does not seem to be a molecular mechanism and somehow manages to use extremely small amount of metabolic energy."

My proposal has been that pumps and channels can be there, but are needed basically for the purpose of taking samples about the state of the cellular environment. This view was inspired by the vision that cell membranes serve as sensors communicating information about the cellular environment to the magnetic body. Metabolic energy is however needed for other purposes and one might argue that the finding of Ling supports the view that a cell in this kind of situation uses quantum credit card to extract energy from some magnetic body.

9.3 Comparison of Ling's vision of the cell to TGD view

Gilbert Ling (`http://gilbertling.org`) has proposed a theory of cell and living systems which challenges some basic assumptions of standard cell biology [I79, I74, I75, I76, I40, I72, I73]. This theory has several points of contact with the TGD view about living matter and it is interesting to compare the two approaches.

9.3.1 Ling's basic ideas and concepts

Ling challenges the notions of ionic pumps and channels, the notion of high energy phosphate bond, and the prevailing view about the role of ATP as energy currency. Ling also questions the views about the role of water and lipid layers of cell membrane in biology. Reading Ling's article about mitochondria [I73] revealed to me how little is known about living matter and how primitive the theories really are. It is difficult to avoid the feeling that the biochemical approach is a heroic attempt to understand living matter without appropriate concepts and ideas and therefore doomed to lead to a vicious cycle of ad hoc hypotheses.

Ling's finding [I75] that a cell can survive for days under conditions of metabolic starvation is his basic argument in favor of the proposal that ionic pumps do not actually exist and that the transfer of various ions and molecules through cell membrane relies on different mechanisms.

Ling's theory [I74] is summarized in the article "Main principles of Lings physical theory of the living cell" (`http://vladimirmatveev.ru/mainprinciples.html`) by Vladimir Matveev [I79]. Ling introduces several new notions.

1. **The notions of resting state and activated state**.

   Biological basic structures in various scales appear in two states: resting state and activated state. These states are characterized by the associations between molecular pairs (to be described below). In the resting state most proteins are folded being covered with ordered water giving rise to several layers at the surface of the folded protein. Some protein however remain unfolded. In active state this layer melts and the protein's charged active sites become active and associations form between them and various ions or other active sites. Some proteins are unfolded also in the resting state. According to Ling ATP, water, and potassium ions (K^+) are adsorbed on the active sites of the unfolded proteins in resting state. In the activation ATP molecules are split and they give up phosphate ions to other molecules.

2. **Association between two molecules - call them A and B for definiteness**.

   Association of B with A means that B tends to be adsorbed by A. Ling's argument [I74] goes as follows. Consider molecules A and B with opposite charges and assume that A is fixed in space (A could be protein and B ion). The fixing of the position reduces the kinetic energy and therefore reduces the total energy of the pair since Coulomb interaction energy is negative. Therefore the association of the molecules is energetically favored. An example of an associated pair would be protein and ion attaching to a charged active site of the protein, which is either anionic or cationic (negatively or positively charged). In this case one can indeed assume that the position of the protein is fixed.

3. **Selective adsorption of B by A**.

   Adsorption probability described quantitatively in terms of affinity of A with respect to B - is enhanced by the presence of association so that one can speak of selective adsorption. Affinity of A with respect to B is defined as the energy liberated as B is attached to A. Electron affinity (`http://en.wikipedia.org/wiki/Electron_affinity`) of atom is an especially important affinity. In Ling's theory affinities of various biomolecules or their functional groups with respect to water molecules, Na^+ and K^+ ions, and other functional groups appear as parameters. In particular, the affinities of C=O and N-H groups of the peptide bonds of proteins with respect to water molecules and other such groups are important. Also the affinities of COOH groups of the amino-acid residues containing two COOH groups with respect to Na^+ and K^+ ions are important.

Affinities characterize the state of the molecule: in particular, they are different for the resting state and activated state. For instance, unfolded proteins are highly affine with respect to K^+ in the resting state and with respect to Na^+ in the activated state. The phase transition changing the affinities accompanies the generation of action potential. The challenge is to understand why the affinities with respect to two ions with same charge and naively with same chemical properties are not essentially same. In principle, the definition of affinity as energy liberated in adsorption can explain this in terms of details of molecular chemistry since the geometry of the molecules matters besides charge distribution. The exponential dependence of Boltzmann factors appearing in equilibrium distributions could explain strong dependence of affinity on molecule.

The physical nature of selective adsorption - that is affinity - is assumed to depend on electron density in the functional group considered. Low electron density characterizes the resting state and high electron density the activated state. The main regulator of the electron density is ATP, which has electron acceptor properties (Ca^{++}, signal factors, hormones, and chemical modifications of proteins serve as regulators) In the resting state ATP adsorbed to the protein site displaces electron density to the adsorption site and when ATP is split, the electron density is transferred to the activated state. This displaced electron density is analogous to "high energy phosphate bond".

4. ***Adsorption of water***.

In Ling's theory the role of water [I40] differs from than in standard theory. The polypeptide backbone of any completely unfolded protein has a geometrically regular order of positive (N-H) and negative (C=O) charges of the dipoles. This geometry is complementary to the space between water molecules surrounding the protein. This complementary makes possible multilayer adsorption of water on the protein surface. Large fraction of the cellular water is transformed to an ordered water. The outcome are stronger dipole-dipole interactions (hydrogen bonds are the major contributors). As a consequence, the water layers become a poor solvent as compared to bulk water and solutes are displaced from the volume of the adsorbed water. Ordered water acts like an ice layer serving as a barrier against diffusion of large solute molecules. The ordered water at cell surface is assumed to explain cell's selective permeability.

As the cell is activated, the "ice layer" melts and diffusion into cell becomes possible and is not prevented by lipid layers. Also the selectivity of each functional group of polypeptide changes: instead of a high affinity with respect to water molecules one has a high affinity with respect to the functional groups of the back-bone. This gives rise to secondary structures of protein (such as alpha-helix).

5. ***Induction process changing in a phase transition-like manner the associations between molecule pairs***.

Activation process is a thermodynamical phase transition. Ling uses as an analog system magnet, a roughly linearly ordered sequence of magnetizable nails, and iron powder. When the magnet is brought to the system, the first nail is magnetized and magnetizes the second nail, which in turn magnetized the third,... The nails also attract that iron powder. The outcome is the organization of the system to a linear structure minimizing free energy. Skeptics can of course argue that this is just a metaphor involving in essential manner non-locality brought in by the presence of the long range magnetic field. Chemistry is however local and it is difficult to see how the non-locality could creep in without introducing some explicit realization for it. The problem is actually much more general: how it is possible that biomolecules manage to find their associates in the dense molecular crowd: how molecule A recognizes the presence of molecule B and how A and B then go to find each other to react chemically.

9.3.2 The fundamentals of Ling's vision from TGD view point

It came as a surprise that Ling's basic notions have rather direct TGD counterparts in terms of magnetic flux tubes and their dynamics based on reconnection and phase transitions changing the value of $\hbar_{eff}$ inducing the change of flux tube length.

The new view about metabolism

More than 15 years ago I used [K7] Ling's finding [I75] related to the ability of the cell to survive under metabolic deprivation as an argument to support the hypothesis that ionic currents are supra currents running with low dissipation; in addition direct measurements support the quantal character of these currents identified as Josephson currents - in particular the fact that they do not depend on the properties of the membrane in question. Ling does not assume channels and pumps [I72], although in TGD framework they could be present. My cautious proposal has been that they exist for the purpose of taking samples about the molecular environment generating chemical sensory data communicated to the appropriate appropriate part of the magnetic body. In any case, metabolic energy is needed for may other purposes - in particular, in the transition to activated state, and one could argue that Ling's experiments indicate the existence of an un-identified energy source used when ordinary metabolic energy is not available.

The recent view about TGD suggests that magnetic bodies serve as metabolic energy reservoirs analogous to population inverted lasers defined by excited cyclotron BE condensates of electron and proton Cooper pairs and of various ions. Electronic Cooper pairs are preferred because of their small mass. Quantum credit card mechanism would allow the extraction of energy from the BE condensates by sending negative energy dark photon signals leading to de-excitation of the BE condensates. In this framework the questionable notion of high energy phosphate bond could be replaced with the storage of energy of this kind associated with ATP or with a system containing ATP. The loading of metabolic batteries could take place by sending positive energy dark photons to excite the BE condensates in question and solar radiation could do this as it generates ATP from ADP by adding single phosphate ion. In cell respiration dark photons at the magnetic body of molecules providing the energy would do the same thing using essentially the same mechanism involving electrons and transfer of three protons per ATP through mitochondrial cell membrane.

TGD counterparts for the basic notions of Ling

Ling's vision is very attractive - at least from a TGD point view. One can however wonder whether it can be realized in the framework of standard chemistry. Can the proposed mechanism of association really lead to the selective adsorption? In particular, it is not clear how a given active site of protein can select between ions of same charge? The basic concepts of Ling find natural TGD counterparts and TGD allows one to overcome the restrictions posed by sticking to the framework of standard chemistry.

1. In TGD framework the notion of association would reduce to that of flux tube or a flux tube pair connecting a pair of molecules or molecule (say active site of protein) and ion. Flux tube pair is favored since it allows to interpret reconnection process as touching of closed flux loops associated with A and B so that flux tube pair connecting A and B is generated.

   This view fits also nicely with one of the variants of the model of DNA as topological quantum computer [K23]. For the variant in question the two flux tubes would carry electrons at their ends and the spin states of the two electrons would give rise to 4 states in 1-1 correspondence with DNA nucleotides so that one would obtain a realization of DNA code in terms of flux tube pairs.

   Flux tube connections allow without further assumptions an additional selectivity in the sense that they can can exist between protein active site and on a particular ion only. As such Ling's proposal cannot distinguish between ions of same charge. TGD allows flux tube connections also between various biomolecules and even between larger structures so that the notion of association is not restricted to protein-ion pairs or pairs of active sites. These connections are absolutely essential for the understanding of DNA transcription, translation and various bio-catalytic processes.

2. Adsorption process would mean a reduction of the length of the flux tube by a phase transition induced by the reduction of the value of $\hbar_{eff}$ so that molecules would get near to each other and chemical reaction would become possible.

   It is intuitively clear that the length of the magnetic flux tube increases by $\hbar_{eff}/\hbar = n$ in the phase transition $\hbar \to \hbar_{eff}$, or more generally by $\hbar_{eff,2}/\hbar_{eff,1}$ in the phase transition

$\hbar_{eff,1} \to \hbar_{eff,2}$. Consider a momentum eigenstate $exp(ipz/\hbar_{eff,1})$ with wave vector $k_1 = p/\hbar_{eff,1}$ defined at a straight flux tube satisfying periodic boundary conditions and therefore satisfying $k = m2\pi/L$, L the length of the flux tube. Suppose that momentum p is conserved in the phase transition. This means that wave vector k is transformed from $k_1 = p/\hbar_{eff,1}$ to $k_2 = p/\hbar_{eff,2}$. To preserve the periodic boundary conditions the length of the flux tube must be scaled by $\hbar_{eff,2}/\hbar_{eff,1}$.

3. Induction process would mean a phase transition inducing reconnection process changing the flux tube connections between molecule pairs. This process would be a quantum phase transition. Whether two molecule can associate depends on the values of the local magnetic fields associated with the reconnecting flux tubes. If the values of both the magnetic field and flux tube thickness are same for the two tubes, association is possible. The value of the flux tube thickness allows to discriminate between different ions of same charge. Flux tube thicknesses characterize also the state of the system (resting state and various activated states). It is also possible that the protein can vary the thickness of the flux tube and therefore reconnect with different molecules. The change of flux tube thickness would take place in the quantum phase transition changing the connectedness structure of the net formed by molecules. The phase transition can be seen as a motor action of the magnetic body. Magnetic body "wakes up" in the activation process.

Concrete examples about a process in which flux tube connectivities change in a phase transition-like manner would be melting of the "ice layer" around a folded protein bringing the proteins into "open air". The shortened flux tubes connecting the active sites of the peptide backbone and di-carboxylic amino-acid residues to water molecules would expand in $\hbar_{eff}$-increasing phase transition and de-reconnect. Water would transform to ordinary water. The resulting closed flux tubes accompanying amino-acids can reconnect with similar loops associated with other active sites of peptide and various secondary structures (such as α-helix) of the protein can form. I have discussed TGD inspired models of protein folding in [K4] in a rather light-hearted manner - mainly as an exercise in order to get familiarity with the notion of magnetic flux tube - and it would be interesting to reconsider the situation by characterizing the active sites by values of magnetic field/cyclotron frequency.

4. Why should the $\hbar_{eff}$ increasing phase transition accompanying the activation process require energy? The following argument suggests an explanation.

    (a) As explained, the length of the flux tube is proportional to $\hbar_{eff}$ and therefore changes. What happens to the thickness of the flux tube? The simplest assumption is that magnetic field strength is preserved so that cyclotron energy scales like $\hbar_{eff}$ if the sheet containing single high frequency boson is transformed to an n-sheeted state with one low frequency boson at each sheet. This brings to mind Bose-Einstein condensate and one can ask whether the formation of BE condensates of genuine bosons could have a microscopic space-time description as n-furcations.

    If bosons are Cooper pairs of fermions one encounters a problem with fermion number conservation in positive energy ontology. In ZEO one can in principle avoid this problem but one can argue that the change of fermion number in quantum jump for the positive energy part of the state is too radical an option. One possibility is allowance of fractional fermion number for a given sheet so that one can say that Cooper pair is de-localized between the sheets. One could also start from many-fermion state so that in the final state one would have one Cooper pair per sheet of the n-sheeted covering. For very large values of n this option is highly questionable.

    (b) The conservation of magnetic flux poses an additional constraint. If the number of sheets becomes n-fold and the total flux is conserved, the flux of single sheet must be a fraction $1/n$ the original total flux. Therefore the transition producing n-sheeted covering of flux tube scales down its cross sectional area roughly by a factor $1/n$.

    (c) A further condition comes from the quantization of magnetic flux telling that the net flux is integer multiple of $m_i \hbar_{effi,i}$ in the initial state ($i = 1$) and final state ($i = 2$).

Conservation of the magnetic flux gives $m_1 n_1 = m_2 n_2 = m$ so that integer m giving the flux in units of $\hbar$ must be divisible both by n_1 and n_2. Therefore the phase transition can occur only when the magnetic flux using $\hbar$ as unit is larger than 1 and the allowed values of n_i are factors of m. For large values of integer n_2 this means that the thickness of the magnetic flux in the initial state must be macroscopic.

(d) What happens to the magnetic energy of the flux tube? By considering a constant magnetic field one easily finds that flux conservation and invariance of B together with longitudinal scaling imply that the energy is scaled by integer $n = \hbar_{eff,2}/\hbar_{eff,1}$. Therefore part of the metabolic energy would be needed to make the flux tubes longer and thus to gain quantum coherence in a longer scale.

One could say that the pumping of the metabolic energy is needed to preserve macroscopic quantum coherence. An attractive idea is that the energy is extracted from some magnetic body by sending negative energy dark photons. The contraction of flux tubes would occur spontaneously and liberate magnetic energy and reduce the value of $\hbar_{eff}$. It is natural to interpret this process as dissipation and loss of potentially conscious information.

5. Also the notions of resting state and activated state of biological structure (cell, protein, etc) have natural counterparts in TGD framework, together with the vision about the role of ordered water in biology. I have used the metaphor "cellular winter" for the resting state and "cellular summer" for the activated state induced by the feed of energy to the system so that it begins to self-organize. The TGD inspired model for ordered water (http://tgdtheory.com/public_html/articles/activatedwater.pdf) [L30] [K37] relies on topological quantization of the magnetic field giving rise to flux sheets giving rise to layered structure and there is also a connection with the notion of pairs of dark DNA identified as sequences of dark protons at opposite sides of the layer realizing genetic code [L10, K37].

It seems that the basic notions of Ling's theory - in particular the notion of association, which in my view remains questionable in the framework of standard chemistry - find natural counterparts in TGD framework. The view about cell membrane as Josephson junction leads to a new view about nerve pulse with Josephson currents of Cooper pairs of electrons and fermionic ions and of bosonic ions serving in the key role.

The ground state of the axon would correspond to a propagating soliton sequence mathematically analogous to that appearing in the sequence of mathematical pendulums. Nerve pulse would correspond to a propagating perturbation analogous to that obtained by kicking one pendulum to rotate in opposite direction. The detailed modelling of ionic currents is a fascinating challenge, and the view about the pairing of molecules and ions by flux tubes could provide a much more detailed and maybe realistic view about what really happens at cell membrane. It would also allow us to answer the question of whether pumps and channels are needed or whether they could be replaced with the TGD variants of the notions introduced by Ling.

Clearly, the basic question is whether standard biochemistry based on locality assumption is enough to describe living matter or whether the non-local quantum physics involving dark matter at magnetic flux tubes and transforming living matter from a soup of free ions and molecules to a dynamical Indra's net formed by biomolecules and flux tubes connecting them is needed.

Ling's view about ionic pumps and channels as compared to TGD views

Ling has empirical evidence that the prevailing ionic pump paradigm is wrong. The basic assumption of the prevailing theory is that both water molecules and various ions inside cell are free. This determines the kinetic equations used in the modelling of ion concentrations in chemi-osmotic theory [I73]. Ling assumes that in the resting state the important ions are adsorbed to proteins and that the activation of the cell changes the situation.

Besides adsorption also the notions of association and induction are needed in the formulation. Ling also emphasizes the role of the cellular water [I40]. Cellular water is not ordinary water but ordered water forming multilayered coverings of biomolecules in the resting state of the cell. This

covering prevents various chemical activities of the molecules below the "ice layer". Only when the ordered water around proteins and other molecules melts, they become active and can participate biochemical reactions via their active anionic or cationic sites to which ions or other biomolecules attach. In this framework the notions of ionic pump and channel must be given up or reformulated.

This picture is consistent with that provided by TGD. Instead of treating cell interior as a soup of free molecules one must treat the system as a kind of dynamical Indra's web in which flux tube connections are changing all the time. If ions are part of this web, one cannot apply ionic pump theory unless one can neglect the constraints caused by the presence of flux tubes.

The most important implication is that the web dictates to a high degree what biochemical reactions can occur and also takes care that the reactants are brought together when needed by reducing the value of Planck constant for appropriate flux tubes of the web. This transition also induces phase transitions changing the volume of a given region of cell. Sol-gel phase transition is basic example in this respect. It would seem that the best manner to describe the transfer of various molecules and ions through the cell membrane in TGD framework is as motor activities of the magnetic body of the cell quantum mechanically rather than biochemistry trying to reduce everything to single particle level and to thermodynamics.

The fact is however that channel and pump proteins exist and must have some function. The minimal function would be taking of samples from the chemical environment. Also in the generation of nerve pulses various voltage-gated ion channels play a key role. As will be found, the construction of a simple model for these channels demonstrates that quantal versions of channels and pumps emerge rather naturally in TGD framework: as a matter of fact, channel and pump proteins realize dark Josephson junctions! In particular, dissipation for ionic pumps is minimized since the transfer of ion through the cell membrane is a purely quantal process involving absorption/emission of Josephson photon with large value of h_{eff}. The unexpectedly low dissipation indeed served as a partial motivation of Ling in his approach.

9.3.3 The role of ATP according to Ling and in TGD framework

The notion of high energy phosphate bond and the real role of ATP in biology has been one of the long standing problems of TGD inspired biology. What is certainly clear is that ATP/ADP in which phosphate ion is transferred to the acceptor molecule is a fundamental process. Often this process is interpreted in terms of the transfer of metabolic energy and the view is that "high energy phosphate bond" carries the energy.

TGD inspired theory of consciousness however suggests a deeper meaning for ATP/ADP process.

1. Negentropic entanglement serves in TGD Universe as a correlate for a conscious experience of understanding: negentropic entanglement (see fig. `http://www.tgdtheory.fi/appfigures/cat.jpg` or fig. 21 in the appendix of this book) would be transferred in the process. The negentropic entanglement need not as such correspond to conscious experience but its presence makes possible conscious experience. Negentropically entangled systems would define what I have called "Akashic records", whose reading by interaction free quantum measurement (and idealized notion) would give rise to conscious experiences. "Akashic records" would be representations defining the reflective level of consciousness giving rise to memories, predictions, sensory and cognitive representations,etc [L33].

2. My own view have been that ATP either carries and provides, generates, or induces a transfer of negentropic entanglement. I have considered all these options. The key observation is that negentropic entanglement is not a single particle property but characterizes the relationship between two particles. If ATP gives P to a particle B one would expect that B is one of the negentropically entangled particles in the final state. The other particle - call it A - must be negentropically entangled with P.

3. The recent view about negentropic entanglement forced by Negentropy Maximization Principle [K49] is very simple and leads to a connection with dark matter hierarchy, p-adic physics, and quantum criticality [K49] [L31]. The negentropic entanglement which can result

in quantum measurement is always maximal entanglement so that density matrix is proportional to unit matrix and correspond to a value of effective Planck constant equal to the integer $\hbar_{eff} = n\hbar$ telling the number of the entangled states. Negentropic entanglement is a prerequisite for an experience defining abstraction about the rule having as instances the state pairs appearing in the entangled state. Note that the state pairs are not unique since any unitary transformation acting in the same manner to the two entangled state basis is allowed.

4. In the recent case this would mean that P and A at the ends of the exchanged flux tube $A - - - P$ must have negentropic entanglement characterized by integer n and that the flux tube $A - - - P$ associated with ADP in the initial state is associated with molecule B in the final state. The transfer of negentropic entanglement is indeed in question. The exchange of the flux tube $A - - - P$ can take place using reconnection process as the basic process.

5. Negentropic entanglement is conjectured to have as a correlate the braiding of the flux tubes connecting the entangled systems. Does this conjecture survive in the recent case? The flux tubes connect two partonic 2-surfaces at the boundary of causal diamond (CD). The space-time correlate for $\hbar_{eff} = n\hbar$ is the analog of n-sheeted Riemann surface. At the partonic 2-surfaces the sheets co-incide. Is it possible for the 3-D projections of the n sheets of single flux tube to become braided (linked and knotted)?

    If closed flux loops associated with A and B reconnect to form a *pair of* flux tubes connecting them (as suggested above) one has two alternative reconnections and one of them is uniquely selected by the conservation of flux. The first has minimal braiding and second one does not. Therefore two-tube connections do not guarantee that negentropic entanglement always corresponds to non-trivial braiding.

    The following argument assigns the braiding to *single* flux tube.

    (a) TGD also predicts another kind of braiding assignable to the ends of string world sheets at which the solutions of the modified Dirac equation are localized by the conditions that electric charge as spin-like quantum number is well defined for them (eigenstate property). The string ends at the 3-D light-like orbit of the partonic 2-surface define a braid and the other ends of strings at other partonic 2-surfaces get braided during time evolution so that space-like braidings are generated.

    (b) The strings seems to be in a natural 1-1 correspondence with magnetic flux tubes defining their cores. If this is the case the braiding for strings corresponds to the braiding for flux tubes idealized with infinitely thing strings. For $\hbar_{eff} = n\hbar$ one should have a light-like braiding of the ends of strings assignable to different sheets of the n-fold covering at the orbit of partonic 2-surface and this braiding would induce the space-like braiding.

It must be admitted that the connection between braiding and negentropic entanglement remains an attractive conjecture at this moment.

What does the transfer of negentropic entanglement mean metabolically?

1. As already noticed, Ling does not believe that energy is transferred in this process and "high energy phosphate bond" is certainly a questionable notion. I tend to believe that also energy is transferred as well but the open question is where it comes from. One can argue that the energy is needed to overcome the potential wall separating the states distinguished by different braidings.

    Remarks:

    (a) Four-dimensional spin glass property of TGD Universe gives rise to a fractal energy landscape and different valleys could be characterized by different braiding structures and phase transitions changing these structures would lead from a valley to another one.

(b) Spin glass property means breaking of ergodicity. In a phase transition from resting state to activated state a large number of these transitions would occur and ATP $\rightarrow$ ADP transferring the entanglement would also involve the extracting of energy from some magnetic body to overcome the potential wall.

2. There is a large number of candidates for the carrier of the energy and Ling's findings about metabolic deprivation suggest that several magnetic bodies can in principle provide the metabolic energy. The energy could be assigned to a population inverted cyclotron BE condensate at the magnetic body of P, ATP, the flux tube AP, or a larger system containing ATP.

   Ling introduces permanently unfolded proteins as a special system and the magnetic body of single unfolded protein or even the system defined by them could be the carrier of the cyclotron BE condensate. One could imagine that under normal circumstances the magnetic body assignable to ATP or a system containing it provides the metabolic energy but under metabolic deprivation (as cells in Ling's experiment [I75]) the metabolic energy could be extracted from some other magnetic body. One can compare ATPs with jam jars in the refrigerator: when the jam jar becomes empty, the jam jars in the cellar can come to the rescue. This would require the generation of magnetic flux tube contact to the bigger energy storage using reconnection mechanism and tuning of flux tube strength and would require some time.

3. I have proposed that in photosynthesis solar photons excite the cyclotron BE condensate of electron Cooper pairs at the magnetic flux tubes of some system. This conforms with the idea that magnetic bodies serve as energy supplies and that the motion of the system defined by magnetic body and biological body is basically transformation of cyclotron energy to kinetic energy, chemical energy, heat and other forms of energy needed by the visible part of the organism. TGD assigns to electron with standard value of Planck constant a causal diamond (CD) with a size, which corresponds to 10 Hz frequency defining a fundamental biorhythm. This would conform with the fundamental role of electrons in metabolic energy storage. There are of course many details to be filled in but this picture looks to me very attractive.

9.3.4 Ling's theory from the perspective of TGD inspired theory of consciousness

Ling formulates his theory using **only the notions of biochemistry and thermodynamics**. This means taking a risk since it is not at all obvious that these notions are enough for understanding life. My personal conviction is that one cannot really understand life without a theory of consciousness. Ling ends up with the notions natural in TGD inspired theory of consciousness but a proper justification of these notions remains lacking because it is simply impossible in the conceptual framework used. Basic problem is of course the non-locality of association process having no description in standard biochemistry.

One can indeed interpret the ATP/ADP process also from the point of view of TGD inspired theory of consciousness from **purely quantal perspective**, and I have already discussed the interpretation of the process as a **transfer of negentropic entanglement.**

1. Flux tubes serve as correlates for attention and ATP serves as re-orientation of the attention by inducing reconnection process. In the transition $A--C\&B---D \rightarrow A---D\&B---C$ by reconnections the attention of A is directed from B to C and attention of B from D to A.

   Note: Is direct attention really asymmetric with respect to A and B? Could attention be symmetric at the fundamental level? Is the "directed" only due to the fact that A is responsible for the variation of flux tube thickness in order to get in tune. The belief that I am aware of the presence of some system but not vice versa might indeed be an illusion: the other system could also be aware about my presence, even in the case that I regard it as "inanimate". It might be however possible to tell which of the two systems performs magnetic motor action generating flux tube connection (by tuning the field value so that reconnection takes place). This argument applies even to the ordinary sensory perception.

The conservation of the signed magnetic flux assigns an arrow to the flux tube and gives precise selection rules: the magnitudes of the fluxes are same for reconnected flux tubes of and also signs so that only one reconnection instead of two is possible.

2. Ling's model assigning different roles to permanently unfolded proteins and folded proteins in resting state has a nice interpretation in TGD context. ATPs are attached to the permanently folded proteins in the resting state. The unfolded protein A would be connected to the phosphate P of ATP by flux tube, and one could say that protein A directs its attention to ATP. The permanently folded proteins would be like guards of a bastion in a permanent wake-up state. In resting state the folded proteins would "sleep" .

3. As the system is activated, the flux tube connection A—PB is generated and one can say that A directs its attention to B, which could be ion, other protein, or some invader molecule. If A has the role of guard, one can expect that A can control the thickness of the flux tubes of its magnetic body and in this manner tune to detect the presence of other molecules. Therefore the system of unfolded proteins could define the part of cell which is in permanent wake-up state and monitors the state of the cell. Activation would wake up and unfold the folded proteins and the cell would be in a kind of alarm state as long as external perturbation lasts.

9.4 Capacitor-like Josephson junctions as systems with large $\hbar_{eff}/h$?

Both Tesla coil and magnifying transmitter can be regarded as a pair of systems in which primary drives secondary system with resonant frequency so that energy is transferred to the secondary. Primary has air gap which acts as a switch. Above a critical voltage about 10 V in the air gap a di-electric breakdown occurs and current runs through the gap. What is remarkable is that the duration of the breakdown period is few milliseconds: this is the time scale for the nerve pulse and suggests an analogy with cell membrane which is also a system with ultrahigh voltage between the plates of a capacitor-like system defined by the two lipid layers of the cell membrane. Also the secondary coil, which can be regarded as a plate of capacitor with Earth defining the second plate, develops local di-electric breakdowns seen as "mini lightnings". The analogy with cell membrane suggests that also these breakdowns are mathematically analogous to the generation of nerve pulse. The glossary of the introduction explains the basic notions related to Josephson junctions.

9.4.1 Cell membrane as Josephson junction

I have developed a model for cell membrane as Josephson junction leading also to a model of nerve pulse, and there is interesting to see whether the findings of Tesla could be understood in terms of this model.

1. Cell membrane is assumed to be a Josephson junction in which a Josephson current

$$J = J_0 sin(\frac{Ze \int V(t)dt}{h_{eff}}) \tag{9.4.1}$$

is running. For a constant resting potential $V(t) = V_{rest}$ one obtains

$$J = J_0 sin(\omega t) \ , \ \omega = 2\pi f_J \ . \tag{9.4.2}$$

a current oscillating with the Josephson frequency

$$f_J = \frac{ZeV_{rest}}{h_{eff}} \ . \tag{9.4.3}$$

Z is the charge of the super-conducting charge carriers. Electronic Cooper pairs with $Z = 2$ are certainly involved and very probably also bosonic ions and Cooper pairs of fermionic ions. The Josephson currents run along super-conducting space-time sheets. $V(t)$ varies rather slowly. Josephson current generates dark Josephson photons with frequencies coming as multiples of f_J having interpretation in terms of EEG and its generalizations [K20].

The dominating contribution to the membrane voltage is constant resting potential. Besides this there is varying part reflecting various activities near cell membrane and the idea is that dark Josephson photons emitted by Josephson current communicate sensory information about these activities to the magnetic body.

2. Without further assumptions one cannot predict the value of $h_{eff} = nh$. One can however end up with a prediction for h_{eff} by considering a more general situation in which the voltage containing time dependent part - briefly "AC part".

   (a) Suppose that this contribution is periodic with a period characterized by AC frequency f_{AC}. This does not mean that the AC part is of simple sinusoidal form but only that $V(t)$ is a superposition of harmonics of some fundamental frequency f_{AC} containing also a constant part defining the resting potential. The alternating part of voltage is expected to relate closely to cyclotron contribution to the membrane voltage so that cyclotron frequency f_c of electron, proton or some ion defines a good candidate for f_{AC} which would depend on cell. Neglecting nuclear binding energies the cyclotron frequencies of ions in given magnetic field are subharmonics of proton's cyclotron frequency.

   (b) The natural assumption is that in dynamical equilibrium the periodicity of Josephson current is that of the alternating current. This gives as the first guess the condition

   $$f_J = f_{AC} \tag{9.4.4}$$

   One can also consider also sub-harmonics:

   $$f_J = \frac{f_{AC}}{l} \quad , \quad l = 1, 2... \tag{9.4.5}$$

   so that Josephson radiation would be seen as master and cyclotron radiation as slave. This condition fixes the value of h_{eff}:

   $$\frac{h_{eff}}{h} = l \times \frac{ZeV_{rest}}{hf_{AC}} = n = 1, 2, ... \quad , \quad l = 1, 2, .. \quad . \tag{9.4.6}$$

   From this formula one can readily calculate the value of h_{eff} assignable to say EEG frequencies and integer valuedness of h_{eff}/h fixes the spectrum of EEG frequencies and implies that this spectrum can be regarded as union of sub-harmonics of maximum frequencies f_{max} such that each sub-harmonic corresponds to its own value of h_{eff}. The cyclotron frequencies of various ions in given magnetic field correspond in first approximation to various values of n in above equation and by small tuning of the magnetic field strength associated with flux tubes carrying particular kind of ions the same formula applies to all ions.

   (c) For $f_{AC} = f_J$ option the value of h_{eff} would be completely fixed by the periodic perturbation and the system produces dark photons with harmonics of Josephson frequency. For more general option $\hbar_{eff}$ is divisible by integer l which would naturally relate to p-adicity with p-adic prime appearing as a factor of l. The results is rather powerful and gives the long sought for quantitative grasp about the hierarchy of effective Planck constants.

3. The integer quantization of h_{eff}/h implies that the resting potential of the cell membrane obeys integer quantization for given value of l and that the changes of the membrane potential correspond to quantized change of the charge of the effective capacitor from $Q = CV$. The resting potential of the cell membrane is indeed known to be quantized. The unit for the resting potential is known as miniature end plate potential (`http://en.wikipedia.org/wiki/Miniature_end-plate_potential#Miniature_End_Plate_Potential`) of order $\Delta V = .5$ mV to be compared with the resting potential of order 60 mV. This would give $\Delta h_{eff}/h_{eff} \sim 1/100 = \Delta n/n$ if neither l nor f_{AC} changes. The changes of h_{eff} would be of order one per cent.

I have made a conjecture that the phase transitions changing h_{eff} are such that $h_{eff}/h = n$ is replaced with its factor. In this case the change of h_{eff} is large and cannot apply in the case considered. h_{eff}/h can be kept however constant if the change $l_i \to l_f$ compensates the change of V_{rest} so that one would have

$$\Delta \frac{V_{rest}}{V_{rest}} = \frac{l_i}{l_f} - 1 \simeq -\frac{\Delta l}{l} \quad .$$

l is however expected to be rather small integer on basis of the model of EEG so that Δl need not compensate small changes of V_{rest}. h_{eff}/h remains also invariant if V_{rest} and magnetic field defining cyclotron frequency can scale in the same manner. This follows from the basic conditions automatically. If neither l or B is changed then a phase transition satisfying $\Delta n/n < 1$ must occur and proceed via a transition to an intermediate state with $h_{eff} = h$ - that is ordinary matter.

9.4.2 Quantization of the DC voltage of capacitor from the quantization of charge

For a given value of $f_{AC} = lf_J$ the formula for h_{eff}/h implies quantization of the capacitor voltage. The quantization of the voltage of a capacitor follows also from the quantization of charge implying $\Delta Q_{min} = e$ as the minimal change of charge. This gives a condition on the AC frequency f_{AC}:

$$\Delta(\frac{h_{eff}}{h}) = l\frac{Ze\Delta V_{min}}{hf_{AC}} = lr\frac{Ze^2}{Chf_{AC}} = k \quad . \tag{9.4.7}$$

Here r is the number of elementary charges in the pulse changing the voltage. If this condition is assumed to hold true for all values of l and r, one can conclude that

$$\frac{Ze^2}{Chf_{AC}} = s = 1, 2, \dots \quad . \tag{9.4.8}$$

and that s divides k. This is true for any k for $s = 1$. This would give a quantization condition for $\lambda_{AC} = c/f_{AC}$:

$$\lambda_{AC} = \lambda_{min} = \frac{\hat{C}}{2Z\alpha} \quad , \qquad \alpha = \frac{e^2}{4\pi\hbar\epsilon_0 c} \simeq 1/137 \quad .$$
$$\hat{C} = \frac{C}{\epsilon_0} \quad , \qquad \epsilon_0 = 8.854 \times 10^{-12} F/m \tag{9.4.9}$$

Equivalently, one would have

$$f_{AC} = f_{max} = \frac{c}{\lambda_{min}} = \frac{2Z\alpha c}{\hat{C}} \quad . \tag{9.4.10}$$

λ_{AC} as the minimum wave-length is therefore dictated by capacitance. In biological applications $f_c = f_{max}$ follows.

Before discussing concrete examples note that C is expressed using Farad as unit: micro-, nano-, and picofarad are more natural units. $\hat{C}$ having dimension of length makes manifest the geometric meaning of C. The allowed values of f_{AC} must come as sub-harmonics of the maximum frequency determined completely by the capacitance.

1. For a plane capacitor one has

$$\hat{C} = \frac{\epsilon_r A}{d} \quad . \tag{9.4.11}$$

Here $\epsilon_r = \epsilon/\epsilon_0$ is the relative permeability, and A and d are the area of the plate and d the distance between them. For $\hat{C} = 1$ m one has

$$\lambda_{min} \simeq \frac{\hat{C}}{m} \times 67.5 \quad , \quad f_{max} \simeq \frac{1}{\hat{C}/m} \times 4.4 \times 10^6 Hz \quad . \tag{9.4.12}$$

2. This gives strong bound on the capacitance. For instance, in the experiments of Tesla f_{AC} is in the range $20 - 100$ kHz. For $f_{AC} = f_{max}$ the corresponding range for $\hat{C}$ is 1.15 mm-0.23 mm. For $f_{AC} = f_{max} = 10$ kHz one would have $\hat{C}/m \simeq 2.30$ mm.

3. Kennelly-Heaviside layer has thickness $d = 90 - -150$ km and be approximated as a spherical capacitor with

$$\hat{C} = \epsilon_r \times \frac{4\pi R^2}{R - \frac{R^2}{R+d}} \simeq \frac{4\pi R^2}{d} = \frac{A}{d} \quad . \tag{9.4.13}$$

In this case one has $f_{max} \simeq 19$ minutes.

9.4.3   Constraint on cyclotron frequency

The TGD inspired model of EEG [K20] suggests that f_J assignable to the neuronal membrane is around 5 Hz. This would suggest that it is second sub-harmonic of an ionic cyclotron frequency around 10 Hz (say that of Mg^{++}) or the third sub-harmonic of cyclotron frequency of Ca^{++} equal to 15 Hz. This would support the formulas

$$f_J = \frac{f_c}{l} \quad , \quad f_c = f_{max} = \frac{2Z\alpha c}{\hat{C}} \quad . \tag{9.4.14}$$

Through these equations the field values at magnetic flux tubes, cell membrane potential, and the shape and size of cell membrane would be in tune. This constraint relates cyclotron frequency and therefore the value of the magnetic field at given flux tube to the capacitance. In terms of the magnetic length $L_B = \sqrt{h/eB}$ this gives rise to the following equivalent correspondences

$$\begin{aligned} L_B &= \sqrt{\frac{r_C \hat{C}}{\alpha} l} \quad , \\ \hat{C} &= \frac{\alpha}{l} \frac{L_B^2}{r_C} \quad . \end{aligned} \tag{9.4.15}$$

Some numerical correspondences are helpful in quantitative estimates. $B = 1$ Tesla corresponds to magnetic length $L_B \simeq 64.3$ nm, and capacitance of 1 Farad to the "capacitance length" $\hat{C} = 1.1 \times 10^{11}$ m. Compton length for electron is $r_C \simeq 2.43 \times 10^{-12}$ m.

Some comments from the point of view of the model of cell membrane as super conductor are in order.

1. The effects of ELF radiation on vertebrate brain suggest the presence of endogenous magnetic field with field strength $B \simeq 2B_E/5$, where $B_E = .5 \times 10^{-4}$ T is the nominal value of the Earth's magnetic field with magnetic length $L_B = 14.4$ μm. For electron the corresponding value of $\hat{C}$ would be $\hat{C} = .62$ m for $l = 1$. For large neurons with radius of order 10^{-4} m one has $\hat{C} \simeq 12.6$ m^2 for $l = 1$. For $l > 1$ the proportionality $\hat{C} \propto 1/l$ however allows smaller cell sizes.

2. For proton and ions $\hat{C}$ would be obtained by scaling down the electronic $\hat{C}$ by the mass ratio $m_E/Am_p \sim 2^{-11}/A$, A the mass number of nucleus. For proton one would have $\hat{C} = 3.3 \times 10^{-4}$ m and for Ca^{++} ion with mass number $A = 40$ one would have $\hat{C} \simeq 1.3$ μm, which corresponds to the length scale of cell nucleus and could characterize nuclear membrane as capacitor.

3. Somewhat unexpectedly, ions would correspond to a capacitor assignable to nuclear membrane whereas electron would correspond to size scale of large neuron. Alternatively large value of l could allow smaller cell sizes. Electron could also correspond to a multicellular system behaving effectively as a single capacitor by quantum coherence. DNA double strand and its subsystems might also correspond to the capacitor-like systems involved with both electrons, protons, and ions.

9.4.4 What about more general capacitor-like systems?

There is a temptation to assume that the situation for the air gap of Tesla coil and for the capacitor formed by the secondary and Earth is same as for the cell membrane except that the DC voltage is replaced with AC voltage. The generalization might apply quite generally to any capacitor-like system.

1. Now electronic and possibly also protonic Cooper pairs with large $\hbar_{eff}$ would be the current carriers. Josephson currents would be present all the time. Dielectric breakdown would be analogous to nerve pulse. The analog of the membrane potential would be defined by the voltage associated the Earth's electric field $E_E \simeq 100$ V/m unless DC voltage is present. Note that the orientation of the capacitor with respect to the Earth's electric field matters. This would define Josephson frequency in absence of other currents and one would have Josephson current even for an ordinary capacitor with frequency $f_J = ZeV/h_{eff}$. Same conditions would apply to f_J and f_{AC} as for cell membrane system. Only V_{rest} would be replaced with V_E so that one would have

$$\frac{h_{eff}}{h} = \frac{ZeV_E}{hf_{AC}l} = n \ , \ \ l = 1, 2.2, ... \ , \ \ n = 1, 2, ... \ . \tag{9.4.16}$$

for the space-time sheet along which the Josephson current runs. The value of effective Planck constant is therefore completely fixed! Rather remarkably, the proposed amplitude modulation mechanism predicts exactly the same value $\frac{h_{eff}}{h}$ as ratio of Josephson frequency for ordinary Planck constant and of AC frequency and it might be possible to regard the two mechanisms as equivalent.

2. If *all* capacitor-like systems carry a small oscillatory Josephson current satisfying $f_J = f_{AC}$ ($l = 1$ in more general formula) in presence of AC current, one could assign to a capacitor a unique value of h_{eff} depending on it orientation with respect to Earth's electric field. This would predict production of dark photons with the AC frequency and its harmonics. Also a capacitor added to DC circuit would carry a small dark Josephson current but now one cannot predict the value of h_{eff} as found in the beginning. This indeterminacy would conform nicely with the quantum criticality of TGD Universe: a small periodic perturbation would fix the value of h_{eff}. The new physics might be present in ordinary AC circuits and might relate to the poorly understood $1/f$ noise in electric circuits. Dark Josephson currents and probably also supra currents would be present in ordinary circuits and one might imagine building a technology based on this new form of high T_c superconductivity.

3. By introducing to the Josephson potential constant part artificially, one can increase the value of h_{eff}/h and cell membranes have indeed done just so.

9.4.5   What $f_J = f_{AC}/l$ condition implies for Earth's electric field?

As argued, if the situation is analogous to asymptotic self-organization pattern, the Josephson current must be periodic having the same periodicity as the external AC voltage. This is guaranteed if $V_J(t)$ is a superposition of Fourier components coming in multiples of f_{max}.

1. If this condition is satisfied and if the voltage $V(t$ contains a DC part - containing at least the contribution V_E associated with the Earth's electric field - to the Josephson voltage, then the condition $f_J = f_{AC}$ reads as

$$f_J = \frac{ZeV_E}{h_{eff}} = \frac{f_{AC}}{l} = \frac{f_{max}}{l} \quad , \quad f_{max} = \frac{2Z\alpha}{\hat{C}} \quad . \tag{9.4.17}$$

The value of h_{eff}/h for $f_{AC} = f_{max}$ would be given by

$$\frac{h_{eff}}{h} = \times \frac{eV_E}{hc} \frac{\hat{C}}{2\alpha l} = n \quad . \tag{9.4.18}$$

2. This in turn poses a condition to $\hat{C}$. For a plane capacitor one has $\hat{C} = \epsilon_r A/d$. This formula applies in good approximation also to spherical capacitor. For a more general capacitor-like system - defined by say folded cell membrane or the neuronal membrane containing also axon and dendites - the capacitance can be parametrized as $\hat{C} = yA/d$.

   For $E_E = x \times 100V/m$ one $eV_E/hc = d \times x \times 10^2 eV/hc \times m^{-1} = d \times 1.24 \times 10^8 x \times m^{-2}$ and one obtains

$$\frac{h_{eff}}{h} = 1.24 \times 10^8 \epsilon_r xy \times \frac{A}{m^2} \frac{1}{2\alpha l} = n \quad . \tag{9.4.19}$$

   This translates to a quantization condition for the area of the plane capacitor:

$$A = nl \times A_{min} \quad , \quad A_{min} \simeq \frac{118}{\epsilon_r xy} \, (\mu m)^2 \quad . \tag{9.4.20}$$

   The size scale of the minimal capacitor is that of cell: in cell scale nk is small integer and therefore also n is near unity. That condition correctly relates the size scale of the cell to the magnitude of the electric field of Earth strongly suggests that both E_E and B_E have been key players in the evolution of life and also supports the vision about Kennelly-Heaviside layer as the analog of cell membrane.

3. As discussed, also Kennelly-Heaviside layer with thickness $d \sim 100$ km can can be approximated as a spherical capacitor with $\hat{C} \simeq xA/d$. One obtains expression for nl from the expression of A as a multiple of A_{min} as

$$nl \quad = \quad \epsilon_r xy \times 4.56 \times 10^{24} \quad . \tag{9.4.21}$$

   The allowed values of n and l are huge. In the case of cell membrane the values of l would be however rather small. For the value of n corresponding ot $n \sim l$ one has $n \leq 2 \times 10^{12}$. The frequency of dark variants of visible photons with energy 2 eV would correspond to dark photon with frequency around 150 Hz, which is somewhat above EEG range.

9.4.6   Cell membrane, DNA double strand, and cortical layers as capacitor-like Josephson junctions

Earth's electric field E_E would not allow large h_{eff} Josephson photons generated by capacitor-like Josephson junctions with much larger size than that of cell. By previous arguments neurons can emit large $\hbar$ Josephson photons and the high value of the resting potential saves the situation: large h_{eff}/h as a prerequisite of intelligent life provides the answer to the question why strong voltages are needed in biology. The resting potential $V_{rest} = .06$ V is by a factor $x = V_{rest}/E_E d \simeq 6 \times 10^4$, $d = 10^{-8}$, stronger than that corresponding to E_E.

Cell membrane as capacitor

Using spherical capacitor as a model for the cell membrane as starting point in the parameterization of capacitances as $\hat{C} = yA/d$, the quantization condition deriving from quantization of elementary charges reads as

$$
\begin{aligned}
\frac{h_{eff}}{h} &= 7.44 \times 10^{14} \epsilon_r y \times \frac{A}{m^2} \times \frac{1}{2\alpha l} = n \ , \\
A &= nl \times A_{min} \ , \quad A_{min} \simeq \frac{20}{\epsilon_r y} \times (nm)^2 \ .
\end{aligned}
\tag{9.4.22}
$$

A scale of about 5 nm defines the size scale of the minimal capacitor. $n \sim 2^{16}$ is possible even for the size scale of cell nucleus.

For a large neuron with size scale of 10^{-4}m one obtains $h_{eff}/h \sim 10^{10}$. The area of cell membrane can be increased by folding and cell interior is indeed filled with a folded membrane. This allows even larger value of h_{eff}/h at neuronal level. Therefore one can understand the required large values of h_{eff}/h and a direct correlation between the evolutionary level measured by h_{eff}/h and cell size scale and total membrane area is predicted.

DNA double strand as capacitor?

Each DNA nucleotide carries two units of negative charge. Could one somehow assign a pair of cylindrical surfaces with the highly coiled DNA double strand and describe it as a cylindrical capacitor? Where are the positive charges? Are positive charges associated with Earth identified as a cylindrical surface around DNA with radius of order $L(151) = 10$ nm defining the radius of the chromosome? And is the idealization as a perfect conductor meaning constant charge distribution at the coiled inner cylindrical surface and outer chromosome surface really justified?

In any case, the capacitance of co-axial cable is given by

$$
\hat{C} = \frac{2\pi\epsilon_r \times L}{log(R_2/R_1)}
\tag{9.4.23}
$$

is good approximation for the capacitance of the system if it behaves as a conductor. $\hat{C}$ depends linearly on length L. Similar formula is expected to apply in the first approximation also to the coiled DNA strand defining chromosome. The value of h_{eff}/h would increase as the total length of DNA strand increases during evolution: for human DNA the length is about $L \sim 1$ m. The linear charge density per unit length is for double strand $4e$ per nucleotide pair and makes $6e/nm$ so that the total charge is $6eL/nm$ and about 6×10^9 for human DNA. $R_1 = 1$nm and $R_2 = 10$ nm are reasonable first estimates.

The expressions for various parameters are

$$
\begin{aligned}
\hat{C} &= \frac{2\pi\epsilon_r \times L}{log(R_2/R_1)} \simeq 14.5\epsilon_r L \; , \\
f_{max} &= 2Z\alpha \times log(\frac{R_2}{R_1}) \times \frac{c}{2\pi\epsilon_r \times L} \simeq 3.2 \; MHz \; , \\
\frac{h_{eff}}{h} &= n = \frac{24\pi}{l} \times (L/nm) \simeq \frac{1}{l} \times 75.4 \times (L/nm) \; , \\
L &= nlL_{min} \; , \; L_{min} = \frac{1}{24\pi} \; nm \simeq .13 \; Angstrom \; .
\end{aligned}
\tag{9.4.24}
$$

For $L = 1$ m (of the order of the total length of human DNA) one obtains $h_{eff}/h \simeq .75 \times 10^{11}/l$. Cyril Smith [J147] claims that for water memory frequency ratio $f_h/f_l = 2 \times 10^{11}$ is special: this ratio corresponds in TGD framework to h_{eff}/h [K37]. $L_{min} \simeq .1$ Angstrom means that non-standard values of Planck constant can be important already for the shortest possible DNA strands. f_{max} is of order MHz and for largest possible values of l ($n = 1$) $f_J = f_{max}/l$ is or order 10^{-5} Hz: $n = l$ gives $f_{max} \simeq 10$ Hz which is perhaps not an accident.

Also proteins are charged (the sign and magnitude of the charge depends on pH of the environment) and this suggests that also they define capacitor type Josephson junctions.

Cortical layers as Josephson capacitors

TGD Universe is fractal and therefore a highly attractive idea is that also the highly folded layers of various brain areas correspond to capacitor-like systems acting as Josephson junctions. Also the six cortical layers- decomposing to cortical columns of radial size scale of order mm would correspond to Josephson junctions but in smaller length scale. The hierarchy of Planck constants would thus make itself directly visible in the structure of brain.

The total area of cerebral cortex (`http://www.wikilectures.eu/index.php/Function_of_Cerebral_Cortex`) is about .25 m^2. For $A = .25$ m^2 - possibly making sense for the highly neural circuits associated with the highly folded membrane-like structure defined by cortical layers - one would have $nl = 1.25 \times 10^{14} \times (\epsilon_r/1.18)$ so that $h_{eff}/h = n \leq 1.5 \times 10^{14}\epsilon_r$ holds true. The frequency of a dark variant of 2 eV visible photon would be about 40 Hz for $\epsilon_r = 1$. This happens to be the celebrated thalamo-cortical resonance frequency (`http://en.wikipedia.org/wiki/Recurrent_thalamo-cortical_resonance` suggested to be an important correlate for consciousness.

This estimate can be criticized since the value of the voltage is taken to be the resting potential. 10-20 mV is the typical value of the oscillating EEG potential (`http://en.wikipedia.org/wiki/EEG`) when measured from subdural electrodes and one expects that the constant part has magnitude which is larger: in the case of cell membrane by a factor of order 100. If the ratio is same in the scale of cortex, one would have "resting potential" of order 1.2-2-4 V which is by a factor 50-100 higher than resting potential. The average thickness of human cortex is 2.8 mm - largest for mammals but for mouse (2.2 mm) larger than for macaque (1.7). In the Earth's electric field $E = 100$ V/m the maximum voltage difference over is 0.28 V of this distance which would be roughly twice the nominal value .06 V of the resting potential. Interestingly, the thickness of cortex is known to be thicker for meditators (`http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1361002/`) [J99]: in principle this means larger value of h_{eff}. One can wonder what happens when the local section of (folded) cortical layer is not orthogonal to the Earth's electric field. If cortical layer behaves as an ideal conductor, the surface charges should arrange the situation in such a manner that the voltage is same along cortical layers and that the orientation of head does not matter.

The quantization of capacitance basically due the quantization of elementary charges and $f_J = f_{AC}/l$ condition is rather strong. Cell membrane is however able to change its shape and could find a shape in which the condition is satisfied.

Artificial life?

The above considerations inspire the question about a recipe for building primitive life forms. Both magnetic and electric fields are needed. Concerning the electric part of the system the following recipe comes in mind.

1. Take a capacitor-like system with as large area as possible and feed in electric field as sum of as strong as possible DC part and AC part. From charge quantization the frequency characterizing the periodicity of AC part must be subharmonic of a fundamental frequency expressible in terms of the capacitance. Capacitance itself and thus the area of capacitor is quantized too. In living matter the quantization rules require a flexible geometry . This might explain why living matter is "soft". Cell membranes can indeed vary their capacitance by deforming their shape. The frequency f_{max} identified as cyclotron frequency f_c in turn can be varied by varying the flux tube thickness. Maybe this kind of softness is required for artificial cells too. The resulting system is critical in the sense that it satisfies very strong quantisation conditions but state function for density matrix makes the system critical and thus gives excellent hopes for "self-organized quantum criticality".

2. The inclusion of magnetic fields is certainly an essential element. In the case of cell membrane and DNA one assumes that flux sheets traverse through DNA double strand and cell membrane and also flux tubes connecting DNA and lipids are assumed. How couls the magnetic body be realized artificially? In Tesla coil secondary serves both as inductance and capacitor so that also magnetic body is present and is able to perform "motor actions" essential for generating reconnections. Here the identification $f_J = f_{AC}/l = f_{max}/l = f_c/l$ would give an additional constraint: $f_c = f_{max}$.

Remote metabolism and the question about simplest possible metabolic pathway

Remote metabolism suggests an extremely simple manner to produce ATP without the need for metabolic machinery and allowing to avoid production of free radicals causing molecular damage. This mechanism could explain the reported ability to survive without nutrition described in the introduction [I92, I19].

1. Drop out all initial steps of the oxidative phosphorylation appearing in both photosynthesis and cell respiration (`http://en.wikipedia.org/wiki/Oxidative_phosphorylation`), and replace the last step involving formation of ATP using ATP synthase (pumping protons against membrane resting potential) with much simpler process.

2. The final step in oxidative phosphorylation involves dropping of 4 protons through the cell membrane. The liberated electrostatic energy goes to ATP as it is formed. The electrostatic energy ZeV_{rest}, $E = eV_{rest} \simeq .06$ eV depends on the charge Z of the charged particle only. One can therefore imagine several basic units: two Cooper pairs of protons, two Cooper pairs of fermionic ions or two doubly charged ions such as Ca^{++}, and electron Cooper pairs moving in opposite direction through the membrane could liberate same energy to be used to build ATP. One could even say that resting potential defines fundamental metabolic energy quantum.

3. The loading of metabolic batteries could take place by remote metabolism in very simple manner: charged particles with charge $\pm 2e$ send negative energy Josephson photon energy $E = -2eV_{rest}$ to some magnetic body and in this manner gain opposite energy as a recoil energy and is pumped to the other side of the membrane.

4. Note that the fundamental energy quantum would be about .06 eV. Metabolic energy quantum has nominal value of .5 eV. This process would not therefore use dark variants of visible photons (decaying to bio-photons) but dark variants of infrared photons decay to IR counterparts of bio-photons. A killer test for the proposal could be a check whether IR analogs of bio-photons with these energies exist.

Absorption of photons at Josephson frequency is obviously a very primitive manner to receive metabolic energy. What about photosynthesis? Could it rely on the absorption of visible photons at Josephson frequency kicking ions to the other side of the photo-receptor membrane, dropping back spontaneously and transferring their electrostatic energy to the electrons in the electron transport chain? This would eventually lead to the kicking of four protons (or two proton Cooper pairs) through the membrane and generation of ATP? Photosynthesis would transform solar photons as natural metabolic energy quanta assignable with near vacuum extremals to the IR metabolic energy

quanta. In [K111] and accompanying JNL article it is demonstrated that this kind of scenario can be considered.

1. TGD suggests two possible states for cell membrane corresponding to far from vacuum extremals and near to vacuum extremals for Kähler action [K13]. For the latter one the Z^0 contribution to membrane potential would dominate and the energies of charged particles defined by membrane voltage are proportional to $Q_Z g_Z V_Z$. Basically due to the large isospin of nuclei the scaling of Josephson energies is large but the energies remain below visible range. If Weinberg angle is reduced from $p = sin^2(\theta_W) = .02397$ to $p = .0295$, the electrostatic energy differences over membrane for ions are scaled up to energies of visible photons for $V = .055$ eV [K13].

2. The following argument demonstrates that the questionable assumption about Weinberg angle for near to vacuum extremals is actually un-necessary.

3. From Table 1 below one indeed learns that for $p = .0295$ and $eV_{rest} = .055$ eV the Josephson energies for Na^+, Cl^-, K^+ and Ca^{++} for near to vacuum extremal using eV as a unit are 2.2, 2.74, 3.07 and 2.31. The peak energies for red, green, blue and white light are 2.19, 2.32, 3.06, and 2.49 eV respectively. For ordinary value of Weinberg angle given by $p = sin^2(\theta_W) = .23$, the energies are below visible energies, and this motivated the hypothesis that Weinberg angle is different for near to vacuum extremals. This hypothesis can be criticized.

4. In the earlier version of the model I however failed to notice that it is Cooper pairs of fermionic ions rather than ions that must be the charge carriers. For Cooper pairs of Na^+, Cl^-, and K^+, $p = .23$ and $E_J = .04$ eV assignable to visual receptors the Josephson energies are doubled being $2.02, 2.80, 3.02$ eV and these energies could correspond to peak energies for visible photons. Therefore there is no need to make the questionable assumption $p = .02397$ nor to assume that instead of fermionic ions one has their exotic bosonic counterparts allowed by the nuclear string model [L10]. For electron the Josephson energy would be scaled by a factor $-1 + 1/2p$ to $E(e) = 1.0859 \times eV_{rest}$ for $p = .2397$. For neutrino the energy would be given by $E(\nu) = -0.0859 \times V_{rest}$: for $p = 1/4$ it would vanish by the vanishing of vectorial part of Z^0 charge. For proton the energy would be $E(p) = (3 - 1/2p)V_{rest} = .914 \times V_{rest}$ and for neutron $E(n) = V_{rest}/2p = 2.086 \times V_{rest}$.

Ion	Na^+	Cl^-	K^+	Ca^{++}
$E_J(.04 \ mV, p = .23)/eV$	1.01	1.40	1.51	1.76
$E_J(.065 \ V, p = .23)/eV$	1.64	2.29	2.69	2.73
$E_J(40 \ mV, p = .0295)/eV$	1.60	2.00	2.23	1.68
$E_J(50 \ mV, p = .0295)/eV$	2.00	2.49	2.79	2.10
$E_J(55 \ mV, p = .0295)/eV$	2.20	2.74	3.07	2.31
$E_J(65 \ mV, p = .0295)/eV$	2.60	3.25	3.64	2.73
$E_J(70 \ mV, p = .0295)/eV$	2.80	3.50	3.92	2.94
$E_J(75 \ mV, p = .0295)/eV$	3.00	3.75	4.20	3.15
$E_J(80 \ mV, p = .0295)/eV$	3.20	4.00	4.48	3.36
$E_J(90 \ mV, p = .0295)/eV$	3.60	4.50	5.04	3.78
$E_J(95 \ mV, p = .0295)/eV$	3.80	4.75	5.32	3.99
Color	R	G	B	W
E_{max}	2.19	2.32	3.06	2.49
energy-interval/eV	1.77-2.48	1.97-2.76	2.48-3.10	

Table 1. The table gives the prediction of the model of photoreceptor for the Josephson energies for typical values of the membrane potential. For comparison purposes the energies E_{max} corresponding to peak sensitivities of rods and cones, and absorption ranges for rods are also given. R,G,B,W refers to red, green, blue, white. The values of Weinberg angle parameter $p = sin^2(\theta_W)$ are assumed to be .23 and .0295. The latter value is forced by the fit of Josephson energies to the known peak energies.

Could photo-reception (http://en.wikipedia.org/wiki/Photoreceptor_cell) in rods and cones and photosynthesis be initiated by the same first step - a resonant absorption of visible photon by a ionic Cooper pair at its Josephson frequency and kicking it through photosystem II (http://en.wikipedia.org/wiki/Photosystem_II) part of thylakoid membrane, which would therefore be near-to-vacuum extremal? If thylakoid membranes are near to vacuum extremals, the Josephson energy of proton Cooper pairs would : $E_J = 2eV_{eff}$, $eV_{eff} = (3-x) \times eV_{thr}$, $x = 1/2p$. For $eV_{thr} = .044$ eV favored by the considerations of [K111] this would give $eV_{eff} = .040$ eV. This happens to be just the nominal threshold potential for sensory receptors. After the absorption the energy of photon would be transferred to electron transfer chain in far from vacuum extremal region of the thylakoid membrane.

Remote metabolism for visible photons would mean the transfer of ion through thylakoid membrane inside photosystem II induced by sending of negative energy photon. One can wonder whether plants could make photosynthesis more effective by by emitting long wave length dark photons received by a source of visible light. Similar mechanism would make possible active vision.

9.4.7 Further comments

The model deserves some further comments.

1. It should be made clear that the basic assumption $f_J = f_{AC}/l = f_c/l$ is perhaps unnecessarily strong. The idea that Josephson voltages and "alternating voltages" assignable to cyclotron BE-condensates are in resonant interaction requires only $f_J = (k/l)f_c$, where k/l is small rational. It is however easy to generalize the above estimate by replacing l with k/l.

2. The above arguments lead to a possibly new mechanism producing dark photons and allowing a control of the value of $\hbar_{eff}/\hbar$ in terms of periodic perturbation of DC voltage. Also very tight conditions on system parameters, such as for allowed values of f_{AC} follow and the charge of the charge pulse follow. I have proposed also amplitude modulation as a mechanism of production of dark photons. In this case one modulates high frequency (f_h) em field with low frequency (f_l) em field and the value of h_{eff}/h is simply the ratio of frequencies: $h_{eff}/h = f_h/f_l$. The mechanism requires that the frequency ratio is integers. The two mechanisms make the same prediction but it is not clear whether one should regard them as equivalent.

3. Especially fascinating is the consistency of the resulting picture with the vision about cell membrane and even larger structures of brain as plane capacitor -like Josephson junctions maximizing their area to maximize the values of h_{eff}/h. This would give direct quantitative grasp to evolution as increase of h_{eff}/h.

4. The model provides a quantitative formulation of an old vision. Already more than fifteen years ago I talked about a fractal hierarchy of super-conductors and Josephson junctions [K58] of which the cell membrane is only one representative. I proposed that even the region between ionosphere and Earth's surface could be analogous to cell membrane and that lightnings are analogous to nerve pulses. It was however not possible to concretize the idea at that time. Now the situation has changed.

   Kennelly-Heaviside layer of thickness about 150 km could have interpretation as the analog of cell membrane. The analogy with cell membrane as Josephson junction goes actually further. Kennelly-Heaviside layer decomposes to two layers with thickness of order 80 km: the lower one corresponds to atmosphere. 172 km corresponds to the thickness assignable to the electron Compton scale $L_e(239)$, which corresponds to the next Gaussian Mersenne prime after $L_e(167) = 2.5$ μm defining the size scale of cell nucleus. Therefore $L_e(237) = 86$ km would correspond to the thickness $L_e(149)$ of lipid layer and 176 km to the thickness $L_e(151)$ of the lipid layer associated also with Gaussian Mersenne. Kennelly-Heaviside layer would be the analog of cell membrane and Earth interior the analog of the cell interior in accordance with early speculations [K43, K41].

   One can consider an alternative interpretation based on p-adic length scales $L(k)$ rather than scaled up Compton lengths $L_e(k) = \sqrt{5}L(k)$. The p-adic length scale $L(239)$ -as opposed

to scaled up electronic Compton scale $L_e(239) = \sqrt{5}L(239)$ is 78.7 km - 20 per cent smaller than 100 km. Remarkably, also M_{241} is Gaussian Mersenne and corresponds to the scale L(241) which equals to 157.4 km. The two kinds of tectonic plates (continental and oceanic) would be analogous to the lipid layers of cell membrane. Note that 78.7 km is rather precisely the thickness of the atmosphere above which there is ionosphere [F1]. The thickness of Kennelly Heaviside layer [F2] inside which radio waves used in terrestrial radio communications propagate, has thickness about 150 km which roughly corresponds to $L(241)$. Also the fact Continental litosphere [F3] has typical thickness of 200 km ($L(239)$) whereas oceanic litosphere is 100 km thick ($L(237)$) fits qualitatively with the proposed formation mechanism of continental tectonic plates.

The first guess for the Josephson frequency would be as Schumann frequency $f_S \simeq 8$ Hz or at least a frequency which is of the same order of magnitude. From the knowledge of the magnitude of the electric field of Earth and from the value of Schumann frequency one can deduce the value of $\hbar_{eff}/\hbar$ associated with this system. The radial electric field of Earth is not constant and goes to practically zero within few kilometers. At the surface of the Earth it is about $E = 100$ V/m so that for 10 km height one has $eV_E < 1$ MeV to be compared with the membrane potential $eV_{rest} \simeq .06$ eV. The value of $\hbar_{eff}/\hbar = ZeV_E/f_S$ would be rather large of order $\hbar_{eff}/\hbar \sim 10^{19} \sim 2^{63}$.

5. Tesla argued that the magnifying transmitter generated telluric currents, which could propagate in the scale of Earth. The skin depth for Earth estimated from the resistance which is $10^{10} - 10^{12}$ times that of copper is in the range 4-40 km and from $j = \sigma E$ it is clear that also telluric currents decay exponentially with distance travelled so that Tesla's claim cannot hold true in Maxwell's electrodynamics.

   One can however ask whether the currents could propagate as dark currents along magnetic flux tubes. In this case the damping would be very small and one can imagine current circuits in the scale of entire Earth. Also Schumann resonances at dark flux tubes would have very high Q-value as opposed to ordinary Schumann resonances whose Q-value (`http://www-personal.umich.edu/~pran/jackson/P506/hw02a.pdf`) is estimated to be about 4 so that one fourth of the energy of the mode is lost during one cycle of duration 1/7.8 seconds.

9.5   Tesla's work, biology, and TGD

If TGD world view is correct, remote metabolism could also have technological implications. Three different applications mimicking biology come in mind. The communication with geometric past by sending negative energy photons and receiving positive energy photons - as memory recall and remote sensing; the initiation of motor actions by sending negative energy signal to geometric past; and remote metabolism. Zero energy ontology justifies these ideas.

Energy is the bottleneck of recent day technology. Nuclear energy has well-known problems. Also the use of, say, oil as a fuel produces environmental problems and for long travels - in particular space travel - the needed amount of fuel poses an insurmountable problem. The storage of energy as electric energy has also its difficulties due to the fact that the lifetimes of accumulators are very limited.

Tesla had surprisingly far reaching vision about the means of generating and transferring energy in the future society. Tesla speculated about an analogy with biology: in future technology the energy user would extract energy from environment and do this only when it needs the energy. Tesla also believed that there exist unidentified energy sources. This does not imply their identification with zero point energy (ZPE) as often erratically claimed - ZPE emerged as an outcome of quantum field about which Tesla knew nothing. Tesla also speculated on a connection to biology.

To me the most amazing and perhaps most important finding reported by Tesla is what he called "cold electricity" and as a child of his time interpreted it as an evidence for aether particles and scalar photons. What is amazing is that in TGD framework the reported properties of cold electricity and aether particles suggest an interpretation as Cooper pairs of dark electrons and dark photons (recall that we *know* that dark matter is there!). If this is really the correct interpretation, dark matter would have been discovered more than century ago!

In the sequel I will discuss a simple formula expressing the conditions for the transition to a phase that Tesla called "cold electricity", identified in TGD framework in terms of dark matter - and study its generalization to the case of cell membrane allowing to deduce formulas relating cell membrane critical potential and p-adic length scale assigned to given dark particle. These formulas are of course only guesses based on general principles and on available numbers. If the proposed general principles are not correct, one can forget the formulas!

9.5.1 Tesla's work

In this section Tesla's work about energy transmission and cold electricity are briefly discussed. After that TGD inspired interpretation of the findings is discussed.

Tesla's vision about energy transmission

Probably already Tesla (`http://en.wikipedia.org/wiki/Tesla`) realized the deep problems related to energy and Tesla's technology based on alternative currents initiated by the discovery of AC magnetic motor became the basis of the modern society and the transfer of information by radio waves the standard.

Tesla's vision was that not only information but also energy could be transmitted as radiation and this served as his motivation in transmitter experiments. The idea (`http://www.teslatech.info/ttmagazine/v1n4/valone.htm`) [H2] was that the energy beam sent to what is now known as Kennelly-Heaviside layer is echoed back and received by the user. The objection against the transfer of energy by radiation is obvious. In Maxwellian world the radiation from energy source propagates to all directions and the power density decreases as $1/r^2$ with distance. Only a small fraction of radiative energy can be used.

One can of course consider a situation in which geometric optics applies reasonably well: this requires however that the wavelength used is small as compared to the size of the antenna. For 200 kHz corresponding to the highest frequency used by Tesla the wavelength is about 1.5 km. For smaller wavelengths one cannot anymore assume that the radiation is reflected from the upper boundary of Kennelly-Heaviside layer.

To develop this vision Tesla studied so called Tesla transmitters (`http://en.wikipedia.org/wiki/Tesla_transmitter`) and magnifying transmitters (`http://en.wikipedia.org/wiki/Magnifying_transmitter`) [H2], which instead of serving as voltage transformers acted as amplifiers: the primary circuit acted as a resonant driving force so that an energy transfer to the secondary was achieved. These circuits act as both receivers and antennas. The circuits applied dynamic switches based on the di-electric breakdown of the surrounding air and generated in the secondary di-electric breakdowns through surrounding air to surprisingly long distances. Rather interestingly, the duration of resonant period after di-electric breakdown putting the switch on was few milliseconds which is the time scale associated with nerve pulse. I do not know whether anyone has really explained this co-incidence. Also the frequency range studied was 20-100 kHz which corresponds to biological time scales. Tesla discovered in his experiments X rays assignable to the high voltages generated in the Tesla transformer.

Tesla also generated radiation propagating through the Kennelly-Heaviside layer (`http://en.wikipedia.org/wiki/KennellyHeaviside_layer`) - not yet discovered at that time - making possible radio transmissions: Marconi received Nobel prize for radio sender but Tesla in fact discovered the phenomenon first as was admitted after Tesla's death. Tesla also found the surface of Earth acts as a conductor with resistance roughly 10^{10} times higher than that of Copper. Tesla also discovered Schumann resonance on basis of his measurements. In my opinion the large scale effects related to di-electric breakdown discovered by Tesla are not easy to understand in the framework of Maxwell's electrodynamics and might involve new physics. It is a pity that they are seen only as an entertainment nowadays.

Cold electricity

Tesla's findings [H6, H3] (see the book by Lindeman at `http://www.teslasociety.ch/info/NTV_2011/free.pdf` and the article by Akai at `http://www.slashdocs.com/inixhk/longitudinal-waves-cold-electricity.html`) led him to

propose the existence of "cold electricity" running as a visible current along the surface of the Tesla coil in a local direction orthogonal to the wire of the coil and consisting of charge carriers not detectable by ordinary amp-meter but generating ordinary electrons at the target.

Cold electricity was not accompanied by dissipation. For instance, the vacuum tube serving as a diode (conducting current only in single direction) was not heated by the cold currents although it generated light. In other words, the currents in question were not ohmic. This brings in mind super-conductivity not yet known at the time of Tesla's experiments. Cold electricity was thought to appear as a result of a "traffic jam" with very strong local electric field leading to a generation of high electronic surface charge densities. This suggests that a high density of electrons is necessary for the cold electricity to appear in a phase transition-like manner.

Cold electricity gave rise to a force parallel to its direction of propagation. As a child of his time Tesla identified dark electricity as aether particles. Tesla assigned to the cold electricity also scalar waves - longitudinal photons - manifesting as light emitted in dielectric breakdowns associated with air gap of primary coil and secondary coil of Tesla transmitter. Longitudinal polarization explained the force in the direction of motion of the scalar waves. Another possibility is that the momentum of cold currents transforming to that of matter gave rise to this force.

Tesla estimated the velocity of the aether particles and concluded that it was superluminal. Tesla claimed also the that energies and the voltages at the secondary coil were too large to be explained in terms of ordinary circuit theory: the discrepancy between the observed value of the voltage for bifilar coil was by a factor about 9 percent higher than predicted (`http://home.comcast.net/~onichelson/VOLTGN.pdf`) [H8, H7]. This might be understood if the ordinary ohmic dissipation for the cold currents was absent so that the energy of charge carriers was transformed to kinetic or electric energy as a whole. Tesla speculated with an additional energy source as an explanation of the strange energetics.

Cold electricity could be perceived as various bodily sensations for pulse lengths not much shorter than nerve pulse duration of order milliseconds. The accompanying light required very long exposure time to become visible in photos. This would suggest exotic photon-like particles were involved and had to transform to ordinary photons in order to become visible for camera. Human eye was however sensitive to this light.

What was remarkable that the time scale for the di-electric breakdown was measured in milliseconds. This happens to be the time scale of nerve pulse duration associated with the electric field of cell membrane higher than the critical value of electric field for dielectric breakdown in air. This motivates the application o f TGD inspired view about quantum biology in order to understand the findings of Tesla.

9.5.2 Scalar waves of Tesla in TGD framework

The scalar waves or so called non-Hertzian waves of Nikola Tesla belong to the fringe region of science. Many proponents of free energy believe that scalar waves might provide a basis for a new energy and communication technologies. Tesla himself was isolated from the official science and found no place in text books because his hypothesis about scalar waves did not fit within the framework of the Maxwell's electrodynamics. Personally I justified my personal prejudices against scalar waves by the observation that the formulations for the notion of scalar waves that I had seen seemed to be in a conflict with the cherished gauge invariance of gauge theories. The discussions with a Finnish free energy enthusiast Juha Hartikka however led me to reconsider the status of the scalar waves.

The surprise was that the non-Hertzian waves of Tesla might be possible in TGD framework. The most plausible explanation relies on many-sheeted space-time.

1. TGD allows so called massless extremals (MEs, topological light rays) as non-linear generalization of Maxwellian plane waves. They are characterized by light-like wave vector and polarization vector orthogonal to it and these vectors can also depend on space-time position [K8]. The most general wave is a pulse with arbitrary profile moving along ME with light-velocity along them and preserving its shape.

   Since TGD space-time is many-sheeted one can take two waves of this kind on top of each other in the sense that their M^4 projections intersect in some region of M^4. The effective space-time is defined by a piece of Minkowski space with effective metric which is sum of M^4

metric and deviations of the metrics of sheets from M^4 metric. Effective gauge potentials are sums of the induced gauge potentials. For two MEs the potentials at the two sheets and if the wave vectors can be chosen to be in opposite direction in which case one obtains an effective standing wave with non-vanishing net energy but vanishing 3-momentum and classical spin. Since MEs can carry light-like charge current the resulting system carries non-vanishing charge density and vanishing current Fourier transforms of the pair give rise to massive spinless states having identification as scalar waves possibly carrying em charge.

In TGD framework classical gauge boson fields of standard model correspond two-sheeted structures - perhaps pairs of MEs connected by wormhole contact pairs having interpretation as gauge boson. One can consider the possibility that the classical space-time correlate for gauge bosons massivation at the level of MEs is this kind of pair of spacetime sheets. For massive gauge bosons the wave vector directions of the two sheets would be opposite in the rest system and spin would be vanishing.

2. The original proposal could have been inspired by the electric-magnetic duality of TGD suggesting a large number of solutions of field equations representing constant energy density configurations of electric field assignable to bio-electrets, which would be in a well-defined sense dual to the magnetic flux tube structures with analogous properties. Also classical gravitational fields generated by classical field energy could be important in the living matter. One must however take this proposal with a big grain of salt since there is no proof for the actual existence of this kind of solutions. Furthermore, one can obtain TGD counterparts of scalar waves as pairs of MEs.

9.5.3   Relating Tesla's work to TGD inspired quantum biology

Skeptics can of course argue that if Tesla were right, his claims would have been verified long time ago. Here I disagree. Dark matter represents the deepest puzzle of modern physics, and all attempts to find dark matter identified as exotic particles of main stream quantum field theories have failed. This suggests that some assumption about the nature of dark matter is badly mistaken. Tesla's experiments tested Maxwell's electrodynamics in extreme situations - typically high voltage pulses generated in switching on of a circuit such as occur in dielectric breakdown over air gap. Interestingly, also cell membrane - another physics mystery - has a very high resting potential generating an electric field stronger than that inducing a dielectric breakdown in air. These situations are different from the extreme situations encountered in high energy elementary particle physics: long wave lengths and low frequencies are combined with high voltages, and this makes possible for the hierarchy of effective Planck constants to make itself manifest if it exist.

My TGD inspired educated guess indeed is that the hierarchy of dark matter phase labeled by the value of effective Planck constant implying macroscopic quantum coherence might have made itself manifest in the experiments of Tesla.

Cold electricity as dark matter in TGD sense

It came as a surprise to me that Tesla's findings - described in [H6, H3] - could be seen as first experimental indications for dark matter in TGD sense.

Consider first dark photons as counterparts of scalar waves of Tesla.

1. Scalar waves could correspond to dark variants of ordinary photons with a high value of effective Planck constant: later an estimate as the ratio $h_{eff}/h = ZeV/f_{AC}$ of Josephson frequency and AC frequency will be discussed. In TGD inspired biology bio-photons result in the transformation of dark photon of same energy to ordinary photon. The low intensity of bio-photons can be explained in terms of low rate for this process. This could also explain why a long exposure time was required to make the light emitted in Tesla's experiments visible. If this interpretation is correct, living matter would be an optimal detector of dark matter so that subjective experience would provide the most straightforward proof for the existence of dark matter whereas its detection by using conventional detectors would be more difficult!

2. I have earlier considered the possibility of obtaining scalar photons in TGD framework [K22], and the model of gauge bosons as pairs of fermion and anti-fermion at opposite ends of wormhole contact together with p-adic mass calculations [K52] suggests (one might even argue "predicts") the existence of longitudinal photons with very low mass. They need not be relevant for understanding Tesla's findings if the transfer of dark matter momentum is able to explain the longitudinal force reported by Tesla.

3. Massless extremals (MEs)/topological light rays represent TGD counterparts for Maxwellian radiation fields. Their special feature is that they can carry light-like current and therefore also charge. Local polarization ϵ and light-like momentum vector k are orthogonal to each other ($\epsilon \cdot k = 0$), and the expression for the current in terms of the induced gauge field demonstrates that non-Abelian character of field makes possible charge current. In the Maxwellian case ϵ should be non-orthogonal to k. Hence charged MEs cannot correspond to Tesla's scalar waves. As in standard model, *all* particles look massless in sufficiently short length scales in TGD Universe, and all particles - including also electron - should have MEs as space-time correlates. MEs would therefore naturally correspond to dark electrons behaving like massless particles below Compton length scale of scaled up by h_{eff}/h.

In TGD framework Cooper pairs of dark electrons could thus serve as counterparts of Tesla's aether particles.

1. In TGD framework cold electricity could correspond to Cooper pairs of super-conducting dark electrons with a high value of effective Planck constant. This would explain the non-ohmic character of dark currents. If the value of h_{eff} is same for dark photons and dark electrons (this is not necessarily true), the Compton wave length of dark electrons would be by a factor E_{photon}/m_e smaller than that for dark photons. For a photon energy of 2 eV this would give a reduction factor of order 4×10^{-6}. This wave length is still macroscopic (of order of 1 m) for the needed values of $h_{eff}/h = n \sim 10^{13}$. The large value of the Compton length implies that the overlap criterion for electron wave functions is satisfied so that the formation of electronic Cooper pairs is possible and lead to a generation of supra currents which do not dissipate. The absence of ohmic dissipation could explain why the vacuum diode serving as a diode was not heated and also why energetics could not be understood in terms of ordinary circuit theory. One cannot of course exclude the possibility of remote metabolism as an additional energy source.

2. If supra currents are formed, they give rise to a path of smallest resistance so that by standard circuit theory of by hydrodynamical analogy the ohmic current along highly resistive winding of the Tesla coil is effectively replaced with the supra current flowing along its surface.

3. One must make a distinction between supra currents which can run even without any potential difference and oscillatory Josephson currents running in presence of voltage. The first guess is that the supra current runs along the surface of the coil and possible Josephson current runs between the coil and ground and is assignable to the sparks generated by the coil. The generation of supra currents and Josephson currents would be favored by the formation of very high electron densities at the locations of the coil in which the normal value of electric field was very high. Using axon as an analogy, the supra currents would flow along axon and Josephson currents between the lipid layers of the axon.

In the case of DC voltage the emerge of Josephson current with frequency determined by the DC voltage looks natural. For AC voltage the first guess is that dark Josephson current oscillating with the AC frequency (or its harmonic or sub-harmonic as will be proposed later) is established. This however requires a constant shift V_J of the Josephson voltage so that only current would remain strictly sinusoidal. V_J might explain why the observed voltage in the secondary coil of Tesla transformer is roughly 10^3 times higher than the estimated one. V_J could reflect the proposed accumulation of charge ("traffic jam") interpreted as a breakdown of the conductivity of the coil and its transformation to a capacitor carrying a constant charge. The claimed loss of the conductor property for the coil for a time interval of few milliseconds could correspond to the generation of supra current along coil and V_J between coil and ground generating Josephson current and direct Ohmic currents.

4. If super-conducting space-time sheets emerge as dark space-time sheets identifiable as n-furcations of space-time sheets at quantum criticality and if each sheet carries a Cooper pair of electrons one has the analog of Bose-Einstein condensate. One can assume that the area S of the critical region of the surface of conductor is that of the partonic 2-surface. The guess is that at criticality the electric flux decomposes into sum of smaller electric fluxes over the sheets of n-furcation such that the small fluxes are equal to charge $2e$ of the Cooper pair.

Using $2e$ as a unit the charge the electric flux over the partonic 2-surface at criticality equals to the value of $h_{eff}/h = n$ identifiable as the total number of Cooper pairs so that one obtains an estimate for Planck constant in terms of the critical electric flux:

$$\frac{E_{cr}S}{2e} \;\; = \;\; n = \frac{h_{eff}}{h} \;\; . \tag{9.5.1}$$

This allows a pseudo-continuum of critical fluxes.

5. It would seem natural to assume "traffic jam" at some critical value of voltage between the ends of the coil implies Bose-Einstein condensate-like state of large h_{eff} Cooper pairs, Josephson currents, and supra currents. In principle this critical electric field has nothing to do with the critical field E_d for the di-electric breakdown of air. The needed phase transition would be forced by the "traffic jam" reducing the ordinary conductivity along the wire of the coil. The traffic jam would occur for some critical voltage V_{cr} between the ends of the coil.

   (a) One especially interesting value of voltage corresponds to the Compton energy of electron:

   $$eV_{cr} = m_e \simeq .5 \;\; \text{MeV} \;\; . \tag{9.5.2}$$

   Also higher voltages than this were encountered in Tesla's experiments. This condition is non-local condition. One should not confuse V_{cr} with V_J, which however can be assumed to emerge in the phase transition.

   Later a justification for the condition will be considered. It is also encouraging that in Modanese-Podkletnov effect [H9] involving a capacitor for which the second plate is high T_c super conductor, radiation pulses allowing no interpretation in standard physics framework are generated above the proposed critical voltage $eV_{cr} = m_e$: the TGD inspired explanation of the effect is discussed in [K89].

   (b) Combining this condition with Eq. 9.5.1 one would have

   $$E_{cr} \;\; = \;\; \frac{V_{cr}}{L} \;\; . \tag{9.5.3}$$

   Here L the total length of the wire of the coil if the electric field is constant along the wire. Hence di-electric breakdowns would occur as an undesired side effect due to the very strong fields forced by the Eq. 9.5.2. In the case of cell membrane this side effect is used for neural communications using nerve pulses. Conditions of Eqs. 9.5.1, 9.5.2, and 9.5.3 would allow to fix the model to a rather high degree. Already earlier additional assumptions correlating Josephson frequency, AC frequency and the geometric characteristics of the system were considered.

   (c) In air the critical field for di-electric breakdown is $E_d \simeq 3$ MeV/m. For higher field strengths a complete di-electric breakdown (meaning that air becomes a conductor) takes place. E_d gives for 17 cm long coil $eV \simeq m_e$ so that one can understand why dielectric breakdowns tend to occur unless coil is longer than this. Also dielectric

breakdowns between subsequent turns of the coil are possible and can be seen as a nuisance. The estimate $E_{cr} = E_d$ together with the condition 9.5.1 gives for $S \in \{$ 1 μm^2, 1 cm^2, 1 $m^2\}$, $n \in \{3, 3 \times 10^8, 3 \times 10^{13}\}$. Note that the size scale of the cell nucleus defines the smallest area for which the dielectric breakdown becomes possible.

(d) The millisecond duration of the current is same as for nerve pulse. Nerve pulse however occurs when the resting potential is reduced *below* the critical value so that the two phenomena do not obey identical physics. The current however decreases as a function of the voltage above criticality (negative resistance): does this mean that oscillating Josephson currents become dominant charge carriers above criticality and that for cell membrane this dominance is taken to extreme meaning that ohmic currents are practically absent?

(e) One cannot completely exclude the presence of Josephson currents also below V_{cr} but due to the absence of V_J they would not contain the dominating purely sinusoidal component but would have the form

$$J_0 sin(\tfrac{f_J}{f_{AC}} cos(2\pi f_{AC} t)) \ , \quad f_J = \tfrac{ZeV}{h_{eff}} \ ,$$

and periodicity defined by f_{AC}. The sine term would oscillate between values

$$\pm J_0 sin(\frac{f_J}{f_{AC}}) = \pm J_0 sin(\frac{1}{l}) \ , \quad l = 1, 2, ...$$

if the condition $f_J = f_{AC}/l$ holds true.

6. The cold currents induce electronic effects - generation of ordinary electrons - at the target. This can be understood if a phase transition to ordinary matter occurred when the criterion for the presence of the multi-furcation is not satisfied anymore. An explosion of a copper wire as it received cold electricity was reported by Tesla. This could be understood if the proposed criticality criterion was not satisfied so that the dark current was transformed to ohmic current heating the copper wire.

7. Tesla reported that dark electricity flowed with superluminal velocity and even determined this velocity. This is in principle possible in TGD Universe: sub-manifold gravity implies that the light velocity determined operationally from the time for the signal to travel between two points along light-like geodesics defined with respect to the induced metric depends on space-time sheet. In TGD inspired cosmology this light velocity is lower than the light velocity empty Minkowski space (geodesics of M^4 instead of those of space-time surface X^4). If the dark space-time sheets are nearer to M^4 than ordinary space-time sheets, the effective super-luminality follows.

8. Cold currents were not seen by amp-meter but caused subjective sensations and were visible. This conforms with TGD view about the role of dark matter in biology.

This scenario leads to concrete (almost -) predictions.

1. If amplitude modulation is the mechanism generating dark photons, the values of Planck constants involved should come as ratios of frequencies involved: only integer ratios for the frequencies can produce dark photons.

2. The energies of ordinary photons generated form a continuum such that highest frequencies correspond to frequencies assignable to photons with energy of order eV_{max}, where V_{max} is the highest voltage generated by the transmitter. Therefore the energies can be in X-ray region (keV region) and even in MeV region. The frequencies of radio waves used were in the range 20-100 kHz so that the range of values of effective Planck constants can be estimated as frequency ratio if amplitude modulation is the mechanism producing dark photons.

3. There is also the amplitude modulation of radio frequency by a frequency associated with the periodic switching of the current through the air gap caused by the di-electric breakdown. This modulation could transform the radio wave photons to dark photons with same energy but frequency considerably below kHz and these dark fields could in turn modulate the ordinary higher energy photons to dark ones so that one would obtain dark photons with frequencies below kHz and energies up to the eV_{max}.

Isn't $eV_{cr} = m_e$ condition rather ad hoc?

The first objection against the condition $eV_{cr} = m_e$ is that it looks rather ad hoc. The study of Dirac equation shows that for $V > V_{cr}$ the sign of the energy of electron changes from positive to negative so that the roles of electron and positron change. One can argue that something dramatic must happen in this kind of situation and the phase transition transforming electrons to their dark counterparts is good candidate in this respect.

An analogous situation was expected to result in atomic physics of very heavy atoms as the energy of electron changes sign in the strong electric field of heavy nucleus. It however turned out that something different takes place. In heavy ion collisions exotic pion-like states decaying to electron and gamma pairs with energy very near to $2m_e$ was observed and this led to a TGD inspired model as lepto-pions identified as bound states of colored excitations of electron [K91]. Darkness in TGD sense had to be assumed since otherwise they would be produced in the decays of weak bosons. Could something similar happen also now?

In zero energy ontology (ZEO) the natural assumption is that the scale of causal diamond (CD) is determined from the condition that the quantity $E - ZeV$ preserves its sign. This would give $m_e = eV_{cr}$ condition for the state at rest. The standard quantization condition analogous to the quantization of magnetic flux but applied to 2-surface with Minkowskian signature has the following equivalent forms:

$$
\begin{aligned}
\frac{ZeVT}{h_{eff}} &= n \ , \\
\frac{ZeV}{h_{eff}} &= nf \ , \ f = \frac{1}{T} \ .
\end{aligned}
\tag{9.5.4}
$$

The time interval T corresponds naturally to the time scale of CD (temporal distance between its tips). The condition for $n = 1$ is consistent implies the quantization condition proposed in previous section and motivated by the model of dark EEG:

$$
\frac{ZeV}{h_{eff}} = \frac{f_{AC}}{l} \ .
\tag{9.5.5}
$$

The reason is that f_{AC} in general is harmonic of f: $f_{AC} = lf$, $l = 1, 2, ...$ Recall that the identification of f_{AC} as cyclotron frequency for some charged boson is natural and requires that ions for which cyclotron frequencies (atomic weights in good approximation) are not multiples of each other cannot appear on the space-time sheet corresponding to same CD. One cannot however exclude the possibility that space-time sheets continue outside the CD and therefore the possibility that same space-time sheet is contained partially to sub-CD of CD.

An objection against $eV_{cr} = m_e$ condition from biology

One can invent another objection against the identification $eV_{cr} = m_e$. For cell membrane the critical membrane potential for nerve pulse generation is .055 eV rather than .5 MeV so that the criticality condition would not apply in this case. Does this mean that electronic super-conductivity is not possible? Should one give up the criticality condition or generalize it appropriately in this case?

The correct solution of the problem comes from the answer to the question "What happens as voltage becomes higher than the critical value V_{cr}?". The conjecture is that h increases to $h_{eff}/h = n$ and n-furcation replaces space-time sheet with its n-sheeted covering. But what does this mean physically?

To answer it is best to make first clear what we want and see whether we can get it.

1. We want criticality condition in the form $eV_{cr} = m_e/n$ with such an n that V_{cr} corresponds to cell membrane resting potential. Therefore mass is scaled down by $1/n$. Somehow particle splits to n fractions so that the total quantum numbers, in particular mass, remain unchanged.

2. We want p-adicity. Since p-adic length scale hypothesis allows besides standard mass corresponding to the p-adic prime $p \simeq 2^k$ characterizing the particle also mass values scaled by powers of $\sqrt{2}$, the natural guess is that p-adic length scale is increased by a factor $n = 2^{\Delta k}$.

3. We want a connection with dark matter in TGD sense: $h_{eff}/h = n$ should hold true for the resulting state. The resulting state must be interpreted as a many-sheeted structure defined by n-furcation and all quantum numbers are fractionized so that a given sheet carries q/n if total quantum number is q. A longstanding issue has been what this fractionization could mean.

   By Maxwell's equations stating that potential difference is same along any path with same end points, the potential along each sheet is the same $eV_{cr,new} = M/n$. The new version of the criticality condition $eV_{cr,new} = M/n$ for single sheet of the n-fold covering is the analog of the original condition $eV_{cr} = M$ for single sheeted space-time surface. This interpretation also allows to understand the formula $E_c = h_{eff}ZeB/M$ for cyclotron energy as a formula for single sheet of covering carrying mass M/n and charge Z/n. The charge-to-mass ratio Z/M remains unchanged but summation over sheets yields the factor h_{eff}/h to the formula of E_c. Hence everything is consistent with the original motivation for dark matter hierarchy.

4. One can imagine two alternative mathematical realizations. The dark particle could correspond to a tensor product of n fractional tensor factors or to a direct sum with a complete de-localization of single fractionalized particle to various branches. For a de-localized fractional single particle state the total quantum numbers would be equal to q/n rather than the desired q whereas for tensor product of fractional single particle states the total quantum numbers are q as desired. Therefore tensor product option seems to be the correct one. The fractionized particle is analogous to a full Fermi sphere with all fractional single particle states filled.

5. One can consider also states for which any number $1 \leq m \leq n$ of single particle states are filled. $m = 1$ corresponds to the option with a complete de-localization and $m = n$ to the states proposed above. I have earlier proposed [K61] that this kind of states - I have called them N-atoms, N-molecules, etc... - might allow to understand emergence of symbolic dynamics in living matter. Fractional second quantization for n-furcations of space-time sheet seems naturally lead to to these kind of states. These states allow a natural conjugation operation. A state with m sheets with each of them containing fractional particle contains holes at the remaining $n - m$ empty sheets. By replacing holes with particles and particles with holes one obtains a conjugate state. The wild proposal is that the pairing of states and their conjugates by entanglement with maximal entanglement entropy defines the molecular analog of sex. State function reduction would automatically lead to this kind of states having negentropic number theoretic entanglement and Negentropy Maximization Principle [K49] would stabilize them.

This picture is highly predictive. From the knowledge of the membrane critical potential one can calculate the value of h_{eff} and from the integer quantization of $h_{eff}/h = n$ gets constraints on the possible values of membrane potential: this constraint is unfortunately rather weak since the values of n are rather large. Situation changes if the values of n correspond to powers of 2: $n = 2^{\Delta k/2}$ so that the mass of the dark particle at given sheet of covering equals to the mass predicted by p-adic mass calculations but in p-adic scale $k_{eff} = k + \Delta k$. Note that Δk must be an even number unless one replaces the condition with the approximate condition $n \simeq 2^{\Delta k/2}$. This hypothesis might mean that the p-adic physics associated with the sheet of covering indeed corresponds to $p \simeq 2^k_{eff}$. The hypothesis predicts the p-adic prime associated with the cell membrane and also restricts strongly the value of the threshold potential of the cell membrane.

1. In the case of electron p-adic length scale hypothesis predicts the value of the threshold potential: $V_{crit}/V_{cr} = V_{crit}/m_e = n = 2^{\Delta k/2}$. For $\Delta k = 46$ one obtains $eV_{crit} = .060$ eV not

too far from the nominal value .055 eV of the threshold potential. The Compton length of scaled up electron would correspond to $k = 127 + 46 = 173$, which is 20 μm - a size scale of cell - and longer than the scale $L_e(167)$. Note that the ratio $L_e(173)/L_e(151) = 2^{11}$ is approximately the same as the ratio of proton and electron masses. I have also introduced an ad hoc hypothesis that powers of 2^{11} represent preferred values of h_{eff}.

2. For biologically important ions one can find the values of membrane critical potential for which n is power of 2. Since the mass of the ion is in good approximation proportional to mass number in good approximation it is easy to get reasonable estimates for the effective (or maybe real) p-adic length scales associated with ions and for the precise value of the threshold potential. The values of k_{eff} and electrostatic energy E in threshold potential are given in Table 2 below.

3. This picture might allow to understand why nerve pulse is generated when the membrane potential is reduced *below* V_{crit}. The earlier vision about resonant interaction between dark variants of elementary particles and their p-adically scaled up versions with ordinary value of Planck constant and scaled down mass [K41] assumes that dark scaled up Compton length nL_c equals to the p-adically scaled up Compton length: this quantizes the values of $h_{eff}/h = n$ to powers of 2. In the case of electron this gives $n = 2^{\Delta k} = 2^{23}$. The reduction of the membrane potential below the critical value would transform dark electrons to ordinary electrons. Same applies to dark ions. If this is the case, the ordinary ohmic conduction would set on and lead to a generation of nerve pulse as a phenomenon analogous to di-electric breakdown. This picture could make sense also for the neutrino option. What is remarkable that ZEO and dark matter in TGD sense would be essential for understanding the highly non-intuitive fact that cell membrane system becomes unstable as membrane potential is reduced in magnitude.

4. One can try to determine the order in which different charged particles make a transition to non-superconducting phase during nerve pulse from the ordering of the values of E as $(e, p, Cl^-, K^+, Ca^{++}, Na^+)$. The inward flux of ions however begins with Na^+ ions and the outward flux with K^+ ions. That Na^+ rather than K^+ flow initiates nerve pulse is not a catastrophic prediction: the transition to a non-superconducting phase initiates the dissipative ion flow only if the concentration of non-super-conducting ions on the other side is low enough (not true in the case of K^+ in the beginning of the action potential).

5. Voltage gated ion channels are assumed for all ions. Nerve pulse can be also initiated by voltage dependent calcium channels, and in this case its duration is about 100 ms instead of few milliseconds. The TGD counterparts for the ion channels should exist and the following correspondences are suggestive.

   - Voltage gated ion channel characterized by channel protein $\leftrightarrow$ n-furcated dark space-time sheet with n depending on ion.

   - Closed/open ion channel $\leftrightarrow$ the magnitude of the membrane potential above/below the critical potential.

Voltage gated ion channels would correspond to dark regions of the cell membrane assignable to proteins rather than to the entire membrane as implicitly assumed hitherto. Metabolic economy (minimization of dissipation) would encourage an analogous interpretation in the case of ion pumps. Ionic pumps (`http://en.wikipedia.org/wiki/Ion_transporter`) use the energy provided by ATP or the electrostatic energy $E = ZeV$ (depending on ion only via its charge) provided by the passive transfer of another ion through the cell membrane - the members of the ion pairs might be connected by a magnetic flux tube! The basic mechanism for pumps would be emission/absorption of negative/positive energy Josephson photon kicking the ion or ion Cooper pair to the other side of the membrane and thus same as in the generation of ATP. Quantal ionic pumps dissipate much less than expected, and Ling's approach postulating the absence of pumps is partially inspired by this observation.

There are also questions to be answered. The estimated value of n is same for K^+, Na^+, Ca^{++} so that one might expect them to reside at same n-sheet. Why the channel proteins are

different? Do different ions correspond to different cyclotron Bose-Einstein condensates? Could cyclotron frequencies be same or related by powers of two so that local magnetic field strengths would be different and ions should correspond to disjoint parts of magnetic body.

Ion	H^+	Na^+	Cl^-	K^+	Ca^{++}
$\frac{A}{z}$	1	23	35	19	20
E/meV	54.6	38.0	50.0	46.0	44.0
k_{eff}	175	189	191	189	189

Table 2. The values of the threshold potential and effective p-adic length scales $k_{eff} = k + \Delta k$ predicted by assuming $h_{eff}/h = n = 2^{\Delta k}$. A and z denote the mass number and charge of the ion. For electron one has $k_{eff} = 173$ (prime) and $E/meV = 60$. Na^+, Ca^{++} and K^+ all correspond to same p-adic length scale $k_{eff} = 189$ (p-adic length scale of 5 mm) if the ion is assumed to correspond to $k = 113$ for atomic nuclei. Another posssibility is $k = 137$ (atomic length scalle) giving $k_{eff} = 213$ (p-adic length scale of 20 meters) and should be assigned with the magnetic body.

It seems that k_{eff} could characterize genuine p-adicity that is p-adicity in the same sense as ordinary particle obeys it.

1. I have proposed earlier that dark and possibly also p-adic copies of electroweak physics and color interactions are present in living matter for the p-adic length scales corresponding to Gaussian Mersennes $M_{G,k} = (1 + i)^k - 1$. $k = 151, 157, 163, 167$ defining four scaled up electron Compton lengths $L_e(k) = \sqrt{5}L_e(k)$ in the range $[L_e(151) = 10$ nm,..., $L_e(167) = 2.5$ μm] [K41]. Weak bosons behave as massless particles below these p-adic length scales for both p-adic and dark copies. The presence of these copies of weak physics is suggested by the large parity breaking effects in living matter (chiral selection), which are still poorly understood.

2. The hypothesis implies a large number of satellite p-adic length scales if one assumes that dark variant of particle can transform to ordinary variant of the particle characterized by a given dark scale characterized $n = 2^{\Delta k}$.

3. The recent conjecture modifies this hypothesis to a statement that given sheet of n-furcation with fractionized quantum numbers - in particular mass - obeys effective p-adic topology characterized by $k_{eff} = k + \Delta k$. In particular, the exotic weak and color physics with massless weak bosons and non-confined color below the p-adic length scale k_{eff} could be obeyed at given sheet of the covering.

Neutrino super-conductivity and cognition

The idea that neutrinos are highly relevant for cognition [K65] is rather attractive in TGD framework. One of the oldest ideas of TGD inspired biology is the notion of cognitive neutrino pair identified as pair of neutrino and antineutrino at opposite throats of wormhole contact, which I have however gave up as unrealistic. In the recent formulation this state would correspond to a superposition of photon and Z^0 boson coupling only to neutrinos. In standard model framework the idea about the relevance of neutrinos for biology is of course complete nonsense, but p-adic length scale hierarchy and TGD view about dark matter allows to consider this idea at least half-seriously. The observed large breaking of parity symmetry in living matter (chiral selection) indeed encourages to ask whether the p-adically scaled counterparts of weak gauge bosons could appear in the length scales of living matter.

There is also second wild idea. In [K13, K20] I have considered the possibility that the cell membrane can exist in two states: the first state is far from vacuum extremal and electromagnetic fields dominate whereas the second state is near to vacuum extremal and also classical Z^0 fields are important. The latter option would mean maximal sensitivity to perturbations highly desirable for cells serving as sensory receptors. This leads to a modification of the model of cell membrane resting potential and rather realistic looking estimate for the frequencies for which the retinal sensory receptors have maximum response.

1. For near to vacuum extremal option induced Kähler form is very small and in good approximation electromagnetic and Z^0 potential energies for e, ν, p and n relate to the treshold value of the electromagnetic potential energy via

$$
\begin{aligned}
&E(X) = Y(X) \times eV_{crit} \ , \\
&Y(e) = (-1 + x) \ , \qquad\quad Y(\nu) = 2 - x \ , \quad Y(p) = 3 - x \ , \quad Y(n) = x \ , \qquad (9.5.6) \\
&x = \tfrac{1}{2p} \ , \qquad\qquad\qquad\quad p = sin^2(\theta_W) \ .
\end{aligned}
$$

These formulas generalize to ions and allow to calculate the values of V_{crit} for near vacuum extremals from the condition $m(X) \times 2^{-\Delta k} = E(X)$, $X = e, p$ or for an ion with given value of A/z (A is mass number and z is degree of ionization). The modified threshold potential is given by $eV_{crit} \to eV_{crit}/Y(X)$ when $Y(X)$ is near unity. The expressions of $Y(X)$ are deduced in [K13].

2. The earlier model [K13] made the questionable assumption that for near to vacuum extremals the value of the Weinberg angle is $p = .0295$, which is considerably smaller than the value $p = .23$ assumed for the phase far from vacuum extremals [K13]. This assumption was motivated by the condition that the energies of biologically important ions gained in membrane potential correspond to three peak energies associated with visual receptors. It has however turned out that the ordinary value of Weinberg angle can be assumed without losing this prediction if one assumes that Cooper pairs of ions Na^+, K^+, and Cl^- rather than ions themselves are the charge carriers. For $p = .2397$ one obtains $(E(e), E(\nu), E(p), E(n)) = (1.085, -0.0859, 0.914, 2.086) \times V_{rest}$. Except for neutrino, the scaling factors are rather near powers of 2. Note that for proton the scaling factor is in good approximation two.

3. Dropping of two proton Cooper pairs in the production of ATP would liberate total energy of about $4 \times .055 = 0.22$ eV. The problem is that this is roughly one half of the metabolic energy quantum. If two proton Cooper pairs and two neutrino Cooper pairs are dropped, the liberated energy is of the order of the nominal value of the metabolic energy quantum. Could it be that the step producing ATP takes place in the region of cell membrane near to vacuum extremal and that also two neutrino Cooper pairs are involved in the process? Note that this discrepancy is encountered also in in standard thermodynamical approach and can be overcome by assigning a gradient of chemical potential to the cell membrane. In quantum approach one cannot use this kind of argument.

If one accepts this picture, neutrino super-conductivity with neutrino Cooper pairs as carriers of Z^0 current becomes in principle possible and is even favored by energetics. I have earlier considered the possibility that neutrinos play a key role in cognition but gave up the proposed realization as unrealistic. In the recent situation one must however reconsider a new variant about the idea of cognitive neutrino Cooper pairs. A nice feature of this notion is that cognition would be shielded from electromagnetic perturbations from environment.

1. One can apply the condition $E(\nu) = m_\nu$ to see whether it is consistent with the electron and neutrino masses predicted by p-adic mass calculations in the lowest approximation [K45]. For neutrinos one can identify two options giving $m_\nu \propto \sqrt{s_\nu}$, $s_\nu = 4$ or $s_\nu = 5$. For electron one has $m_e \propto \sqrt{s_e}$, $s_e = 5$. For $s_\nu = 5$ masses are identical for same p-adic length scale. For $s_\nu = 4$ one has $m_\nu = 2/\sqrt{5}m_e = .89 m_e$ in the same p-adic mass scale.

2. Assume the recent Wikipedia value $p = .23970$ for the Weinberg angle. For electron $\Delta k = 46$ giving $k = 173$ (prime) predicts $V_{eff} = 2^{-23} m_e/(-1 + x) \simeq .0561$ eV differing by 2 per cent from the nominal value .055 eV of the threshold potential for neurons.

3. For $s = 5$ neutrino $\Delta k = 54$ gives $k = 181$ (prime) and $V_{eff} = 2^{-27} m_e/(2 - x) \simeq .044$ eV differing by 10 per cent from the nominal value .040 eV of the threshold potential for photoreceptors in retina. Interestingly, one has $E(p) = eV_{eff}(p) = .040$ eV. These observations provide support for the idea that ordinary neurons/visual receptors correspond to far

from/near to vacuum extremals, for the p-adic length scale hypothesis, and for the criterion $m = eV_{eff}$. Note that the p-adic mass scales for neutrinos and the light variant of electron are longer than those associated with Gaussian Mersennes. This is the case also for the ordinary weak bosons.

These considerations allow to take at least half-seriously the possibility that cell membranes correspond to near to and far from vacuum extremals depending on whether the membrane corresponds to neuron (cognition) or sensory receptor (sensory experience) and that electrons are light and dark for the far from vacuum extremals and neutrinos are light and dark for the near vacuum extremal.

Magnetic body and topological light rays from the point of view of energy storage and transfer

As noticed, in Maxwell's theory the dispersion of EM waves is problematic from the point of view of energy transmission unless geometric optics applies. In TGD Universe topological light rays possibly associated with magnetic flux tubes make possible precisely targeted communication and this difficulty might be circumvented. Remote metabolism possible in zero energy ontology also involves these structures and brings in additional flexibility.

The system using energy could store it temporarily at its magnetic body and transform the energy of cyclotron BE-condensate into various forms of energy assignable to visible matter. Tesla's vision was that energy transfer could take place in planetary scale by reflecting what he called longitudinal scalar waves from the upper boundary of Kennelly-Heaviside cavity. One can even imagine that the part of the magnetosphere associated with atmosphere, ionosphere, the part of magnetosphere rotating with Earth, or even entire magnetosphere could serve as an energy reservoir from which one could receive energy somehow. One can even ask whether solar radiation automatically takes care of the loading of these energy reservoirs. If so, the only problems to be solved would be how to control the magnetic body of the system using energy and generation of negative energy photons. One can also consider the option in which the magnetic body of the system is loaded by irradiating it with dark photons at cyclotron frequencies.

I have proposed that the generation of dark photons with given integer value of $\hbar_{eff}/\hbar = n$ is possible by performing amplitude modulation of high frequency radiation with frequency f_h using low frequency radiation such that the frequencies are related by $f_h = n \times f_{low}$. I have not been able to give a convincing justification for this proposal. This would generate dark photons with large value of $\hbar_{eff}/\hbar = n$. An open question is whether it automatically also generates dark magnetic flux tubes with accompanying the dark photons or whether they must be generated by a phase transition increasing $\hbar_{eff}$. In previous section a mechanism utilizing very strong electric fields and high voltages to generate dark Cooper pairs and dark photons as Josephson radiation from AC current system was discussed.

Lightnings, ball lightnings, and plasmoids as primitive life forms?

If one takes seriously the idea that Earth's electric field (https://en.wikipedia.org/wiki/Atmospheric_electricity) $eE_E = 100$ eV/m played the role of the electric field associated with cell membrane during the prebiotic period and also requires that the condition $eV_{cr} = .5$ MeV for the establishment of dark supra currents along helical structures, one must conclude that the minimal length of this kind of structure is about $L = 5$ km if the electric field remains constant as function of radial distance. A typical cloud-to-ground lightning flash indeed begins at this height. This would suggest that lightnings are generated when the criticality condition is satisfied.

E_E however weakens with height and the voltage associated with E_E reaches maximum $eV_E = .3$ MeV at height of 30-50 km. This is rather near to $eV_{cr} = .5$ MeV: perhaps lightning is generated when this maximum increases locally above $V_{cr} = m_e = .5$ MeV. This would mean that lightnings are initiated at much higher heights than thought and by above considerations could involve dark supra currents. This conforms with the recent observations that lightnings produce gamma rays and electrons with anomalously high energies (https://en.wikipedia.org/wiki/Atmospheric_electricity).

For the electric field $eE = 3$ MeV/m corresponding to di-electric breakdown in air perhaps assignable locally to the lightning the length would be $L = 18$ cm. I have proposed that plasmoids

consisting of plasma and magnetic fields could correspond to primordial life forms. A charged helical structure carrying current and associated magnetic field defining its magnetic body would serve as a candidate for a plasmoid. Plasmoid and "ground" would define the "plates" of a capacitor-like system. If this view is correct, $L = 18$ cm is the minimum size scale of plasmoids (say ball lightnings).

9.5.4   How could this picture relate to biofield research?

Various biofield therapies (healing by touch, remote healing, using electromagnetic fields, etc) rely on the observation that weak electromagnetic fields have effects on living matter and the assumption that this can be used for healing purposes. The article "Biofield Research: A Round Table Discussion of Scientific and Methodological Issues" [J31] gives an overall view about the challenges encountered. Biofield therapies represent alternative and complementary medicine and the attitudes of the mainstream are still very hostile. Bio-electromagnetism is a well-established branch of science studying effects of various kinds of electromagnetic fields on living matter and brain. Interestingly, Tesla is the father of the oldest healing method based on pulsed magnetic field generated by Tesla coil. This method is also accepted by standard medicine. The pain relieving effects of this treatment is still poorly understood. Furthermore, the work of the pioneers of bio-electromagnetism like Blackman and Adey revealed that ELF electromagnetic radiation have essentially quantal effects on brain in frequency-amplitude windows and that the field values involved are extremely small: of order 1-10 V/m in typical experiments [K20]. These effects are also poorly understood.

A further idea not accepted by mainstream medicine is the notion of "subtle energy". The concept is often used in a metaphoric sense and it is not clear whether its meaning is nearer to that of information. A more precise meaning for subtle energy could be as some yet unknown form of metabolic energy. Note that in TGD framework metabolic energy is accompanied by negentropic entanglement and conscious information at some level of the self hierarchy.

In the round table discussion some basic theoretical problems of biofield research were summarized. What happens to the physiology of the healer during healing? What are the receptor systems and transduction mechanisms in the healee? What is transmitted between healer and healee?

TGD allows to consider a possible answer to the latter two questions [K20]. The work of Blackman and others encourages the hypothesis that the effects on vertebrate brain are quantal and correspond to cyclotron frequencies for Ca^{++} ions in magnetic field which is 2/5 of the Earth's magnetic field (.3 Gauss). For the ordinary value of Planck constant quantal effects are definitely ruled out - the energy of photons would be ridiculously small when compared with thermal energy. This could be used as a justification for the hypothesis about hierarchy of effective Planck constants $h_{eff}/h = n$ following from the basic structure of TGD, and whose applications are discussed also in this article. If the thickness of the magnetic flux tube can be controlled as one particular magnetic motor action, also the local magnetic field can be varied in certain limits, and the outcome is a narrow frequency window.

The understanding of the amplitude windows for external electric field, call it E, is more difficult and has been a longstanding challenge. This article suggests the reduction of amplitude window to a window for Josephson energy. Denote by θ the angle between the plane of plates of Josephson junction and E. The energy gained by electron as it moves the distance d between the "capacitor plates" of a Josephson junction is $eV = eEdcos(\theta)$. It is also to the energy received by dark electron as it receives Josephson photon with energy equal to the electrostatic energy $eV = eEdcos(\theta)$. One can argue that the momentum gained by the electron in the absorption of Josephson photon and thus also that of Josephson photon must be in good approximation tangential to the membrane layer inside which it is confined. Since the momentum of the Josephson photon is orthogonal to its polarization, $cos(\theta)$ must be rather near to $cos(\theta) = 1$.

1. The first proposed quantization formula proposed in this article is that Josephson frequency $f_J = ZeV/h_{eff}$ is sub-harmonic of cyclotron frequency: $f_J = f_c/l$, $l = 1, 2, ..$, with cyclotron frequency f_c identifiable as the frequency of irradiation. This formula relates the voltage V assignable to the radiation amplitude to its frequency equal to f_c.

2. Josephson junction corresponds to a two-layered structure such that the electrostatic energy in the voltage between the outer surfaces of the structure corresponds to electron mass scaled by the value of Planck constant $h_{eff}/h = n = 2^{\Delta k}$: $eV = m_e/2^{\Delta k}$. This works nicely for cell membrane and the cautious proposal is that it works more generally.

3. A resonant interaction between "large" Josephson junctions and cell membranes is needed and becomes possible by the exchange of Josephson photons if the Josephson energies eV and the value of h_{eff}/h - that is Δk are same for the two systems. This gives a quantization condition for the thickness of the "large" Josephson junction using the value of electric field $E = x$ V/m with x in the range $[1, 10]$: $eV = eEdcos(\theta) = eV_{crit} = .055$ eV giving $dcos(\theta) = 5.5/x$ cm. $x = 1$ corresponds to $cos(\theta) = 1$ giving that the thickness of the Josephson junction is is 5.5 cm: this is roughly the scale of brain hemisphere. Variation of the angle θ gives frequency window via $cos(\theta) = 1/x$. At least two frequency windows are reported and correspond to $x \in [1/2, 1]$ and $x \in [1/10, 1]$. Already in the first case the range for θ would be 60 degrees. It seems that several values of d in the range of $[.55, 5.5]$ cm are required in both cases. They could correspond to p-adic length scales $L_e(k)$ in the range $k \in [181, 183]$ for the first case and $k \in [177, 183]$ for the latter case.

4. Cell membrane as Josephson junction is only a macroscopic description of the situation. Membrane proteins defining channels and pumps are very natural candidates for a more precise microscopic description of Josephson junctions at cell membrane scale. Ca^{++} channels would be especially interesting in this respect since Ca^{++} is a boson and can form Bose-Einstein condensates as such. The natural question is what are the microscopic counterparts of Josephson junctions in longer length scales.

What would be transmitted between the healer and healee could be dark photons and possibly also dark electrons and even ions. The ability to generate negentropy would be also transmitted and perhaps a better manner to think about the situation is to regard healer and healee as a single system as long as the flux tube connections generated by reconnection of flux tubes are present. Also remote metabolism in which healee emits negative energy Josephson photons received by healer can be considered.

9.5.5 Tesla coils from TGD view point

In the sequel coils considered by Tesla are reconsidered from TGD viewpoint and an attempt to understand in more detail the phase transition to dark matter as a phenomenon accompanying resonance is made.

Is the model for the resting potential really consistent with the interpretation of Tesla's experiments?

Is the proposed picture consistent with what happens in Tesla's experiments, where very high voltages somewhat above $eV_{crit} = m_e$ were created? In living matter the voltage values are much lower and this determines the value of $n = 2^{\Delta k/2}$. Does this mean that one has $n = 1$ in Tesla's experiments? This would be rather disappointing but could quite well make sense for the coil-Earth system regarded as capacitor. In both situations very strong electric fields are encountered and the idea about large value of n is very attractive.

The solution ansatz assumes generation of light fractional electrons as in the case of cell membrane and starts from from the idea that the subsequent turns of Tesla coil are analogous to the lipid layers of cell membrane and define Josephson junctions. The observed radiation assigned to dark currents could also correspond to Josephson radiation.

1. Since electric voltage propagates with finite velocity of order light velocity along the coil, there is a potential difference between corresponding points of two subsequent turns of the coil. Could it be that super-conductivity sets on and oscillatory Josephson currents flow between the two subsequent turns and the observed light emission can be assigned with dark currents is Josephson radiation? The electric field is very strong at points where charge accumulates and one expects phase transition. Since the maximal value of the oscillating potential difference

between subsequent turns above critical voltage $eV_{cr} = m_e$ is smaller than $eV_c r$, a scaling of electron mass downwards is however expected to occur by the proposed criterion for cell membrane: $m_e \to m_e/n$, $n \simeq 2^{\Delta k/2}$, $n = h_{eff}/h$. Electrons would become light.

2. To estimate n one can use a simple estimate for the voltage as function of time and angle variable ϕ along the helical coil of radius R given by equations $z = KR\phi$, $\rho = R$. The distance along coil given by $s = \sqrt{1 + K^2} R\phi$. One can express K as the ratio of height to the total length s_{tot} of the coil: $K = h/s_{tot}$. The voltage is given by $V(t, \phi) = V_0 sin[\omega_{AC}(t - \sqrt{1 + K^2} R\phi/c)]$. The voltage difference between points of subsequence turns with values of ϕ differing by 2π is $\Delta V \simeq (\partial V/\partial \phi)2\pi = (\partial V/\partial t)2\pi R\sqrt{1 + K^2}/c$. Josephson current is given by

$$J = J_0 sin(\tfrac{\int dt \Delta V}{h_{eff}}) = J_0 sin[\tfrac{2\pi}{f_0} \tfrac{1}{h_{eff}} V(t)] \quad , \quad f_0 = \tfrac{c}{R\sqrt{1+k^2}} \quad . \tag{9.5.7}$$

3. Near zeros of V one has in the first approximation $V(t) = V_0 \omega(t - t_{max})$ and Josephson current behaves as

$$J_0 sin[\omega_{eff,J}(t - t_{max})] \quad , \tag{9.5.8}$$

where

$$\omega_{eff,J} = (2\pi)^2 \frac{f_{AC}}{f_0} V_0 \frac{1}{h_{eff}} \tag{9.5.9}$$

defines the analog of Josephson frequency for effective voltage

$$V_{eff} = (2\pi)^2 \frac{f_{AC}}{f_0} V_0 \quad . \tag{9.5.10}$$

If one applies the earlier argument this would mean that the critical voltage $eV_{cr} = m_e$ is scaled down to $V_{eff,cr} = (2\pi)^2 \frac{f_{AC}}{f_0} m_e$ and that electron becomes dark electron with p-adically scaled down fractional mass at each sheet of multi-furcation.

4. Using the proposed formulas $h_{eff}/h = n = 2^{\Delta k/2} = V_{cr}/V_{eff,cr}$ one obtains the estimate $n = (2\pi)^{-2} \frac{f_0}{f_{AC}}$. For $R = .1$ m and f_{AC} in the range $[20, 10^2]$ kHz one would have n in the range $[380, 76]$. The condition $n = 2^{\Delta k/2}$ restricts the range to even powers of 2: $\Delta k = \{16, 14, 12\}$. The corresponding p-adic scales would be $L_e(k)$, $k = 127 + \Delta k$ giving $k = 143, 141, 139$. $k = 139$ corresponds to atomic length scale and $k = 143$ to $4 \times L_e(139)$.

5. The surface density of electronic charge carriers should be few electrons per surface area defined by $L_e(k)$. This condition looks reasonable since electron density is about one electron per atomic volume. On the other hand, from the critical value of electric field in air the charge density would be only few electron charges per μm^2 (cell size scale). Electrons should indeed separate to its own dark phase at n-sheet. This would also lead to high charge density for ions inducing dielectric breakdown.

What traffic jam in Tesla coil could mean?

What "traffic jam" or its analog could mean from the circuit theory point of view and how the traffic jam could be resolved in TGD framework?

1. First trial

In the following a simple manner to illustrate the idea in terms of effective description of coil as L, C, and R in series is discussed first.

1. It is essential that in the experiments of Tesla both primary and secondary coils were in resonance with the same resonance frequency so that primary coil acted as driving force for the secondary and in the resonance created the situation possibly forcing the new physics to emerge via a phase transition to dark matter phase. Primary feeds the secondary with a sinusoidal input at resonance frequency. Modelling the secondary as a circuit with L,C, and R in series, one obtains simple second order differential equation for its behavior

$$\frac{L d^2 I}{dt^2} + R\frac{dI}{dt} + \frac{I}{C} = \frac{dV_{ext}}{dt} \equiv g(t) = A sin(\omega_0 t) \tag{9.5.11}$$

The right hand side represents the voltage assignable to the primary. For L, C, R in parallel one must express effective R,C, L using the real R, C and L using the formula for $1/Z$ as sum of $1/R, 1/C, 1/L$. Resonance frequency transforms however from $1/\sqrt{LC}$ to $\sqrt{R/L}$ in parallel case at the limit of vanishing R. $R = 0$ in complete resonance for series is replaced with $R = \infty$ for parallel case (the current does not flow at all through R so that the outcome is pure L, C circuit).

2. Solutions are sums of two solutions of homogenous equation and a special solution of inhomogenous equation. Solutions of the homogenous equation reduce to linear combinations of two exponent functions

$$I_{\pm}(t) = exp(-\Omega_{\pm}t) \ , \ \ \Omega = \frac{-R}{2L} \pm i\omega \ , \ \ \omega = \sqrt{\frac{1}{LC} - (\frac{R}{L})^2} \ . \tag{9.5.12}$$

3. The solutions of inhomogenous equation can be obtained by the variation of coefficients for homogenous solutions that is in the form $I_{\pm}^1 = C_{\pm}(t)I_{\pm}(t)$ and are given by

$$I_{\pm}^s(t) = \int_0^t \frac{g(t)}{L} I_{\pm}(t)dt \times I_{\mp}(t) \ . \tag{9.5.13}$$

The outcome from the exponentials is a combination of trigonometric functions and constant functions, which vanish at origin. The resonance corresponds to $\omega = \omega_0$ and means that the exponential decay for the special solutions is compensated by the energy feed. At the limit $R/L \to 0$ the amplitude of $I_{\pm}$ divergences and the solution for R/L is combination of trigonometric functions multiplied by t so that the envelope of the solution increases linearly.

4. Physically the resonance means that the charge of the capacitor oscillates with amplitude, which becomes very large at resonance $\omega = \omega_0$ (the amplitude is proportional to L/R at resonance for the series case): note that large inductance makes the resonance stronger. The charge of the coil begins to fluctuate with a large amplitude. To estimate the charge notice that in a reasonable approximation the current has same phase along the coil. The reason is that the voltage represents a signal propagating with almost light velocity along the coil and the phase change $\Delta\phi = \omega T = \omega L/c \sim 10^{-3}$ and therefore rather small. Charge is given by $Q(t) = \int I(t)dt$ in good approximation (current all points of coil is in the same phase).

5. Near resonance the amplitude of charge oscillations becomes very large and the system must become unstable. Something must happen. TGD inspired proposal is a transition containing plasma phase and dark matter and dark magnetic flux tubes as a counterpart of Tesla's cold currents.

Second trial

Second trial is inspired by catastrophe theory.

1. Voltage and frequency would be the control variables and $|Z|$ could be taken as behavior variable if cusp is assumed to model the situation. There would exist a critical frequency interval inside which two phases are possible. The first phase could be ordinary and second phase could correspond to di-electric breakdown generating plasma and dark currents flowing along dark magnetic flux tubes. This is just one possibility but perhaps the most realistic one. The transition to the phase containing plasma and dark currents takes place at certain frequency above certain critical voltage and frequency range becomes wider as the voltage increases. Plasma can be assigned with the capacitor defined by the di-electric surrounding the coil and the super conducting dark phase with the dark magnetic body of the coil itself. Both are generated at say "the lower" sheet of the cusp. The critical voltage corresponds locally to surface charge density (essentially normal component of electric field at the surface of the conductor) above which di-electric breakdown takes place.

2. The end points of the frequency interval correspond to effective resonances since a sudden transition between the two phases takes place as one approaches the apparent resonance frequency either from below or above. For genuine resonance would result from both sides and hysteresis is basic prediction of this model. L, C, R change in discontinuous manner inducing discontinuous change of Z. In particular, the phase changes suddenly and discontinuously so that resonance interpretation is suggestive but would be wrong. Catastrophe theory with $|Z|$ as behavior variable predicts discontinuity of $|Z|$ at the transition.

3. The phases have electric *resp.* magnetic character, and would be in certain sense duals of each other. In second phase dissipation is small and therefore also $|Z|$ is small whereas in the second phase dissipation is larger and $|Z|$ is large. Whether resistance increases or decreases in the transition to dark plus plasma phase depends on the proportion of the two phases involved.

4. In this picture one does not have genuine resonances but pairs of dual phase transitions. Unfortunately, the testing of this proposal is not easy since the impedances are measured assuming linearity and using rather weak voltages around 1 V whereas plasma phase and cold currents are generated at voltages, which are above kilovolt scale. Intriguingly, the resonances appear in this kind of situation as pairs,and it is possible to reproduce them by a suitable circuit model. It does not look too plausible that small amount of dark phase and plasma could be present at so low voltages but one must have an open mind in this respect.

5. It is possible to obtain also a connection to real resonances since in the vicinity of the resonance frequency the criterion for the formation of plasma is expected to be satisfied for high enough voltage. If the value of surface charge density is what matters then the frequency dependent real part of the charge of the coil defined as integral of the current $I = V/Z$ near resonance determines the threshold for the generation of the plasma and dark current. The total charge per area of the coil must be above certain critical value corresponding to the critical electric field at which di-electric breakdown occurs. This threshold condition defines the boundaries of the region of (V_0, ω) plane inside which the two phases can be present. The phase transition between ordinary and plasma containing phases takes place at its boundaries. Cusp catastrophe would correspond to a frequency interval around resonance.

Could one detect the generation of dark matter in the behavior of frequency dependent impedance?

The generation of dark matter would involve also the emergence "dark magnetic flux tubes". Dark magnetic flux tube would correspond topologically to the analog of n-sheeted covering space for

$n = h_{eff}/h$. Ohmic currents would be replaced with dark supra currents flowing along dark magnetic flux tubes and correspond to Tesla's cold electricity. The generation of strong electron densities and thus strong electric fields at the surfaces of the conductors - in particular coils - is the prerequisite for the phase transition to dark electronic super-conductivity. This would manifest itself as local dielectric breakdowns as in the experiments of Tesla. Resonances mean strong ohmic currents and the phase transition could accompany resonances for sufficiently high voltages.

If the dark magnetic fields correspond to separate space-time sheets carrying dark electron Cooper pairs, there is a temptation to conclude that the presence of the dark currents ("cold electricity" of Tesla) is not seen in the description of circuits using ordinary circuit theory applying only for the visible matter. In particular, one can argue that the contribution of the induced dark magnetic fields to the inductance characterizing visible matter becomes vanishing. In the framework of circuit theory this would look like a transition to a state in which the visible part of system - say coil - behaves like a capacitor. Here one must make distinction between two meanings of capacitance: could behaves like a charge reservoirs defining together with ground a capacitor like system or could itself becomes analogous to a pair of capacitor plates. If the second end of the system is grounded, these two views seem to be more or less equivalent.

1. In circuit theory description this kind of transition would be analogous to a resonance since it involves a change of the sign of the phase of the frequency dependent impedance $Z(\omega)$ when the reactance $X(\omega)$ in the expression of impedance

$$Z = R + iX \ , \ \ X = \omega L - \frac{1}{\omega C}$$

vanishes. Note that system is modelled as $R, C,$ and L in series. $R, C,$ and L are assumed to be slowly varying functions of frequency ω and provide effective reparameterization for the frequency response of a complex system.

Also modelling as $R, C,$ and L as parallel is possible and means that inverse of Z is sum of inverses of various contributions. This means a reparameterization giving:

$$\omega_{\pm} = -i\frac{1}{2RC} \pm \frac{1}{2}\sqrt{-(\frac{1}{RC})^2 + \frac{4}{LC}} \ .$$

One can say that these resonances are duals of each other and related by $R/L \leftrightarrow 1/RC$. One can say that the roles of inductance and capacitance are changed in the parallel coupling. Note that at the limit $R \to 0$ in parallel case second resonance frequency approaches to $\omega_+ = \sqrt{\frac{R}{L}}$. Note that the limit of very large R gives $\omega_{\pm} = \pm 1/\sqrt{LC}$. The interpretation is that the current does not flow through R and one obtains pure L,C resonance.

2. The resonances of course have interpretation in terms of ordinary circuit theory thinking and possible phase transitions to dark phase only accompany the resonances. The turns of the coil are insulated from each other and same applies to the primary and secondary of a transformer like system as well as components of a system consisting of several coils. The insulation is obtained by using di-electric which polarizes so that one obtains effectively capacitor like systems since insulating material develops a polarization as a reaction to the charge of the coil. One has effectively L and C in parallel. This gives rise to a resonance frequency. Since C behaves like surface area per distance between the plates, and L is proportional to the length of the coil, the resonance frequency decreases with the size of the coil.

Resonance interpretation in strong sense requires also that the values of the phase are near to $\pi/2$ for the inductive phase and $-\pi/2$ for the capacitive phase for R, C, L in series. For R, C, L in parallel the roles of L and C are changed. The strength of the resonance depends on how large the change of the magnitude of the phase angle of Z is. One has two kinds of resonances depending on the sign of the change of the phase angle as ω increases. For R, C, and L in series the transition from capacitive to inductive phase - Φ decreases - would correspond to series resonance in ordinary circuit theory, where capacitance dominates at low frequencies for series configurations. Increase of Φ could be called "antiresonance". Parallel resonance would correspond to the increase of Φ as function of ω and decrease for

"antiresonance". In the following I will speak only about resonances. The resonance with a phase transition decreasing/increasing Φ is expected to be followed by a reverse transition increasing/decreasing it in the case that Φ is near $\pm\pi/2$ between resonances (this requires small enough real part of Z).

3. For coils these two kinds of resonances are expected to correspond to different kinds of phase transitions.

    (a) An obvious and directly observable phase transition occurring at resonance is the generation of plasma phase in di-electric breakdown from the surface of di-electric surrounding coil wire or from the di-electric surrounding entire coil. This phase transition dissipates energy, and one expects that resistance increases in the vicinity of the resonance as function of ω. This means also maximum for reactance. Phase transition like property would suggests sharp peak like maximum instead of a smooth parabolic maximum.

    (b) The phase transition to dark super-conductivity is expected to be assignable to the coil itself and involve generation of dark magnetic flux tubes and Cooper pairs of dark electrons as current carries at it. This phase transition is expected to reduce dissipation and induce a peak like minimum in resistance difficult to explain in terms of plasma generation - this assuming that impedance corresponds to the entire current rather than only its visible part. This is the case if the dark current transforms to ordinary one in the measurement of the current-voltage frequency response.

    (c) These two phase transitions have electric *resp.* magnetic character and are could be seen as duals. The data about impedances of certain kind of coils suggests that these phase transitions occur pairwise at nearby frequencies ω_1 and ω_2] spanning a frequency range $[\omega_1, \omega_2]$ inside which the sign of the phase angle Φ between current and voltage remains constant. Even Φ is expected to be approximately constant for small enough values of resistance. The could be also seen as support for the proposal that resistance has maximum/minimum, which could be assigned with the proposed two kinds of phase transitions.

    (d) There is however a strong objection against this speculative line of thought. Complex circuitry can produce this kind of behaviors without any new physics. This is clear from the rules for the analytic expressions of the circuit parameters as one builds circuit from smaller circuits in parallel or in series. The phase transitions related to new physics should occur for strong electric fields above the threshold for dielectric breakdown. The peaky behavior however occur also for the impedances obtained using low input voltages (actually the only possible manner to determine impedance) so that poor resolution is the natural explanation for it.

4. Since the dark matter resonance could induce (quantum) phase transition and criticality, one expects that various physical observables are in general non-analytic functions of the dimensionless parameter $(\omega - \omega_0)/\omega_0$ near ω_0. This applies also to the phase transition to plasma phase. ω would be be analogous to temperature and ω_0 to a critical temperature. Whereas high temperature super conductivity is in finite temperature range, the dark phase would exist in the recent situation in finite frequency range around the resonance frequency (of course, also the temperature range could be finite).

5. Typically non-analytic sharp peaks involving functions u^m, where one has $u = |(\omega - \omega_0)/\omega_0|$ and m is so called critical exponent, appear. For $|Z|$ one expects have $m < 1$ meaning divergent and discontinuous derivative at ω_0. The sides of the curved "V" (possibly upside down) would be convex - in other worlds, the derivate would decrease in magnitude as one proceeds from the singularity outwards. Ordinary circuit theory predicts a smooth parabolic behavior $|Z| = \sqrt{R^2 + bu^2}$ for which "V" would be replaced with what looks like a bottom of a smooth potential well. For very small resistance R this situation looks in a non-optimal frequency resolution like $Z \simeq R + ku$ having discontinuous but *finite* derivative at ω_0. These

are very general qualitative predictions and easily testable using sufficiently high frequency resolution so that the local diffeo-invariants can be identified reliably.

6. It could quite well be that the resonances look like smooth parabolic peaks in good enough frequency resolution. This does not mean that the assignment of phase transition to the resonance is physically wrong. In TGD framework the notion of resolution is an essential part of the physical description and different length scale resolutions correspond to different sheets of many-sheeted space-time. At small space-time sheets the description in terms as ordinary resonances could quite well make sense. Of course, already the usual description of critical systems relies on the notion of resolution - in the recent case for frequency and the successes of the conformal field theory justify fully the notion of resolution.

TGD based view about high T_c superconductors provides additional insights about the situation.

1. Since charge carriers are concentrated at the surfaces of conductors, conductors are effectively 2-D systems and since quantum TGD itself describes a universe which is effectively 2-dimensional, 2-D conformal field theories with temperature replaced with frequency as an external parameter could provide a lot of theoretical information about the system both at criticality and in its vicinity. Of course, dark phase could also occur in finite temperature range as the properties of living matter suggest. One should of course test whether linearity is true or whether also amplitude of the oscillating voltage could a parameter analogous to the dimensionless parameter $(\omega - \omega_i)/\omega_i$ so that dark phase would exist also in voltage windows.

   By conformal invariance the observables are scaling covariant at criticality and various correlations functions behave in a simple manner at criticality being characterized by anomalous dimensions. In the vicinity of critical point various observables are simple power functions of $(\omega - \omega_i)/\omega_i$ characterized by critical exponents (`http://en.wikipedia.org/wiki/Critical_exponent`). The anomalous dimensions and critical exponents do not depend on the details of the system, and one characterize the system by its universality class near criticality.

2. In TGD inspired model of high T_c superconductivity the analog of percolation (say (liquid trickling through a porous material) (`http://en.wikipedia.org/wiki/Percolation_theory`) serves as a basic mechanism of high T_c superconductivity. Magnetic flux tubes with relatively small value of h_{eff} would be present and super-conducting but have short length. In the phase transition to super-conductivity the flux tubes would be scaled up in length and combine to longer ones corresponding to larger value of h_{eff} and supra currents would flow through the entire wire. In 2-D case the phase transition to percolation is believed to be describable by a 2-D conformal field theory.

   There exist rather detailed theoretical results about the behavior of the system at criticality and outside it and it might be possible to extrapolate these results to the recent case. One should be however very cautious since in TGD framework the view about renormalization group evolution crucial for the standard view about criticality is not quite the standard one.

3. Continuous coupling constant evolution having continuous scaling parameter as argument is in TGD framework replaced with a discrete evolution with discrete hierarchy of p-adic length scales replacing continuous scale. All physical states corresponds to fixed points of renormalization group for each p-adic length scale. 2-D conformal field theories indeed describe fixed points renormalization group which the effective 2-dimensionality of TGD Universe implied by strong form of holography and general coordinate invariance conforms with this. Various quantum criticalities differ only in the degree of criticality measured by the number of variables which are critical. In catastrophe theory the singularities of potential function provide a visualization of the situation: the simplest situation occurs with potential has extremum. A more critical situation occurs when also the matrix defined by the second derivatives of the potential function has vanishing determinant. This sequence can be continued indefinitely if the numbers of control parameters and behaviour variables are arbitrarily large.

What does this general picture imply in the recent situation? For instance, should one interpret the entire frequency range in which system is dark super-conductor as critical so that the standard thermodynamical picture assigning criticality only to the phase transition point would not apply as such in quantal situation. It seems that self-organized criticality is nearer to the TGD picture although the critical system is not attractor in the ordinary sense in TGD framework. State function reduction generates critical states and negentropic entanglement and Negentropy Maximization Principle guarantees their stability.

What would be remarkable is that the generation of dark matter phase would be directly measurable using standard measurements. For instance, one could study the frequency dependence of impedance for simple coils and transformers to see whether resonance involving minimum of frequency dependent resistance occur and whether they look like phase transitions - being peaked. If this is the case, one could study the properties of the system around resonance and try to identify further signatures for dark matter (say Josephson currents between turns of a coil). The conclusion is that it is better to be very cautious: the exotic phenomena are expected tro occur for very high voltages and electric fields for which linear circuit theory fails. Peaking however occurs for weak voltages so that they are probably due to poor resolution.

Could the arrow of time change in electric circuits?

The change of the arrow of geometric time means that dissipation as a loss of energy takes place in reversed time direction. Second law holds still but in a generalized form. In zero energy ontology (ZEO) the quantum jump sequence corresponds to a sequence of pairs of state function reductions to the opposite boundaries of causal diamonds (CDs) defined as intersections of future and past directed light-cones. The arrow of geometric time would change in each state function reduction since the state is prepared state at either boundary and de-localisation occurs at opposite boundary whose position (and thus the size of CD in quantum superposition) varies.

For large enough CDs the arrow of geometric time as perceived by an observer would remain constant. For short time scales characterizing CD the observer would interpret the change of the arrow of time as thermodynamical fluctuations. In living matter the change of the geometric arrow of time might take place continually. Italian theoretician Fantappie indeed suggested long time ago that this might be the case and introduced the notion of syntropy. Syntropy could be interpreted in TGD framework as time reversed counterpart of entropy [J103].

The reversal of the arrow of geometric time implies that the system becomes apparently an over unity system producing energy instead of dissipating it. Since dissipation power equals to $P = I^2/R$ in circuit theory, time reversal would imply a negative resistance. The concrete signature for the change of the arrow of time is that the magnitude of the phase angle between the current and voltage defined by the impedance would become larger than $\pi/2$.

There are indications for this kind of phenomenon in coil like systems. For instance, the measurements of inductance for a coil reported in the master thesis "Voltage distribution along reactor winding under very fast transients" by Salman Ejaz and Saeed Anwar (`http://publications.lib.chalmers.se/records/fulltext/171671/171671.pdf`) demonstrate this kind of effect (Figure 9) [H4]. The graphs of impedance demonstrates also the change of the sign of the phase angle as function of frequency suggesting interpretation as a time reversed resonance. The radical interpretation would be as a temporary change of the arrow of geometric time. Also over-unity effects have been reported - in particular by the free energy community.

The transition to time reversed situation occurs by state function reduction suggesting that it cannot be performed continuously. For a given CD one cannot change the arrow of time in a continuous manner by going through an intermediate frequency for which resistance vanishes. This conclusion does not hold true if the system decomposes a collection of CDs with different arrows of geometric time in the transition.

Skeptic can invent at least the following objections against this interpretation.

1. The system measuring the impedance does not work properly and gives phase whose magnitude exceeds $\pi/2$ predicted by the positivity of resistance.

2. The model of an electric component using LCR parameterization is only an effective description for a complex system which can involve also a generation of plasma phase meaning that

the coil is not anymore a closed system since charge carriers leak out. It can happen that the magnitude of the phase difference between current and voltage can become larger than $\pi/2$.

Could remote metabolism work for a Tesla coil acting as a capacitor?

The best manner to demonstrate new phenomenon is to generate it artificially. The previous considerations suggest a possible model for how artificial remote metabolism could be realized in terms of something akin to Tesla coil or magnifying transmitter. Bifilar coil (`http://en.wikipedia.org/wiki/Bifilar_coil`) looks like a promising realization of the coil. There are two options corresponding to the possibilities that the currents in the two components of bifilar coil runs in same or opposite directions. In the latter case, the magnetic field generated by the bifilar coil is very weak and coil acts as capacitor.

1. The secondary in Tesla transmitter acts as both inductance and capacitor. The alternating magnetic field associated with the inductance implies magnetic motor activity for topologically quantized magnetic field, and would make it ideal for developing reconnections with the flux tubes of a larger magnetic body providing via remote metabolism the energy and charge to the secondary acting as a capacitor. It is however essential that the strength of the magnetic field at the flux tube is same as that at the larger magnetic body.

2. The model for cold electricity in terms of dark matter suggests that when the voltage along bifilar coil exceeds critical voltage V_{cr}, it becomes charged and together with Earth forms a capacitor in voltage V_J defining Josephson potential for the resulting Josephson junction. A good guess for V_{cr} is $eVcr = m_e = .5$ MeV. V_J is rather high and above the critical voltage V_d for dielectric breakdown. The generation of charge is due to the "traffic jam" for electrons making also possible the phase transition to dark matter. If this picture is correct, Josephson currents do not appear below V_{cr} and coil or bifilar coil acting as a capacitor is necessary for the the remote metabolism. The constant part of voltage would make the resulting coil/capacitor hybrid analogous to cell membrane. Also DNA double strand could serve as a similar coil/capacitor-like system: now the traffic jam would correspond to the presence of two electron charges per nucleotide due to the attached phosphates expected to relate closely to metabolism and therefore also remote metabolism.

3. For general coils or bifilars for which the currents are parallel the transition to the dark phase would have measurable circuit theoretic correlates. The traffic jam for electrons would generate dark supra phase propagating along dark magnetic flux tubes. Only very weak ordinary magnetic fields are generated. Therefore the inductance in visible sector is very small and system becomes capacitive. The resonance like transitions from a situation in which the phase of the frequency dependent impedance $Z = R + i(\omega L - 1/(\omega C))$ (R, L and C depend on ω) characterizing physics in the visible sector suddenly changes sign and changes from almost $\pi/2$ to $-\pi/2$ could be seen as a measurable signature for the generation of dark Cooper pairs (cold currents of Tesla). Dark phases could appear in finite frequency ranges.

4. The interpretation in terms of the credit card mechanism would suggest that the resulting system is able to store energy at its magnetic body and also load it when needed - even from foreign magnetic body. The loading should be a spontaneous process and understandable in terms of the need to survive reducing to Negentropy Maximization Principle [K49]. Hence the system would in this respect act like a living system. Loading means the sending of negative energy signals to the magnetic body as phase conjugate Josephson photons. This involves also the change of the arrow of the imbedding space geometric time in the time scale defined by single cycle of the process. Macroscopic quantum phenomenon would therefore be in question.

9.5.6 Tesla's findings from a new viewpoint

Tesla's experiments with induction coils generated strong AC electric fields inducing charge separations leading to di-electric breakdowns through the surrounding air, kind of mini-lightnings. I have proposed that both real and mini-lightnings involve large h_{eff} phase making possible high

temperature super-conductivity along pairs of magnetic flux tubes forming possible U-shaped loops which reconnect with the target: this provides a model for high T_c superconductivity. There is evidence that electrons in lightnings travel to the surface of Earth with very low dissipation and also gamma rays are observed. These facts are not consistent with the standard physics models for lightnings since the dissipation in atmosphere does not allow these phenomena.

A concrete model for the Cooper pairs would be as pairs of electrons at neighboring tubes with magnetic fluxes which have same (opposite) directions. The presence of magnetic fields concentrated at flux tubes favors formation of $S = 1, L = 1$ Cooper pairs ($S = 0, L = 2$) Cooper pairs [K12, K78, K64].

To proceed one should try to find a more concrete model for the generation of large value of h_{eff} making possible super-conductivity.

How to understand the value of $heff$?

The basis problem is to understand how h_{eff} depends on the parameters characterizing the situation at the magnetic flux tube connecting two systems. I have considered several mechanisms for the generation of large h_{eff} phase.

1. The model for h_{eff} in systems involving charge separation stimulated by AC current was based on the identification of Josephson frequency with the frequency of AC current: $f_J = E_J/h_{eff} = f_{AC}$ predicting $h_{eff}/h = E_J/hf_{AC}$ [K111].

   The findings of Pollack and the difficulties to understand metabolic energy quantum of nominal value .5 eV in the simplest model for cell membrane as Josephson junction as Josephson energy for Cooper pair equalto to $ZeV = 10 - 10.6$ mV inspired the assumption that cyclotron energies at flux tubes traversing cell membrane can be different at the two sides of the cell membrane [K20, K64]. This would lead to a generalization of the notion of Josephson junction associated with the transmembrane protein and generalizes $f_J = f_{AC}$ to $\Delta f_c + f_J = f_A C$ predicting $h_{eff}/h = E_J/(h(\Delta f_c - f_{AC})$ so that h_{eff}/h would get arbitrarily large values near resonance $f_{AC} = f_C$. Note that correct sign requires $\Delta f_C - f_{AC} > 0$.

2. The conjecture $h_{eff} = h_{gr} = GMm/v_0$ could make sense at microscopic level for particle-Earth pair and would predict a universal spectrum of bio-photons if identified as resulting from the decays of dark cyclotron photons to bio-photons. The first guess for the parameter v_0 would be as a rotational velocity associated with the two systems such as Earth and electron rotating with it. In case of planetary orbits $v = v_0$ is not consistent with

$$\frac{v}{c} = \frac{\sqrt{\frac{v_0}{c}}}{4\pi n}$$

   following from Bohr rules in $1/r$ potential (n denotes the principal quantum number).

3. $h_{eff} = h_{em} = Z_1 Z_2 e^2/v_0$ hypothesis is a natural looking generalization in systems involve large charge separations, say the exclusion zones discovered by Pollack providing a model for prebiotic life forms. The philosophy would be that when the coupling strength between systems becomes so large that perturbation theory fails, the value of h_{eff} increases and makes perturbation theory is in powers of $1/h_{eff}$) possible again. At space-time level this means emergence of non-determinism so that 3-surfaces at the future and past boundaries of causal diamond are connected by n-branched space-time surface for which branches fuse at the two ends. Dark matter would be Nature's manner to define what non-perturbative phases are. The strong hypothesis $h_{eff} = h_{em} = h_{gr}$ might make possible reconnection between em and gravimagnetic flux tubes and ATP synthase is here a candidate system.

4. Rotating magnetic systems with high negative charge are also good candidates for generating large h_{eff} at the magnetic flux tubes possibly contain dark proton sequences identifiable as dark nuclei. I have also proposed that a system subject to constant torque allowing description in terms of potential function which is multivalued as function of the angle coordinate ϕ leads rather naturally to generation of large h_{eff} [K40] when one requires internal consistency.

Could dark electrons or protons at magnetic flux tubes serve as current carriers?

There are clearly many options for h_{eff} to choose if one wants to model Tesla's findings. Some options are characterized by AC frequency and some options by rotation velocity. The electrons in the secondary Tesla coil were believed to get stuck which one could take to mean that ohmic AC current does not flow anymore. If this really occurs electrons do not carry any current and high negative local charge density is generated.

One can consider several mechanisms for the super-conductivity.

1. Some fraction of electrons flows as dark Cooper pairs along magnetic flux tubes. The members of the Cooper pair could reside at the flux tubes of the approximately dipolar magnetic field located in the interior of the coil and and at the exterior of the coil near its surface and carrying magnetic fluxes in opposite direction. The interaction of spin with magnetic field usually tends to disrupt the Cooper pair but not it stabilizes it. One can consider several guesses for the value of h_{eff} since AC current is in question.

2. If the notion of exclusion zone makes sense also for more general systems than water, one might guess that perhaps dark magnetic flux tubes carrying dark protonic currents along them are generated. The objection is that water is not present now and this option works only if there is source of protons. This option does not look very promising now.

Second challenge is to identify candidates for the supra currents and Josephson currents possibly appearing in the system.

1. Mini-lightnings carrying supra currents could form when U-shaped flux tubes from the secondary coil reconnect with "ground" and dark supra current flows along them. The formula $h_{eff} = Z_1 Z_2 e^2 / v_0$ or even $h_{gr} = M_E m(pair)/v_0$, v_0 rotational velocity of Earth, suggests itself now. Z_2 could be the charge $2e$ of the Cooper pair and Z_2 could be assigned with ground as charge reservoir.

2. One can also consider Josephson currents flowing along flux tube pairs associated with the time-dependent dipole magnetic field accompanying the coil. They would replace the Ohmic AC currents when electrons are "stuck". Josephson frequency would co-incide with AC frequency.

In the case of Josephson current the problem seems to be that the voltage defining Josephson frequency varies periodically as also the magnetic field for AC current. The sticking of Ohmic charge is however expected to destroy AC current so that one would obtain static voltage if ohmic DC current runs through the coil. Thus DC current seems to be necessary.

Static magnetic fields are also necessary for high T_c super-conductivity. They are achieved if the AC component of the Ohmic current becomes small or vanishing. In Maxwell's ED also also a small DC current present unless the coil contains ferromagnet. In TGD Universe it is also possible that a magnetic field with flux tubes carrying monopole flux requiring no DC current is is generated. This kind of monopole magnetic fields could be responsible for the magnetic fields encountered in cosmology and astrophysics (the observed fields are 11 orders of magnitude stronger than the predicted) and could also appear in superconductors and even in ferromagnets.

In this situation the formula $h_{eff}/h = E_J/h f_{AC}$ would state that the coil acts as a generalized Josephson junction with AC current replaced with Josephson current with $f_J = E_J/h_{eff} = f_{AC}$. The formula $h_{eff}/h = E_J/(h(\Delta f_c - f_{AC})$ would require that the magnetic field strengths at the ends of coil are different so that also the cyclotron frequencies are different. AC frequency would be equal to the generalized Josephson frequency: $f_{AC} = \Delta f_c - E_J/h_{eff}$. In this case one can consider even the possibility that there is no DC current so that one has $f_{AC} = \Delta f_c$. This fixes the increment ΔB for the magnetic field.

Part III

REMOTE MENTAL INTERACTIONS

Chapter 10

TGD inspired view about remote mental interactions and paranormal

10.1 Introduction

The latest TGD inspired articles related to quantum biology, quantum mind, and remote mental interactions were published in JNLRMI around 2003. Several new ideas related to basic TGD, TGD inspired quantum biology and theory of consciousness have emerged during the subsequent 8 years. The article *Evolution of TGD* [L25] provides a short summary about the development of idea. The general vision is that both biology, consciousness, and remote mental interactions and related phenomena labelled as paranormal are predicted to share the same basic mechanisms, and that the proposed vision provides basic concepts and the language allowing to speculate and build simple models. One cannot of course take the proposed models too seriously at the level of details.

My original intention was to write just single article trying to give a summary about the progress of quantum TGD first and after that I will discuss the implications for quantum TGD based view about biology, consciousness and remote mental interactions and related mysteries. It however turned out that book would provide a more concise a more approrpriate manner to represent the overall view. One cannot of course take the proposed models too seriously at the level of details.

This is the the first part of an article devoted to remote mental interactions.In the first part of the article I will summarize the new ideas that have emerged since 2003, the basic problems and basic ideas, and what parapychological phenomena are at general level. The is also a more detailed representation at my homepage [K110] as a chapter of a book.

In the second part of the article I will discuss some applications of the basic vision. The notion of conscious hologram is discussed from the point of view of remote mental interactions. The notion of magnetic body is in decisive role as it is also in the understanding of quantum biology in TGD framework.

TGD inspired model for OBEs relying on the notion of magnetic body is summarized. The idea is that OBEs could correspond to sensory experiences assignable to magnetic body rather than real body. Also the connections with the work of other researchers, such as Shnoll, Persinger, and Tiller are discussed briefly. The challenge of testing the vision is also considered.

The appendix of the book gives a summary about basic concepts of TGD with illustrations. There are concept maps about topics related to the contents of the chapter prepared using CMAP realized as html files. Links to all CMAP files can be found at `http://www.tgdtheory.fi/cmaphtml.html` [L35]. Pdf representation of same files serving as a kind of glossary can be found at `http://www.tgdtheory.fi/tgdglossary.pdf` [L36]. The topics relevant to this chapter are given by the following list.

- Magnetic body [L52]

- Basic Mechanisms associated with magnetic body [L39]

- Hierarchy of Planck constants [L50]

- Negentropy Maximization Principle [L54]

- Quantum model for nerve pulse [L62]

- Quantum model for sensory perception [L63]

- Quantum model for sensory receptor [L64]

- Quantum model of EEG [L65]

- Bio-anomalies [L41]

- Biophotons [L42]

- Cell membrane anomalies [L44]

- DC currents of Becker [L46]

- ELF effects on brain [L47]

- Microtubules [L53]

- Pollack's observations [L56]

- Quantum antenna hypothesis [L58]

- Quantum gravity and biology [L60]

10.2 Brief summary of the basic vision around 2003 compared with the recent situation

To get perspective it is perhaps good to briefly summarize the basic vision about TGD inspired model for biology and consciousness as it was around 2003 according to the articles published in JNLRMI. The recent view about TGD inspired theory of consciousness is described in the chapter of the book "TGD Inspired Theory of Consciousness" [K47]. The general vision was that both biology, consciousness, and remote mental interactions and related phenomena labelled as paranormal are predicted to share the same basic mechanisms, and that the proposed vision provides basic concepts and the language allowing to speculate and build simple models. One cannot of course take the proposed models too seriously at the level of details.

Several new ideas and concepts have emerged since 2003.

The most important ones are following.

1. ZEO giving justification for notions like negative energy photons propagating to the geometric past and the notion of causal diamond (CD) providing imbedding space correlate for the notion of self and predicting a hierarchy of fundamental time scales and predicting a connection between biology and elementary particle physics.

2. Hierarchy of Planck constants [K24] giving rise to phases behaving as dark matter and suggesting the identification of living matter as ordinary matter controlled by dark matter in this sense.

3. The identification of ATP as a correlate of negentropic entanglement and information theoretic interpretation of metabolism [K39].

10.2.1 TGD inspired theory of consciousness

The article *TGD inspired theory of consciousness and biosystems as macroscopic quantum system* [L5] describes the basic assumptions and ideas TGD inspired theory of consciousness and of quantum biology. The basic vision is essentially now although some simplification has taken place and the picture has become more detailed.

1. TGD inspired theory of consciousness can be regarded as an extension of quantum measurement theory by raising the observer from a status of something external to the Universe able to only induce state function reductions (in von Neumann's view) to something described by quantum physics. The crucial almost paradox like problem is the conflict between the determinism of Schrödinger equation and non-determinism of state function reduction. Similar closely related problems relate to the relationship between experienced time and the geometric time of physicist. Whatever the theory of consciousness is, it must solve these problems.

2. Quantum jump as a moment consciousness, self as sequence of quantum jumps somehow integrating to a flow of consciousness, self hierarchy, and the identification of sub-selves as mental images of self, represent the basic identifications. It seems possible to reduce self hierarchy to a hierarchy of quantum jumps: higher levels of self hierarchy would be analogous to bound states of elementary particles and self hierarchy would relate closely to the corresponding hierarchy at the level of physics.

3. Quantum classical correspondence requires space-time correlates for selves. Space-time sheets are natural correlates of selves at space-time level. At imbedding space level so called causal diamonds CDs) introduced after 2003 in the context of zero energy ontology define this correlates. At the level of "world of classical worlds" (WCW) the correlate is sub-WCW assignable to the CD.

   The notion of many-sheeted space-time forces to modify the notion of sub-system. Flux tubes connecting space-time sheets are natural correlates for entanglement. It is possible for space-time sheets without flux tube connections to contain topologically condensed space-time sheets which are connected by flux tubes although space-time sheets. This would correspond to a situation in which two selves are un-entangled but possess sub-selves which are entangled. The notion of finite length scale resolution is essential for this definition to make sense. This leads to the idea about sharing of mental images by quantum entanglement producing what might be called stereo consciousness.

4. The possibility of quantum jumps and state function reductions occurring in quantum parallel manner is also something new and also relates to the many-sheeted space-time: see the article *Biosystems as macroscopic quantum systems* [L1]. The quantum jumps taking place at the scales of sub-selves and their sub-selves could give rise to the experience of a flow of subjective time. One must be however very cautious with this concept: it is not possible to be conscious about not being conscious so that continuous flow of subjective time might be an illusion perhaps created by the model of self as a continuous narrative. At the fundamental level there might not be continuous narrative. Already dreams represent states of consciousness in which this narrative is only piecewise continuous.

5. The identification of quantum jump as relating entire deterministic *quantum histories* as analogs of solutions of Schrödinger equation solves the problems related to the conflict of non-determinism of state function reduction and determinism of Schrödinger equation and classical field equations which in TGD framework define an exact part of quantum theory. Quantum measurement theory involves also the notion of classical variables. These can be identified as zero modes which by definition do not contribute to the metric of WCW and are therefore not quantum fluctuating variables. The entanglement between zero modes and quantum fluctuating degrees of freedom must be fundamental element of state function reduction and also sensory perception and conscious choice.

6. p-Adic physics as physics of cognition and intentionality [K53] is a central element of this picture and forces a generalization of number concept. Reals and p-adic numbers characterized by prime $p = 2, 3, 5, ...$ are completions of rationals and one can glued reals and p-adic

numbers and their extensions along rationals and common algebraics to form a book like structure. The notion of adele - well-known to mathematicians - seems to catche quite well this vision [K105].

7. *Negentropy Maximization Principle* (NMP) [K49] defines the basic variational principle of TGD inspired theory of consciousness and states that the gain of conscious information in quantum jump is maximal. There are variants of NMP depending on what one means with quantum theory.

   (a) For the ordinary definition of entanglement entropy this means that the two systems involved become un-entangled. Interpreting the density matrix as fundamental observable this gives standard quantum measurement theory.

   (b) The introduction of hyper-finite factors of type II_1 strongly suggests by the fact that WCW spinors correspond to this kind of von Neumann algebras leads to a further modification of measurement theory since state function reduction to a one-dimensional ray of Hilbert space is not possible in general but always happens to an infinite-dimensional sub-space (in the ordinary sense of the word). The state spaces can of course contain factors of type I for which ordinary measurement theory applies.

   (c) For rational or even algebraic entanglement coefficients the entanglement entropy can be defined using p-adic norm for some p-adic prime p and can be negative and always is for certain primes p. Entanglement would carry genuine information and is expected to be stable under NMP. This leads to the vision about negentropic entanglement as a basic characteristic of living systems.

   At space-time level one can also say that the - in general discrete- intersections of real and p-adic partonic 2-surfaces consisting of rational (or more generally, points in some extension of rationals) defined cognitive representations in the intersection of cognition and matter. This discretization would directly correspond to the fact that all cognitive representations have finite resolution and are necessarily discrete: computation represents a basic example of this. At more abstract level the partonic 2-surfaces represented by algebraic equations making sense both in real and p-adic sense can be said to belong to the intersection of matter and cognition and represent living systems. Quite surprisingly, the art of algebraic geometry which typically involves counting the numbers of rational points of algebraic surfaces would directly relate to fundamental biology!

The basic implication of this vision is the necessity to re-consider the existing views about the relationship between subject and geometric time. I summarized the ideas about time as they were around 2003 in the article *Time, space-time, and consciousness* [L6]. There were several poorly understood issues and some of these issues are still far from well understood.

1. What is the precise relationship between geometric time and experienced time? How the experience about continuous flow of time emerges? (Is it an illusion: one cannot be conscious about being not conscious, dark moments of visual perception). What induces the arrow of psychological time inducing the apparent arrow of geometric time? Why the contents of sensory experience are restricted to so narrow a time interva whereas the contents of memory come from much larger space-time region. Note that the interpretation of the correlate of self as 4-D space-time regions provides a new vision about memory.

2. In the article *TGD inspired theory of consciousness* time-like entanglement and signals proceeding in the reversed direction of time was suggested to provide the basic mechanism of memory, intentional action, and (remote) metabolism. Libet's paradoxical findings about strange time delays of consciousness provide the basic support for this vision. The challenge is to give a more precise mathematical content for the notion of negative energy signal propagating backwards in time. Phase conjugate laser wave was proposed as its physical analog. The basic question is to understand how the arrow of geometric time emerges so that one can use these terms.

In TGD framework the notion of many-sheeted space-time challenges the notion of subsystem. One must also give a more precise mathematical content to the notions of U-process, state function reduction, and state preparation.

1. Quantum jump should consist of unitary process characterized by a unitary matrix U followed by a state function reduction in turn followed by state preparation. State function reduction should be a cascade like process proceeding from top to bottom as a splitting of systems to pairs of unentangled subsystems until negentropic or bound state character of entanglement does not allow splitting anymore [K49]. The identification of hte unitary process U and U-matrix remained however open questions at that time. ZEO leads to a rather detailed minimal vision about what happens in quantum jump [K6].

2. What happens in quantum measurement? Non-quantum fluctuating zero modes of "world of classical worlds" (WCW) correspond to classical degrees of freedom in TGD and are excellent candidates for classical variables of quantum measurement - such as direction of the point of some "meter". With these zero modes quantum fluctuating degrees of freedom must entangle before state function reduction and measurement must induce state function reduction eliminating entanglement unless it is negentropic. Does state function reduction follow from macroscopic character of zero modes in the sense that there would be analogy with spontaneous magnetization which also selects single direction of magnetization rather than their quantum superposition.

   And what is the role of cognition interpreted in terms of p-adic space-time sheets? Is p-adic-real algebraic entanglement carrying negentropy involved? At what level the state function reduction inducing a sequence of state function reductions in the sequence of entangled systems does take place: does the primary reduction take place at the level of cognition?

   Ther answers to these questions are still more or less guess work.

10.2.2 TGD inspired quantum biology

Many ideas about basic mechanisms of quantum biology already existed around 2003. Mention only the notion of magnetic body and the hypothesis that living matter resides in the intersection of real and p-adic worlds implying that negentropic entanglement(see fig. `http://www.tgdtheory.fi/appfigures/cat.jpg` or fig. 21 in the appendix of this book) is a fundamental characteristic of living matter.

The assumption that living matter is ordinary matter controlled by dark matter - identified as a hierarchy of macroscopic quantum phases labeled by the value of Planck constant coming as integer multiples of ordinary Planck constant - has allowed to find a more detailed formulation for these intuitive ideas. The alert reader has perhaps noticed that the hierarchy of Planck constants and negentropic entanglement seem to provide two different manners to realize macroscopic quantum coherence. Are these two realizations independent of each other and if not, how do they relate to each other? This remains an open question to high extent.

1. High T_c super-conductivity was assumed to play a key role in living matter but the precise mechanism of super-conductivity was poorly understand. For the views at that time see the articles *Biosystems as macroscopic quantum systems* [L1] and *Quantum model for sensory receptor* [L4].

   A detailed model for high T_c bio-super-conductivity was however lacking. The hierarchy of Planck constants allows to construct this kind of model [K12, K13] applying also in the case of ordinary condensed matter systems. Rather remariably, dark electrons at magnetic flux tubes play a key role in this model. Also negentropic entanglement could stabilize Cooper pairs.

   Another new element not present at the time of writing of these articles is the new physics model of cell membrane as almost vacuum extremal of Kähler action [K32] motivated by quantum criticality and the expectation that large values of Planck constant correspond to almost vacuum extremals if one accepts the TGD based explanation for the hierarchy of Planck constants as a result of dynamics rather than something fundamental. It must

be emphasized that the existing high precision determinations of Planck constant do not exclude the hierarchy since they do not detect dark matter. This leads to a picture about cell membrane as an analog of computer monitor with lipids representing pixels to which one can attach various qualia. These qualia need not however correspond ours which are assigned to sensory receptors.

2. In the article *Manysheeted DNA* [L2] several ideas related to DNA were discussed.

    (a) Homeostasis in many-sheeted space-time roughly states that supra currents at super-conducting space-time sheets determine the dynamical equilibria also at the space-time sheets containing ordinary matter. The strange findings about the behavior of cell membrane ionic currents support this hypothesis (they are quantal and flow even in absence of metabolic energy feed suggeseting that Josephson currents are in question).

    (b) Quantum spin glass degeneracy generalizing ordinary 3-D spin glass degeneracy to 4-D one meaning that strict determinism breaks down to piecewise one. Hence not only quantum states but also quantum jump sequences and therefore conscious experiences should have space-time correlates. These correlates would relate to conscious experience like written text to conscious thoughts and would provide a kind of feedback essential for symbolic memory. 4-D spin glass degeneracy provides also a justification for the hierarchy of Planck constants.

    (c) A further key idea was healing by time reversal. The idea is that the reversal of the arrow of geometric time implies that second law holds in opposite direction of geometric time so that basically entropic process looks like negentropic one. Also the notion of magnetic mirror, topological self-referentiality, the identification of information molecules as quantum links in quantum web, the idea about molecular recognition mechanisms, the connection between metabolism and generation of quantum coherent states, scaling law of homeopathy were further ideas discussed in the article.

    The developments since 2003 have enriched this picture with several new ideas.

    (a) ZEO and the notion of CD allow to assign the arrow of geometric time directly to the zero energy states rather than their dynamics. Dark matter as a hierarchy of phases with large value of Planck constant can be identified as controller of ordinary matter in living systems, and negentropic entanglement assumed to have ATP as a correlate allow to a more detailed articulation of these ideas.

    (b) The idea about DNA as topological quantum computer [K23] with braids realized as magnetic flux tubes connecting DNA nucleotides with lipids of cell membrane is another key idea and means that DNA becomes the hardware of quantum computations with software represented by the braidings of flux tubes.

3. The article Macrotemporal quantum coherence, quantum spin glass degeneracy, and number theoretic information concept [L8] described the vision about living matter as a macroscopic quantum system. The notion of negentropic entanglement and the idea about life as islands of rationality in the oceans of real and p-adic continua was described already in this article.

4. The article *Biosystems as conscious holograms* [L7] develops the idea about living matter as conscious hologram. One of the key mechanisms was time mirror mechanism (see fig. http://www.tgdtheory.fi/appfigures/timemirror.jpg or fig. 24 in the appendix of this book) finding a justification in ZEO. A model of remote mental interactions and an model inspired by the findings of William Tiller was proposed with key role played by the notion of magnetic body able to receive information from and control even in-animate matter. ZEO provides first principle justification for the time mirror mechanism.

    The vision was applied to develop a model of bio-photons. The model of cell membrane as almost vacuum extremal, which emerged later, led to a radical proposal: bio-photons are nothing but large $\hbar$ EEG photons which have suffered an energy conserving phase transition reducing the value of Planck constant to ordinary one.

5. The article *Quantum model for nerve pulse, EEG, and ZEG* [L3] describes a TGD inspired view about nerve pulse and EEG. I would not speak about *ZEG* in the title now since the status of Z^0 radiation fields is still uncertain (classical Z^0 fields are however in an essential role in the model of cell membrane and sensory receptor).

Electronic super-conductivity and possibly super-conducting states assignable to biologically important ions are key elements of the model but the model of electronic super-conductivity was not convincing: it was assumed that super-conducting space-time sheets are at very low temperature. The model of electronic super-conductivity was not too convincing at that time and considerable progress has taken place with the advent of the hierarchy of Planck constants [K12, K13].

In case of biologically important ions it had already become clear that TGD inspired nuclear physics [L10] allows fermionic nuclei with given charge to have bosonic companions with the same charge and therefore same chemistry. This would make possible to assign Bose-Einstein condensates and super-conductivity even to atoms which are chemically equivalent with fermionic atoms.

EEG and its possible variants were identified as communications and control tools mediating sensory information to the magnetic body and allowing magnetic body to quantum control biological body. This means the presence of a completely new level in biological information processing. Again the hierarchy of Planck constants plays a key role in making possible for ELF photons with extremely small energy to have energies which are above thermal energy and thus have biological effects and carry information [K20, K69].

The aim of this chapter is to describe in some detail the recent view about remote mental interactions. Also connections with the work of other researchers are summarized.

10.3 Basic questions and basic ideas

The basic ideas of TGD inspired model for remote mental interactions and related phenomena such as OBEs and near death experiences are summarized in the chapters *Quantum model for paranormal phenomena* [K67] and *TGD based model for OBEs* [K87] of the book "TGD Inspired Theory of Consciousness". Also the chapter *Bio-systems as conscious holograms* [K10] contains a summary of a model for how conscious hologram might allow to understand remote mental interactions, and TGD based view about the work of Willian Tiller related to intentional imprinting. The chapter contains also a section about bio-photons: there could be a connection with remote mental interactions since bio-photons could result from the transformation of large $\hbar$ dark photons by a phase transition reducing the value of Planck constant, which in turn would be essential for communications between biological body and magnetic body.

I have not worked with this topic during last years, and I apologize for my very restricted views. The most important new ideas relate to the notion of magnetic body, ZEO, negentropic entanglement, and dark matter hierarchy. It would be be interesting to deduce explicitly the implications of new ideas that have emerged since 2003 but the following discussion is just a commentary.

10.3.1 Basic questions

The general idea is that remote mental interactions are by no means paranormal in the sense that they would be in conflict with well-established laws of physics, as skeptics want to see them. Our personal magnetic bodies apply remote mental interactions to receive communications from biological body and to control it routine. Remote mental interactions having living matter as a target would correspond to a situation in which the personal magnetic body of operator is able to receive information from the biological body of target or control it. Becoming possessed would be one manner to say this. Hypnosis would represent the basic example of this. The target could be also water perhaps containing some organic matter as in Tiller's experiments. Also psychokinesis acting on inanimate targets such as computers can be considered but in this case the mechanisms of remote mental interaction cannot be quite same as in the case of biological targets.

The basic question is why the remote mental interactions having living target are so rare if they apply same mechanisms as living matter in general. A possible reason is that living matter has developed an immune system preventing the situation in which the organism becomes possessed. This would be very similar to what has taken place in the evolution of computers. The restriction of communication windows to narrow frequency ranges depending on species and even individual, and the counterparts of passwords realized as temporal field patterns could make this kind of immune system possible. Cyclotron frequencies would be central here and hierarchy of Planck constant would allow arbitrary low frequencies with energies below thermal energies at physiological temperature range. The first guess is that passwords using genetic code so that communications restricted to those occurring between the members of the same species become possible. The challenge is to invent plausible physical realizations for the passwords. One possible proposal inspired by the experiments of Gariaev and collaborators would realize the values of bit as two orthogonal photon polarization directions. Another realization would be in terms of a collection of frequencies interacting resonantly with the target DNA and inducing gene expression: no explicit knowledge of address of the target would be needed.

Second basis problem in many remote mental interactions such as the intentional effect on random number generator is "Who knows how?". How the mere intent can be transformed to action without any knowledge about the details of the action? The attempt to understand how neuro-feedback affect the behavior of single neuron leads to the same question.

1. Magnetic mirrors make possible also feedback and this feedback could make possible learning. For instance, in psychokinesis (especially so in micro PK), this learning would be crucial and analogous to that what occurs when we learn to drive a car. In healing this kind of feedback might help to find the healing frequency by trial and error.

2. It is quite possible that also multi-brained and -bodied higher level collective selves actively participate in the process as a third party such that the remote mental interactions would act as a relay states. I have suggested similar explanation for Sheldrake's findings about learning at the level of species and Tiller's findings about the "transfer of intent". This could make possible coherent amplification effects (TEM, prayer groups) and could make available information resources of all brains involved with the group. This could for instance explain the ability of a remote viewer to see an object on basis of data which need not have any meaning for her.

3. A fast amplitude modulation of alpha waves introducing higher harmonics to the carrier wave is a good candidate for mediating communication between brains and higher level multi-brained selves. Mesoscopic 'features' in brain involve precisely this kind of amplitude modulation and might represent just this kind of messages. Interestingly, also speech is produced by a fast amplitude modulation of 10 Hz basic vibration frequency of speech organs (assignable to electron CD as a fundamental frequency) and kHz (quarks) frequency is a special frequency from the point of view of hearing.

Third key question relates to the metabolic aspects of remote mental interactions. One expects that negentropic entanglement between operator and target is involved. The hypothesis about the presence of ATP molecule at the magnetic flux tube connecting operator and target as a prerequisite for negentropic entanglement would reduce the energetics of remote mental interactions to basic metabolism. This allows to make quite strong conclusions about the character of these interactions. Here one must however remember that earlier model assumed much more general mechanism of metabolism involving transfer of particles to larger space-time sheets liberating or using zero point kinetic energy in this manner. It could be part of $ATP \leftrightarrow ADP$ mechanism or completely independent mechanism utilized by the prebiotic metabolism. It could be also involved with the remote mental interactions for which targets are in-animate.

Fourth question relates to mechanisms and here time mirror mechanism involving sending of negative energy photons to geometric past is the natural candidate for both intentional action, remote metabolism, and memory. Also its counterpart involving sending of positive energy signals to future can be considered. It must be emphasized that the reflection need not always occur. The negative energy photon could be just absorbed without any signal generated and this leads to ask what happens in the case of memory.

10.3.2   Key ideas of the TGD inspired model of remote mental interactions

During years a rather concrete TGD inspired model of remote mental interactions has developed.

1. The basic notions of the TGD inspired model are magnetic body as an intentional agent controlling biological body and receiving data from living body or even "dead" matter system with massless extremals (MEs) mediating these communications, zero energy ontology and the related notion of causal diamond (CD) serving as an imbedding space correlate of self and assigning to elementary particles fundamental macroscopic time and length scales as those of CD, the hierarchy of Planck constants making possible macroscopic quantum phases and zoom-ups of quantum systems, and the vision about living matter as something residing in the intersection of real and p-adic worlds and the closely related notion of negentropic entanglement crucial for the functioning of living matter and conscious intelligence in TGD Universe. Note that this means that life corresponds to number theoretical quantum criticality in a well-defined sense.

2. Zero energy ontology means a radical departure from standard physics. The creation of zero energy states from vacuum is possible and means that in principle (just in principle!) the claims of parapsychologists about ectoplasm and of yogis about the possibility to create of matter from nothing are consistent with the basic conservation laws of physics. In TGD inspired biology this process could take place routinely. Causal diamond is the imbedding space correlate for the zero energy state. Positive and negative energy parts of the state reside at its boundaries. p-Adic length scale hypothesis and number theoretical vision suggest that the proper time distance between the tips of CD comes as powers of two. For electron and quarks playing key role in the model of DNA as topological quantum computer this temporal distance would correspond .1 seconds and 1 millisecond respectively suggesting a direct connection between elementary particle physics and basic bio-rhythms.

   The translates and Lorentz transforms of CDs are also CDs and one can assign to CDs a moduli space further expanded by the introduction of the hierarchy of Planck constants. One expects that this moduli space is crucial for understanding of the geometric qualia [K68] . The communications between sub-selves would be naturall based on resonance. CDs are characterized by resonance frequencies which in the rest system of CD come as harmonics of the fundamental frequency determined by the proper time distance. This would allow a universal coding of geometric data using frequencies. Both MEs and CDs could be regarded as being analogous to music instruments and this in fact explains basic facts about music experience. These resonance frequencies should play a key role in biology and also in remote mental interactions- even those in which target consists of "dead" matter since fundamental biorhythms characterize also elementary particles in TGD Universe.

3. p-Adic physics as physics of cognition and intentionality is an essential element of approach. Intentions are represented as p-adic space-time sheets. In the intersection of real and p-adic worlds these space-time sheets have a mathematical representation making sense also in real context so that one can say that these surfaces are in the intersection of real and p-adic worlds and the phase transitions transforming surfaces belonging to different number fields are possible. This makes possible transformation of intentions to actions and their reversals possible in the intersection of real and p-adic worlds. U-matrix indeed makes indeed sense also for transformation representing the transformation of say p-adic space-time surface to a real one and is coded only by data assignable to the rational and common algebraic points of real and p-adic variants of partonic 2-surface [K49] . Note that zero energy ontology makes possible also the transformation of intentions to actions as p-adic-to-real phase transitions without breaking of the conservation laws.

4. Negentropic entanglement, which can be both space-like and time-like in zero energy ontology, makes possible quantum superposition of macroscopically different configurations of the target system correlated with the states of operator system. The operator should be able to achieve the negentropic entanglement and intentionally increase the amplitude of the desired outcome in this superposition. Negentropic entanglement need not involve binding energy

and I have proposed this as a deeper level explanation for the nebulous notion of high energy phosphate bond crucial for metabolism in living matter. Quite generally, negentropic entanglement would make possible for the operator to transfer metabolic energy and momentum to the target. Remote healing involves often positive emotions like compassion and love suggesting that negentropic entanglement accompanies healing process. The hierarchy of values of Planck constant would make possible this process in long time and length scales.

5. Addressing of the target is key problem in remote mental interactions. Here password consisting of a collection of frequencies interacting resonantly with the DNA of living target and inducing remote gene expression dictated by the frequencies is one possibility. Gariaev's findings that scattering of red laser beam from DNA generates broad band of frequencies, which are biologically active, could be interpreted in this model. The photons would correspond to the same energy but wide range of frequencies corresponding to different values of Planck constant. These frequencies would define the address of the target, eventually some part of DNA inducing gene expression. The interaction would be by the superposition of the electric field of incoming radiation with the electric field of flux tube inducing the analog of Becker's healing current in turn loading metabolic resources and generating negentropic entanglement and also gene expression.

6. The notion of hologram is often used as a useful metaphor: Gariaev talks about DNA hologram and I have talked about conscious hologram. This notion obviously requires more detailed definition to be testable. What hologram does is that scattering of laser beam from it is effectively scattering from target. Magnetic flux tubes make TGD Universe an Indra's net: could it be that the scattering from object behaving like bio-hologram could actually take place from the target which it represents! Photons would travel from object to the target along flux tubes, scatter, and arrive along flux tubes and leave the object. The object, which actually acts as a relay station, would define pseudo-hologram. Also frequency coding of the address could be combined with this picture if the lengths of flux tubes are multiples of wavelength (proportional for Planck constant).

10.3.3 Some examples of remote mental interactions interpreted in TGD framework

Some examples about remote mental interactions with living target are in order.

1. In telepathy the communications from biological body of target would be based on EEG and its scaled analogs. Also ECG could be involved. In TGD Universe even electromagnetic field might by replaced with electroweak and color field below some scale in scale hierarchy defined by Planck constants.

2. In hypnosis magnetic body of operator would control the biological body of the target, which would be "possessed" and behave like a part of the biological body of operator.

3. It would be also possible to share sensory percepts and memories of the living target. The mechanism would be time mirror mechanism applying also to ordinary memory and sensory perception.

In the case of in-animate targets the modelling is not so straightforward. One could however assume that also now negentropic entanglement is involved and that the ATP of the operator is used. Note however the possibility of the more general mechanism at the end of the target.

1. In psychokinesis with inanimate target negentropic entanglement would be mediated by flux tubes containing ATP assignable to the operator. The metabolic energy of ATP of operator is transferred to the target. The increase in the rate of metabolism could therefore serve as a signature.

2. In the remote mental interaction with computer the intention is to affect the pattern of random numbers and the mere transfer of metabolic energy is not enough since the effect must also have a correct sign. The net effect is the change of the distribution of random

numbers from expected and Tiller observes strange periodicities in the distribution. It seems that remote mental interaction must be able to affect the probabilities of the outcome so that they are not identical as randomness would require. What could be the mechanism? Direct entanglement with the representation of bits is not plausible. While writing this article it occurred to me that there might be a connection with the model for Shnoll effect [K5] which I developed for a couple of years ago and based on a deformation of probability distributions based on p-adic mathematics and quantum groups. What is remarkable is that the parameters characterizing statistical distributions vary slowly with periodicities assignable to the gravitational fields in solar system. Could it be that also the statistical effects of intentional action could be characterized by the same mathematics leading to purely number theoretical predictions? This will be discussed in more detail below.

3. In the intentional imprinting of Tiller creation of flux tubes connecting the magnetic body of operator and non-living target would take place. Intentional action induces changes such as change of pH and this could rely energetically on the use of ATP. Magnetic fields should be important and cyclotron frequencies might be important. When a sequence of random bits is used, periodicities with cyclotron frequencies are suggestive supporting the hypothesis involving magnetic flux tubes and Shnoll effect.

4. What could be the mechanism in the case of remote viewing? Magnetic body should receive from the target extrasensory input generating sensory percepts or more abstract cognitive mental images such abstract shape. Could the signal arrive from the target to the magnetic body of operator and therefrom to the biological body - maybe brain - of the operator to create genuine sensory percept? To have a genuine sensory percept back-projection to sensory organs is necessary and in TGD based model for sensory qualia the back projections to sensory organs are in a central role: the virtual world sensory input from brain and possibly from magnetic body to sensory organs used to build standardized mental images. Or is there any creation of sensory percept?

5. In the case of precognition the situation is not at all clear. In ZEO based vision the simplest view is that the "upper" light-like boundary of CD corresponds to the seat of sensory percepts realized as mental images. Memories would correspond to information arriving from the geometric past inside CD. Precognition would mean receiving information from the geometric future of CD. Is this possible? How this would be realized. The vision about generalized Feynman diagrams suggests that given CD surrounds a vertex of generalized Feynman diagram in certain scale and that larger CDs are present and precognition would involve time reversed signals at the level of next CD. There presence of larger CD and longer time scale would mean that prophets are indeed "messengers of Gods".

Why we do not remember the geometric future. Is the reason that the contents of conscious experience is about the boundary of CD which performs the state function reduction.

10.4 Parapsychological phenomena

In this section various parapsychological phenomena are discussed in the general framework introduced in the previous section.

10.4.1 Extrasensory perception, precognition, and other parapsychic effects

The general model for paranormal effects relies on same basic ideas as the model of quantum biology.

1. The transformation of p-adic [K53] space-time sheets makes possible the transformation of intentions to actions. Since p-adic space-time sheets have literally infinite size in real sense, distance does not matter. The set of points in the intersection of p-adic and corresponding real space-time sheet obeying same algebraic equations consists of rational and possibly also algebraic points common to real and p-adic variants of imbedding space.

Parapsychological phenomena involve the transfer of information and negentropic entanglement makes possible genuine information at quantum level as also breaking of the second law of thermodynamics in the time scale of CD in question. Hence remote mental interactions should involve the generation of negentropic entanglement (see fig. `http://www.tgdtheory.fi/appfigures/cat.jpg` or fig. 21 in the appendix of this book) irrespective of whether the target is living system or consists of "dead" matter.

2. The idea about field body serving effectively as an intentional agent is second element of the model. The topological light rays representing negative energy signals propagating into geometric past created by a transformation of p-adic space-time sheet to a real one might be said to represent the "desire" inducing neural activities in the brain of geometric past. This mechanism provides not only a model for how magnetic body uses biological body as a motor instrument but also for PK.

   MEs acting as bridges between different organisms would mediate em oscillations allow a directed transmission of smaller MEs behaving effectively as particles moving with light velocity. These MEs could be both real and p-adic and -using the terminology of Qigong practice- would represent qi (action) and yi (intention) respectively. An essential element would be resonance: sender and receiver in should be accompanied by MEs characterized by the same fundamental frequency: only these MEs could resonantly connect healer and healee. Healer must have ability to continuously vary the healing frequency.

   MEs would naturally correspond to pairs of positive and negative energy space-time sheets. They would be attached to magnetic flux tubes and magnetic mirrors consisting of two flux sheets would make possible sensory-motor loop.

3. Zero energy ontology justifies the notion of negative energy signals and brings in also CDs as correlates of selves and natural fundamental targets of remote mental interactions. Zero energy ontology and the new view about time allows to assume that sensory qualia are at the level of sensory organ (objections such as phantom leg phenomenon can be circumvented) and that symbolic representations of objects of perceptive field and their attributes reside in brain.

   Sensory input generates sensory representations based on real space-time sheets possibly accompanied by p-adic cognitive space-time sheets. Field body can share these mental images by quantum entanglement and also receive sensory information as classical signals involving using frequency coding and coding by temporal patters. These latter representations would correspond to cognitive and emotional aspects associated with the sensory input. One could even say that higher level sensory representations are somatosensory experiences of field body. The intersection points of real and p-adic space-time sheet would determine the physical cognitive representation and would be always discrete. The analogy with the discreteness of numerics should be noticed. Since this model would apply also to extrasensory perception, the attribute "extrasensory" becomes somewhat misleading attribute.

4. Extrasensory perception could also result from the direct electromagnetic perturbation of the sensory magnetic canvas outside the body and the sounds generated by auroras and meteors might be genuine "extrasensory" perceptions of this kind [K69] . The frequency spectrum for the sounds produced by meteors and detected both sensorily and electronically in in the range $37 - 44$ Hz [F4] , which is the range of thalamocortical resonance frequencies associated with sensory representations in magnetic sensory canvas model. The sounds are several orders of magnitude more intense than they should be unless em perturbations propagate to Earth in a channelled manner. Only few meteors generate these sounds. These observations suggest that a resonant amplification of the em perturbations by magnetic mirrors of the sensory canvas channelling the em field to the surface of Earth are in question.

5. One might argue that if memes are not universal, remote cognition is not very useful. If memetic and genetic codes are realized in terms of CDs of quarks and leptons, one would have universality. If DNA double strand provides the relay station through which sensory input and motor output of the magnetic body flows, one would achieve universality of communication and control mechanisms at the level of living matter. An interesting question is

whether memes are really species-specific as the morphic fields are in Sheldrake's theory. The ability of shamans to transform at the level of conscious experience to animals suggests that this might not be the case. There is also a famous real life story about a student who spend several days in the experiental world of dog. Various identification phenomena would very probably involve also magnetic mirrors acting as bridges between say shaman and animal (or possibly multibody collective self defining 'species self') and making possible to share the experience of animal. Same mechanism as in the case of long term memories would be in question but with personal memories being replaced with the experiences of another species.

The fact that p-adic space-time sheets have literally infinite size suggests that cognition and intentionality are cosmic phenomena and that there might be cosmic pool of shared cognitive mental images. Hence memes could be completely universal.

10.4.2 Psychokinesis

One can classify psychokinesis to various types depending on whether the target is living or "dead" and whether the effect on target is a mere transfer of energy and momentum or control action involving information transfer.

Below I briefly discuss an early TGD inspired model of PK, a general model of PK assuming time mirror mechanism (see fig. `http://www.tgdtheory.fi/appfigures/timemirror.jpg` or fig. 24 in the appendix of this book) of ordinary intentional action but applied by the magnetic body of the operator to a system different from the biological body, and a more specific model for machine-human interactions. Also concrete examples of various kinds of PK effects are discussed.

A possible model for psychokinesis with non-machine targets

In [K101] a mechanism of psychokinesis based on the generation of wormhole magnetic field configurations making possible levitation was proposed. Although this mechanism was yet general it deserves a discussion and reader is recommended to see [K101] for details. Basic mechanism is the levitation of diamagnetic substances in an external magnetic field: the force results when the diamagnetic substance repels external magnetic field from its interior. The force is essentially the gradient of the net magnetic energy inside the volume defined by the object.

The mechanism is purely TGD based and relies on the generation of a pair of space-time sheets having opposite time orientations, and carrying opposite magnetic fields and opposite energy densities, and the subsequent interaction of the second space-time sheet with the object moved in the psychokinesis. Exactly the same mechanism applies in case of MEs (massless extremals) and could be used to generate coherent locomotion of organism resulting as a recoil effect when the second ME is absorbed by the body part. MEs provide a candidate for the mechanism of psychokinesis.

TGD based general view about PK

A general TGD based explanation psychokinesis relies on the same fundamental mechanism as ordinary intentional action, long term memory, and remote metabolism. The model applies more or less as such also to telepathy and could also allow to understand the notion of water memory explaining homeopathic effects.

1. The basic mechanism of PK and retro PK relies on quantum jumps transforming the p-adic space-time sheets representing intentions to real space-time sheets representing desires represented as negative energy signals to the geometric past. These signals modify the output of say random number generator to a non-random one. Magnetic flux quanta would realize the bridges along with the negative energy signals would propagate. The mechanism would favor retro PK if the operator is in active role. Genuine PK is also possible but in this case target would be active sucking metabolic energy provided by the operator.

2. Negative energy signals could consists of dark phase conjugate photons or even massless W bosons since TGD allows scaled up variants of electro-weak gauge bosons with large Planck constant and arbitrarily small mass scales. Dark W bosons are especially interesting since

they can induce charged entanglement and purely non-local charge transfer mechanism and have been proposed to play a key role in the generation of the nerve pulse.

3. Magnetic flux quanta are the bridges making possible (presumably) unconscious feedback so that the operator can unconsciously learn how to affect the machine. How intentions can have effect on system whose functioning is unknown to the operator is actually the basic mystery of, not only psychokinesis, but of remote healing and remote mental interaction in general, as also of the phenomena labelled as instrumental transcommunications (ITC). The learning by feedback, much analogous to that happens when we learn to drive bicycle, would solve this mystery. The effects of group activity could be understood if groups tend to form collective selves so that coherent amplification of the effect occurs.

4. The ability of the PK able person to imagine the desired effect is important and could correspond to the ability to generate p-adic space-time sheets representing the intention. The desire about the action represented by the corresponding real space-time sheet should induce the effect optimally. In personal discussions with a PK-able psychic I indeed learned that he always tried to imagine in every possible detail how he moved the physical object (say a box of matches). The role of imagination is important also in remote healing [J145] . Perhaps the p-adic pseudo constants made possible by the non-determinism of p-adic differential equations should be in a good approximation genuine constants.

5. The optimal targets are initial value sensitive- or more generally-critical.

   (a) Quantum criticality is the basic characteristic of TGD Universe and the prediction is the existence of a hierarchy of criticalities. Number theoretical criticality would in turn characterize living matter and might be a characteristic of optimal targets.

   (b) Also quantum criticality in the sense that several values of Planck constant are possible with large values of $\hbar$ assignable to negative energy signals mediating the desire of the PK-able person. PK requires energy and this favors systems, which can utilize standardized metabolic energy quanta liberated in the dropping of particles to larger space-time sheets.

   In many-sheeted space-time particles topologically condense at all space-time sheets having projection to given region of space-time so that this option makes sense only near the boundaries of space-time sheet of a given system. Also p-adic phase transition increasing the size of the space-time sheet could take place and the liberated energy would correspond to the reduction of zero point kinetic energy. Particles could be transferred from a portion of magnetic flux tube portion to another one with different value of magnetic field and possibly also of Planck constant h_{eff} so that cyclotron energy would be liberated. In the following only the "dropping" option is discussed.

   (c) Water would be an optimal system from the point of PK and retro PK. Homeopathy might indeed involve PK like aspects. Benveniste's experiments [I41, I42] gave support for the notion of water memory but could not be replicated when the experimenters did not know in which bottles the treated water was. The preservation of water memories represented in terms of many-sheeted lasers for with 1/0 corresponds to a population inverted state/ground state, requires metabolic energy feed and the system might suck this metabolic energy from the biological body of the experimenter [K37] .

6. As noticed, the proposed model is extremely general and seems to apply to almost any paranormal phenomena. For instance, the claimed re-incarnation experiences could be understood in terms of the general mechanism for long term memory. The person who remembers having lived in past could share mental images of a person in the geometric past by time like entanglement (episodal memory), or could be able to communicate with negative energy signals to the brain of a person on geometric past memory recall and thus receive declarative memories. It is quite possible that survival of fittest in our culture has led to an evolution of an immune system preventing sharing of mental images and communications with other brains.

Machine-mind interactions

Machine-mind interactions represent a modern branch of parapsychological research and nowadays methodologically highly advanced. These interactions are studied several groups and individuals: mention only the Princeton Engineering Anomalies Research (PEAR), which is a group directed by Prof. Jahn, the Anomalous Cognition Project of Dick Bierman, and the retropsychokinesis work of Helmut Schmidt. In the sequel some aspects of this work are discussed.

The generation of negentropic time like entanglement between operator and target leading to a superposition of pre-existing and desired zero energy states and a subsequent increase of the amplitude of the desired outcome could be the general mechanism of machine mind interactions. 'Who known how?' is a highly relevant question in the case experiments involving the attempt of operator to affect the function of a machine like computer whose detailed functioning is not known for the operator. This question could have two answers. Either the operator learns to who to affect the outcome by the simple sensory-motor loop provided by MEs or there is third party who knows and corresponds to a higher collective level of consciousness.

1. Retro psychokinesis with random number generators

The analysis of experiments [J43, J44, J122] discussed in the [K94] suggests that the geometric past can change in the time scale of a fraction of second. Both the work done at PEAR [J65] and the work of Helmut Schmidt with retro psychokinesis [J143] provide support for the change of the geometric past in much longer time scales. PEAR experiments demonstrate the anomalous effect also in the direction of future. For instance, the experiments of Schmidt done 1992 discussed in New Scientist [J53] demonstrate that martial art students were able to affect the visual display determined by pre-recorded random numbers. The probability for this kind of deviations from non-randomness was about 1/1000. Henry Stapp proposed an explanation for this in his paper published in Phys. Rev. A [J149] based on nonlinear quantum mechanics.

The change of also geometric past in the quantum jump between quantum histories implies the notion of a four-dimensional physical reality and forces to regard three-dimensionality of reality as illusion created by the 3-dimensionality of our sensory experience (recall the notion of the association sequence). This implies that our geometric past is changing all the subjective time and that communications to the geometric past and future are possible and are consistent with the weak causality violation hypothesis of Schmidt [J143] . What this hypothesis implies that in the newest quantum history generated by RPK all separate records contain the pre-recorded random numbers are altered in the same manner in RPK. Schmidt has tested weak causality hypothesis by using two separate cassette tapes containing the pre-recorded random numbers, one used in the PK experiment and another one kept locked in a safe. The records were indeed found to be identical after the experiment.

The results of Schmidt suggest also classical signalling to the direction of the geometric past. Real space-time sheets with negative time orientation could serve as the geometric correlates for these signals.

2. The work of Princeton Engineering Anomalies Research group

The study of anomalies in human-machine anomalies provide a highly sophisticated and controlled manner to study psychokinesis in its various forms. For instance, in the experiments carried out in PEAR group (Princeton Engineering Anomalies Research) [J65] operators try to affect various kinds of electronic, mechanical, acoustical, optical and fluid devices. In unattended calibrations these devices yield random output whereas in the experimental situation operator tries intentionally to affect the output so that non-randomness results. Each input that operator tries to affect consists of 200 bits formed from a random physical signal and operator can have either the intention to increase the number of 1:s (high) , the number of 0:s (low) or have no intention at all (baseline). Operators can exert their efforts from a distance of thousands of miles, before or after the the actual operation of the devices. Over the laboratory's 20-year history, thousands of such experiments, involving about 100 millions of trials, have been performed by several hundred operators.

The observed effects can be summarized as the average for the sum of bits which is 100.026 for high and 99.984 for low. The effect is by a factor 3.6 higher than the expected margin of error. Effects are thus quite small, of the order of a few parts in ten thousand on average, but they are

statistically repeatable and compound to highly significant deviations from chance expectations. Effects are highly operator specific and there are significant disparities between male and female performances. The random devices respond also to the group activities of large numbers of people and are especially sensitive to the effect of small intimate groups, group rituals, sacred rites, musical and theatrical performances, and charismatic events.

Time mirror mechanism suggests the following model for the machine-human interactions encountered in say PEAR experiments.

1. The effect of intention could be on the generator of random noise, on bit sequence represented in the computer memory, or even on the recorded value of the sum of bits. A possible mechanism in the latter two cases is the reversal of electromagnetically represented bit.

2. The general mechanism of intentional action involves negative energy signals inducing a change in the charge distribution determining the value of bit. Negative energy photon could induce a dropping of ions to a larger space-time sheet. Also the emission of negative energy dark W bosons (appearing in TGD based model of nerve pulse) could induce a change in the net charge. In both cases the sign of charge would correlate with the character of intention and for the first mechanism there would be asymmetry between "high" and "low" (proton, electron).

3. The work of William Tiller

[J153] [J153, J154, J155, J161] has performed experiments involving intentional imprinting of targets such as water. The model for the findings of Tiller is discussed in [K10] . The imprinting manifested itself as temporal and spatial oscillations of pH and temperature. The surprising finding was conditioning: also the air around intentionally imprinted device exhibited these oscillations. Also computer could be conditioned. The Fourier transform of the correlation function for bit sequences of random number generator demonstrated peaks at harmonics of $f = 1/T$, $T = 113.778$ min. 2^n-multiple of .1 seconds for $n = 16$ would correspond to $k = 143$ and $T = 109.23$ minutes which is by about 4 per cent too small. The proposed assignment of cyclotron photons with motor action leads to ask whether large $\hbar$ dark cyclotron photons with these frequencies could induce a periodic perturbation of the random bit sequence?

Could Shnoll effect and statistical effects of psychokinesis have common mathematical description?

In the remote mental interaction with computer the intention is to affect the pattern of random numbers and the mere transfer of metabolic energy is not enough since the effect must also have a correct sign. The net effect is the change of the distribution of random numbers from expected and Tiller observes strange periodicities in the distribution. It seems that remote mental interaction must be able to affect the probabilities of the outcome so that they are not identical as randomness would require. What could be the mechanism? Direct entanglement with the representation of bits is not plausible.

1. This brings in mind Shnoll effect [K5] in which probability distribution $p(n)$ for an integer valued observable transforms from expected smooth distribution - say Poisson distribution - to a many-peaked distribution. The distribution could relate to microscopic observable but the modification of distribution seems to depend on gravitational field created by solar system so that astroscopic and microscopic dynamics couple at the level of probability distributions. I have proposed a mathematical model involving p-adic numbers and their quantum counterparts as a model for the effect but have not been able to undersand this astro-micro correlation. Could it be that Shnoll effect allows to describe also statistical psychokinesis. This would lead to precise number theoretic predictions and the model would be testable.

   There is an interesting analogy with quantum computation in TGD framework. Individual bits or bit sequences correspond to outcomes of quantum computations inside CD and their distribution determines the outcome of the computation. Intentional variant Shnoll effect would mean that intentional action can affect this distribution. One could localize this intentional action to a CD containing the CDs defining bits.

It is however far from clear whether this model can be formulated as a modification for the probability for a given value of bit. It might well be that the effect is global rather than local and on the distribution of number of bits with a given value. Indeed, in TGD framework reality is 4-D and the sequence of bits produced by random number generator is what correspond to the event rather than single bit!

2. One can of course consider also a local model. A negentropic entanglement with the macroscopic quantum states of random number generator affecting the environment of system responsible for the random event could be in question and change the situation in such a manner that second value of bit becomes more probable. Could the magnetic fields associated with the flux tubes mediating the negentropic entanglement with RNG and interacting with the target make second bit energetically slightly more favored? Could the negentropic entanglement prevent the normal state function reduction producing the random number and produce the random number as ATP is transformed to ADP so that operator would perform some fraction of state function reductions? How it is possible to have an effect with a correct sign without any precise knowledge about the functioning of RG?

Telekinesis and electrostatics

In the book "Mind at Large" edited by Tart, Puthoff, and Targ there is an article "An Investigation of Soviet Psychical Research" by Wortz *et al* reporting among other things the research related to the electrostatic aspects of telekinesis. The article mentions the work done by Vasiliev and associates with Nina Kulagina and the work of Adamenko with Alla Vinogradova, another highly gifted person in telekinesis. Kulagina and Vinogradova are said to have been able to move objects of .1 kg along table. Interestingly, according to the article PK able persons tend to be women. Adamenko has tried to understand the phenomenon theoretically and has proposed that the static charges of objects and electrostatic forces generated by the subject might explain the effects.

Adamenko's work

The objects moved by subject persons were located at a table which was a di-electric cube with of side length of .5 meters in Adamenko's experiments.

1. Vinogradova was able to induce an electric charge in cube and then move objects located at the cube. With biofeedback training also other subjects were able to replicate Vinogradova's feat.

2. To move the object the static friction (friction coefficient between .1 and .3) must be overcome. Adamenko theorizes that there is kind of buyonancy force caused by the flow of air molecules involved and that the electric field somehow induces this force.

3. The reported electric field was 10 kV/cm and corresponds to the voltage at which a dielectric breakdown occurs in a dry air. The reported movement of the air could correspond to a corona wind resulting at strong electric fields.

4. Adamenko assumes that the objects had either static charge or that they were polarizable and developed a dipole moment in the external electric field. The electrostatic interaction with the electric field induced by Vinogradova would have been the cause of the movement.

TGD based model

TGD based model for phenomena is based on the general mechanism of mind-matter interactions allowed by the many-sheeted space-time concept. There are three questions to be answered: How the table and possibly also object were charged?; How the motion of the object was caused?; How the object was lifted from table to circumvent friction force? *How the table and object were charged?* The charging of the table is certainly crucial for the PK effect. Vinogradova could have emitted "topological lightrays" (MEs), as a matter fact high frequency (microwave) MEs propagating like particles within low frequency (ELF) MEs. Negative energy ELF MEs could have served as correlates for entanglement. Entanglement is however not necessary in this case since conscious

telepathy is not involved. Microwave MEs would have induced bridges between the atomic space-time sheets of the object and super-conducting magnetic flux tubes of Earth. The bridges would have made possible ionic and electronic currents between these space-time sheets and led to the charging of the table and possibly of also object. A suitable intentional targeting of MEs would allow to control the charge distributions of the table and object and therefore the pattern of the induced electrostatic fields.

What could have produced the motion of the object?

The interaction of the object with the electrostatic field of the table is a possible explanation for the PK effect. The distribution of the charges of the table and object would allow to control the field pattern and thus the direction of the electrostatic force. This is however not the only mechanism. Ionic currents from the magnetic flux tubes to the atomic space-time sheets of the object produce recoil effect (momentum is conserved only in many-sheeted space-time, not for single space-time sheet), and this could have been the fundamental mechanism of motion (essentially the mechanism of rocket motion). In both cases the subject would have produced only the ME bridges taking care of the control of motion but would not have provided the energy and momentum.

The experiments of Modanese and Podkletnov [H9] provide support for the mechanism. Modanese and Podkletnov studied capacitor at a rather low temperature and at a voltage near the di-eleectric breakdown voltage. The second electrode was a super-conducting disk. The resulting discharge was large and coherent and accompanied by radiation pulses of unknown type. The pulses induced the motion of the air and kicked test penduli. The force was proportional to the mass of the penduli. The effect caused by the pulses did not weaken with distance. This supports the view that the pulses were TGD counterparts of the Tesla's scalar waves realized as pairs of massless extremals with three momenta in different directions [K22] and induced temporary bridges between test penduli and magnetic flux tubes inducing the flow of ions and the recoil effect. The same mechanism should be at work as a microscopic and incoherent version in the case of lifters.

How to circumvent the friction?: a connection with the physics of lifters

Lifters exhibit the called Biefeld-Brown effect [K89] . Lifters are asymmetric capacitors consisting typically of a wire electrode and planar electrode, are in a voltage slightly above the voltage causing di-electric breakdown. Lifters move in the direction of the smaller electrode. Also the flow of air from the small electrode to the large one is involved. On basis of the experimentation and guide the findings of Juha Hartikka, I ended up with a simple model of lifters. What would happen is that there is an electric discharge in the form of small plasmoids (discharge sparks would be analogous to ball lightnings), whose emission from the small electrode causes the recoil effect. The emission of the scalar wave pulses could induce the motion of the air by Modanese-Podletnov recoil mechanism. Since the table is charged, there should be a strong electric field also in the narrow space between the object and table. Therefore electronic discharges from the object could occur, and lead to a small scale lifter effect lifting the object slightly above the table. This does not require the object to carry a net charge.

Could the remote EEG sensor of Sergeyev be based on the same mechanism as PK?

In the same article also the remote EEG sensor invented by the mathematician Sergeyev claimed to remote sense EEG from a distance of 5 meters is described. Unfortunately, the information related to the invention of Sergeyev is classified. What is however known from the existing literature is that the sensor is surprisingly simple, consisting of a metal disk suspended into water and coated with a semiconductor. The immersion in water is reported to double the effectiveness of the sensor. According to the report, the ordinary EEG sensors can detect EEG only up to a distance of few centimeters since the noise of the environment masks the (Maxwellian) EEG at larger distances. Furthermore, the amplifying effect of water is not consistent with the high value of the di-electric constant of water if ordinary Maxwellian electrodynamics is behind the sensor.

Sergeyev's explanation for the functioning of the sensor utilizes bio-plasma hypothesis. The use of the term bio-plasma is remarkable since professional physicists know that plasma state at the temperatures and densities of living matter is not possible in standard physics universe. In TGD framework super-conducting ions leaking from the magnetic flux tubes of the Earth's magnetic field can give rise to what might could be called bio-plasma, and Sergeyev's sensor is indeed said

to produce bio-plasmagram. Also maser (microwave laser) effect in bio-matter producing ions and electrons flowing into air is mentioned.

All this suggests that EEG MEs containing microwave MEs inducing a leakage of the ions from magnetic flux tubes to the atomic space-time sheets of the metal disk and in this manner generate plasma. The strength of the resulting electric signal would be modulated by the intensity of the net flux of EEG MEs so that information about EEG would indeed result. EEG MEs would not topologically condense at atomic space-time sheets but propagate as bridges connecting the boundaries of the magnetic flux tubes and atomic $k = 151$ (cell membrane thickness) space-time sheets. This would explain the dissipation free propagation. For positive energy MEs the effective phase velocity would be of the same order as the alpha wave phase velocity since these MEs would tend to "stuck" (in quantum sense). The basic sensing mechanism would be very much the same as explaining the generation of nerve pulse. Also Z^0 MEs could be involved and would usually have a very weak interaction with the environment. The ability of water to act as a many-sheeted maser, presumably crucial for the functioning of living matter, could explain why the water amplifies the effectiveness of the sensor.

Also the remote sensing of the pulsating magnetic fields produced by Nina Kalugina and having strength nearly equal to that of the Earth's magnetic field are mentioned in the article. The possible significance of the pulsating magnetic fields for PK is still poorly understood in the TGD framework: the problem is that solutions of field equations representing this kind of field configurations are not known. One might however think that the pulsating magnetic fields carry also supra-currents, and that their presence intensifies the leakage of charged particles to the atomic space-time sheets of the remote sensor device.

10.4.3 Healing as rejuvenation?

The article of Lian Sidorov [J145] and its references give a thorough view about remote healing and viewing. One particular healing method goes under name Qigong [J56]. Qigong is a general term for a large variety of traditional Chinese energy exercises and therapies. Qigong is generally considered as a self-training method or process through Qi (vital energy) and Yi (consciousness or intention) cultivation to achieve the optimal state of both body and mind. The traditional Chinese medicine postulates the existence of Qi, which could be regarded as a kind of subtle energy circulating around the physical body.

The physiological, chemical and electromagnetic effects of both internal and external Qigong have been studied ([J145] contains large number of related references). Also the effects of Qigong healing on cancer has been studied [J56].

Negentropic entanglement as Qi?

In TGD framework the energy associated with MEs and supercurrents flowing along magnetic circuitry could be a natural counterpart of Qi. The positive metabolic energy assignable to negentropic entanglement or negentropic entanglement could be an alternative identification for Qi. If entanglement is entropic it corresponds to bound state entanglement and this entanglement of its negative metabolic energy could be seen as the counterpart of "sick Qi".

Yi could in turn would translate to p-adic cognitive representations representing also intentions, perhaps p-adic variants of MEs or even magnetic mirrors. Internal Qigong refers to self healing whereas external Qigong means directing Qi energy or intention to help others by opening Qi blockages or inducing the sick Qi to get out of body, or helping to achieve Qi balance. The transfer of metabolic energy by ATP-ADP process [K27] would be basically a transfer of negentropic entanglement in TGD framework and Qi blockage could be interpreted as a blockage preventing transfer of this entanglement (of metabolic energy in standard framework) would be basically a transfer of negentropic entanglement in TGD framework and Qi blockage could be interpreted as a blockage preventing transfer of this entanglement (of metabolic energy in standard framework).

Zero energy ontology in principle makes possible the creation of matter from vacuum as zero energy states. This process involves a generation of a new CD serving as a correlate for self carrying positive and negative energy parts of the zero energy state at its future and past boundaries. The standard physics interpretation would be as a quantum fluctuation in a space-time volume dictated by CD. At space-time level space-time sheets within CD would be the correlate. Also the

transformation of p-adic space-time sheets to real ones and vice versa in the intersection of real and p-adic worlds becomes possible.

Healing as regeneration of negentropic resources?

De-differentiation of cells taking place in the healing of cancer cells resembles rejuvenation. But what does rejuvenation mean? The first guess is that it corresponds to time reversal and running of biological programs backwards so that the stage before the emergence of disorder is reached. This interpretation is attractive but during the preparation of this article I realized that it does not conform with the most recent view about what the arrow of geometric time is [K6].

To begin with, one must understand how the arrow of psychological time is induced from quantum arrow. This question is not completely understood in TGD framework. There are several arrows of time: quantum arrow of time, arrow of the geometric time of 8-D imbedding space, and the arrow of the geometric time of 4-D space-time sheet of subsystem identifiable psychological time.

1. Quantum arrow of time has a nice explanation: for zero energy states either positive or negative energy states (but not both) can be chosen to have well defined single particle quantum numbers - they are prepared. The simplest manner to identify quantum jump and unitary process U would be as state function reduction taking place alternatively for positive or negative energy part of the state. One would have time-flip flop at imbedding space level: the arrow of 8-D imbedding space geometric time would alternate. This of course sounds weird unless one makes a sharp distinction between different times.

2. What about the arrow of the time at 4-D space-time level? What is clear that observer of space-time as Flatlander does not observe the change of the arrow of imbedding space time but experiences constant arrow of time reflecting itself as second law. In fact, entropy defines natural time coordinate for Flatlander. This can be understood if quantum average 4-D space-time surfaces associated with subsequent zero energy states effectively combine to form a multiply folded towel like structure. In quantum jump 4-D space-time surface can be said to turn downwards at the upper end of CD, return back to turn upwards at the lower end of CD, and so on. Flatlander would experience the flow of 4-D time as a continual increase of entropy manifesting itself as properties of the space-time sheet with which Flatlander identifies herself. The 4-D arrow of time would not change. Only by observing space-time sheets in different time scales would make possible for the Flatlander to discover that the 8-D imbedding space arrow of time alternates. Phase conjugate laser beams and self assembly in biological systems would represent examples of processes allowing to overcome the restrictions of being Flatlander. During last decades we have been indeed able to overcome these restrictions as the discovery of phase conjugate laser beams demonstrates [D19]. In TGD framework massless extremals (MEs, topological light rays) provide a representation for the phase conjugate laser beams. Also the discovery of Italian physicist Fantappie that living systems are characterized by both entropic and syntropic processes demonstrates the presence of both directions for the arrow of time at imbedding space level [J103, J158].

In this framework healing corresponds to rejuvenation if the age of cell is as entropy defining also a measure for the amount of differentiation that has occurred. By second law ageing would be reduction of negentropy resources and healing as rejuvenation would mean the increase of negentropy of the system. This is possible if the notion of negentropic entanglement is accepted. The healing as increase of the negentropy of the system implying rejuvenation should take place in state function reductions and NMP [K49] would make them possible if the notion of number theoretic entanglement entropy is accepted.

How topological light rays and magnetic flux tubes relate to healing?

Massless extremals are excellent candidates for the space-time correlates of communication and control signals and depending on the sign of the energy can propagate in both time directions. Real bosons correspond to wormhole contacts connecting positive (negative) energy MEs whereas virtual bosons are identified the wormhole contacts connecting positive and negative energy MEs.

In zero energy ontology it makes sense to speak about quantum jumps transforming p-adic MEs to real ones and about reflection of MEs in time direction so that positive energy ME transforms to negative energy ME or vice versa. Also MEs analogous to virtual particles are possible. They correspond to pairs of MEs with opposite time orientations so that the wormhole throats carry opposite signs of energy. In this case the classical momentum is not anymore light-like and although wormhole throats are massless the boson itself can be interpreted as a virtual off-mass-shell particle.

In quantum optics time reversal is known as a phase conjugation [D19] and is one of the basic notions of holography. MEs act as both quantum holograms and receiving and sending quantum antennae of [K56]). MEs can generate reference waves of coherent photons interacting with other MEs and activating dynamical holograms of coherent light. If the reference wave is phase conjugated, the resulting hologram is time reversed.

What makes this so interesting is that MEs and magnetic flux tubes are the tools of of quantum control in the TGD based view about biosystem as a symbiosis in which MEs control superconducting magnetic flux tubes controlling ordinary matter at atomic space-time sheets via the many-sheeted ionic flow equilibrium. The coherent light pattern emitted by ME resulting from the interaction of ME with the reference wave (its phase conjugate) could act as a control command (time reversed control command) inducing process (time reversed process).

How topological light rays and magnetic flux tubes relate to healing?

1. In the original vision about healing as time reversal for biological programs phase conjugate reference waves would provide a simple and general mechanism of healing by time reversal allowing the living matter to fight against second law. This picture is however inconsistent with the recent view about the arrow of time.

2. In the recent view about the arrow of time topological light rays generate non-local single particle excitations at the flux tubes carrying cyclotron Bose-Einstein condensates and the resulting negentropic entanglement induces healing.

10.4.4 Near death experiences

Near death experiences are rather commonly experienced, say by the victims of various accidents. These experiences are known for centuries but it was the best-selling book "Life after Life" of Raymond Moody which brought these experiences known to the general public [J128] .

1. What NDEs are?

NDEs seem to possess invariantly the same characteristic features. There are feelings of peace and joy, time speeded up, heightened sense, lost awareness of body, seeing bright light, entering another world, encountering a mystical being or deceased relatives and coming to a point of no return. The experiences seem to proceed in quite universal manner. First comes a loud buzzing or ringing noise and a long dark tunnel. Patient sees his own body from outside and does not feel any pain or agony anymore. Patient meets others and a being of light who shows his life in its entirety as a kind of playback to evaluate. Then comes the point of no return, and although patient feels peace, joy, and love, the patient has to return to continue his life. Often these experiences induce very profound changes in the subsequent life of the patient. The claims of Moody have been supported by subsequent research and hardly anyone, even the most foolhardy skeptic, denies the reality of these experiences.

The latest twist in the development emerged when University of Southampton research team announced the result of a one-year study of NDEs of victims of a heart attack supporting the view that consciousness and mind exist after the brain has ceased to function and the body is clinically dead. The resuscitated patients were various times clinically dead, with no pulse, no respiration and fixed dilated pupils. Independent EEG studies have confirmed that brain's electric activity, and hence brain function (according to standard dogmas of neuro science) ceases in this kind of situation. 11 per cent of patients who survived the heart arrest however recalled emotions and visions during this state. This announcement has created considerable excitement in various consciousness related discussion groups and the question whether some of the basic dogmas of neuroscience are badly wrong has been raised by the neuroscientists themselves.

2. TGD based view about life after death very concisely

It is good to summarize the latest TGD based view about consciousness after physical death before comparison with other theories and detailed analysis of NDEs. The view, which is certainly not the only possible one can imagine, is supported by the improved view about psychological time.

The basic notion is that of 4-D body involving both the physical body and the magnetic mirror structures associated with it. 4-D body is gradually carved like an artwork via p-adic-to-real phase transitions representing the progress of front of volition to the geometric future and by the reverse phase transitions deconstructing the 4-D body or its parts. This fractal trial-and-error construction of the 4-D body occurs in various time and length scales. Gradually increasing stable 4-D body results. The volition is concentrated to the front of the p-adic-to-real phase transition so that the experience of 4-D body for which deconstruction processes occurs only in the time scales short compared to the duration of lifecycle, would be about entire lifecycle and in this sense 'timeless'.

The simplest view assumes that the front of volition does not propagate after the physical death. One could however consider the possibility that the front of volition continues to propagate by transforming p-adic magnetic mirror structures to real ones: volitional life would continue in electromagnetic form. This would make possible the communications of the deceased with living since the resulting real magnetic mirrors could connect the deceased with the living. On the other hand, the repertoire of possible p-adic magnetic mirror structures would be very wide because of the p-adic non-determinism.

Since magnetic mirror structures are fundamental for the field realization of the genetic code, one can quite well consider the possibility that this process induces also the self-organization of the ordinary living matter around the magnetic mirror structures. This would have interpretation as a reincarnation. Buddhas able to resist the temptation to reincarnate would continue their life at the field level. Interestingly, the development of physics from Newtonian physics of the material bodies to Maxwellian physics of fields would mirror the evolution of consciousness from concrete biological life to life at the field level.

3. Astral plane theories for NDEs

There are several theories of NDEs. A theory enjoying popularity in New Age circles is based on the notions of the astral projection and next world stating that we have another body that is vehicle of our consciousness which leaves the body at the moment of death. Although completely respectable as such, this kind of theory is not based on existing or even postulated physics, and is therefore hard to test. The notions of 'higher vibrational level' and 'astral plane' are simply devoid of a physical meaning.

In TGD framework the idea about 'vibrational levels' generalizes in an astonishing concreteness to an entire hierarchy of electromagnetic life forms and electromagnetic bodies whose sizes vary to astronomical length scales [K32, K69] . In this framework the idea about brain as a seat of consciousness is an illusion resulting from the fact that sensory data is mostly about the immediate region around body. Of course, even the idea that consciousness (as opposed to its information contents) can be localized to some part of space-time, is basically wrong in TGD approach.

A possible test for the astral projection theories is a weighing of the body after death to deduce the weight of the astral body (assuming of course that astral planes obey ordinary physics!). If 'astral planes' correspond to the p-adic space-time sheets, this test of course does not make sense. Magnetic mirror structures are obvious candidates for astral body and are real but their separation from body is impossible so that this kind of measurements do not make sense. The notion of 4-D body also suggests that the physical body remain in the geometric past in the physical death wherefrom it can communicate with the living ones via the magnetic mirrors of magnetic body which continues to be generated by p-adic-to-real phase transition.

Extrasensory perception via astral bodies is a second possible test. This test might make sense if extrasensory perception can be generated by patterns of ELF em fields as supposed in the TGD inspired model of qualia. Magnetic mirrors connecting organisms to each other and also to 'nonliving' matter make possible ESPs. Also direct electromagnetic perturbations of the magnetic sensory canvas can give rise to ESPs: in [K43] the possibility that the strange sounds produced by meteors [F4] could correspond to ESPs is discussed.

4. Tunnel experience

The theory of Grof and Halifax [J110] is based on the observation that NDE involves elements

which might be assigned to the moment of birth. Perhaps NDE is reliving the moment of birth. The counter argument is that the newly born baby does not see anything unless she is able to perceive extrasensorily. 'Nothing but hallucinations' theories are of course no explanations at all and belong to the same category as 'consciousness as mere illusion' theories. In neuroscience framework also the wake-up reality is seen basically as a hallucination produced by brain and coupled with sensory input to guarantee correspondence with what is out there.

The tunnel is experienced also during epilepsy and migraine, during meditation and relaxed state of mind, and with certain drugs like LSD, philocybin and mescaline. It has been suggested that the physiology of brain could explain the properties of near death experiences [J59] . The theory of Cowan [J59] states that the tunnel results from a failure of the inhibition leading to brain induced activity yielding visual experiences. What is however questionable is why person would feel falling into the tunnel, to say nothing about meeting deceased relatives. Blackmore and Troschienko have proposed a theory in which also the motion along tunnel could be understood as a visual illusion [J49] .

TGD based explanation for tunnel experience might be simply as a direct visual experience about magnetic flux tube structures resulting from the perturbation of the magnetic sensory canvas outside body. Thus a genuine ESP would be in question. Magnetic field obeys indeed same basic equation as incompressible liquid flow. Both retinas and pineal gland ('third eye' literally since it contains retinal pigments and serves as a genuine third eye in some species [K32] are magnetic structures. The practically always present vortex in center ('third eye' in my private terminology) could correspond to the magnetic flux tube structure emanating from the pineal gland whereas the very dynamical flow could correspond to the contribution of retinas. If the magnetic mirrors are universal electromagnetic bridges connecting us to other living beings, in particular to our friends and relatives, the meeting of the 4-D bodies of the deceased relatives would happen at the level of fields.

The movement along the tunnel could correspond to the propagation of p-adic-to-real phase transition along this kind of magnetic mirror structure transforming it from p-adic to real: thus the tunnel would be created after the physical death. During lifetime these em bridges would be p-adic and physical death be followed via the transformation of these bridges to real ones.

I cnnot resist the temptation of telling about a personal 'tunnel experiences' taking place every-daily although this might be criticized as highly unscientific. For me science is attempt to identify the regularities of conscious experience and the only conscious experience I have is my own! As I close my eyes in a half-meditative state achieved by writing at computer terminal, I can see a dim flow consisting of points. Typically this flow enters to or emergences from a tunnel. It can be rotating spiral like flow or simple sink or source. Source or sink can be also linear structure. Earlier this experience was not stable and tends to fade away all the time, and after few minutes I was not anymore able to achieve it. Situation has changed quite recently: I can have the experience almost anytime in peaceful state of mind. During the "great experiences" this flow was much more complicated and completely visible and formed a stable background of the ordinary visual experience and of hallucinatory visual images.

There is however no experience of entering into the tunnel in this case so that the tunnel need not be the same as encountered in NDEs.

5. OBE aspect

Blackmore explains OBEs [J48] as resulting from the replacement of ordinary self-center experience of world with bird's eye of view model where brain sees own body from above. Bird's eye of view is only a memory model so that extrasensory perceptions are predicted to be impossible during OBEs. There is however some evidence that patients can report very precise visual perceptions during OBE. It has been indeed argued, that some other senses than vision, namely [K65] [J48] , could create indirectly these perceptions. It is however difficult for even the most hardborn materialist to understand how a clinically dead person could be able to effectively see by hearing, since this feat is impossible for even completely healthy person.

The idea of Blackmore about bird's eye of view is very attractive as such and can be interpreted in TGD framework in quite different manner. Cognitive maps based on the canonical identification map [K29] typically exterior to inside and vice versa. Thus both a p-adic map of the external world realized inside brain and a p-adic map of body and its surrounding realized outside the body are possible and would give models of the external world and self. The inside-to-exterior map could

provide a bird's eye of view about body and its immediate surroundings.

Both exterior→interior and interior→exterior maps could contribute to the conscious experience even under the normal wake-up consciousness and the exterior contribution would thus represent genuinely extrasensory contribution to the conscious experience. When the ordinary sensory input and volitional activity ceases as during NDE, the contribution of the model of external world to the conscious experience becomes negligible. The ability to experience tunnel unstably during relaxed wake-up consciousness with eyes closed is consistent with the interpretation that these two components are competing. It is quite possible that during sleep the bird's eye of view component also dominates but that no memories about this period are generated for the simple reason that the brain functions necessary for the generation of the memories are not active.

The notion of magnetic sensory canvas implies that we actually see at ELF frequencies. Same applies to other senses. This implies the possibility of experiences without any sensory input or even without any neuronal activity. The needed ELF MEs acting as sensory projectors would be generated in the dropping of ions from atomic space-time sheets to the magnetic flux tubes of magnetic body carrying field strength .2 Gauss (Earth's magnetic field has nominal value .5 Gauss). If the ion drops in high n cyclotron state the subsequent decay of the state by cyclotron transitions generates a bundle of parallel ELF MEs giving rise to the sensory projection. This representation can be generated by the entire body and would give rise to a three-dimensional vision about body as seen by the environment. There is some evidence for this kind of anomalous vision.

1. Yogis have reported altered states of consciousness in which they see their own body three-dimensionally, that is simultaneously from all directions.

2. Becker tells in his book "Cross currents" [J41] about a young cancer patient who told that he can see the interior of his own body. The patient could locate the calcium deposit left as tumor vanished. This supports the view that ELF MEs could project from the entire body to the sensory canvas.

3. Also the OBE experiences, for instance those associated with NDEs, could have a similar interpretation. The sensory input from eyes and even the input from neural activity could be absent during NDEs so that the visual experience should be determined by the background ELF component emanating from the brain and body. The third person perspective associated with OBEs might be always present but be masked by the strong sensory input.

What has been said applies also to other senses. Maybe a personal reminiscence is allowed .I As I was younger I often woke-up partially and realized that I hear my own snoring as an outsider: not a pleasant experience! Sometimes I had an experience which might be interpreted by saying that the hearing in the first perspective is superposed with the hearing in the third person perspective. The third person hearing has a time lag so that the outcome is a kind of double breathing with time lag.

Sensory canvas hypothesis provides a more concrete view about the situation. p-Adic-to-real phase transition of a p-adic magnetic sensory canvas to real one could also be part of the fundamental volitional process. The magnetic mirrors connecting brain to sensory canvas should be there also in the absence of sensory input. Could it be that the out of body view is always involved but masked by the from the body view and after the physical death only out of body view remains?

The competition between bird's eye of view and sensory view has also EEG correlate. Delta waves in the EEG spectrum are natural EEG correlates for the external part of cognition. The reason is that this part of EEG frequency spectrum has a shape and intensity very similar to that for the so called sferics [F7] , which correspond to meteorological electromagnetic perturbations typically associated with thunder storms. Could sferics be the electromagnetic correlates of discarnates?! The degree of the sensory alertness correlates directly with the the ratio of the EEG net intensities in the delta band and in higher EEG bands [F7] . This is consistent with the competition predicted by NMP. Certainly in the NDE experiences studied by the Southampton team only delta band is present in EEG. Note that delta waves dominate also during deep sleep.

Also alpha band is a good candidate for communicating sensory information to higher level selves having magnetic sensory canvas receiving sensory input from several brains simultaneously. It is indeed alpha band in which detectable changes occur in remote vision and remote healing [J145]

. Could it be that higher than alpha consciousness somehow transforms to alpha consciousness in physical death and could it be that alpha consciousness relates with the fact the lowest Schumann frequency associated with the perturbations of Earth's magnetic field is in the alpha band? It might be that magnetic transition frequencies are involved with the 'vertical' communications from brain to the sensory canvas whereas Schumann resonances would be involved with the lateral communications between different sensory canvases. The fact that hypnagogic experiences involving also identification with other persons (personal experience) appear in the borderline between wake and sleep when dominating EEG frequencies are around 7.8 Hz supports this view.

6. Life review

Blackmore explains the life review as an effect analogous to the lively episodal memories generated by stimulating temporal lobes. This explanation leaves open what exactly happens in the stimulation of the temporal lobes and what episodal memories are. To say nothing about the systematic review and evaluation.

In TGD framework brain and perceptive field are four-dimensional and it is quite possible that episodal memories are multitime experiences involving input which comes from the moment of the geometric time when the recalled experience happened and happens again at the level of sensory representation but not as real life event since this would involve macroscopic volition and induce miracle life events in the geometric future. The notion of 4-D body makes this idea concrete. In the physical death 4-D body becomes in some sense mature (about possible de-construction processes in shorter time scales). The volitional contribution essential for the illusion that world is 3-dimensional is not anymore present and entire 4-D body is experienced as a whole. Perhaps this is just what life review is.

Since geometric memories are in question, the review is only a narrative since our geometric past changes all the subjective time and the review is about geometric past subjectively now. Life review would be a temporal counterpart of the OBE experience in the sense that one sees one's geometric life history from outside in a 4-dimensional sense. This is possible since p-adic cognitive representations are four-dimensional and four-dimensional bird's eye of view could begin to dominate at the moment of death.

Also genuine subjective memories about time interval equal to the wake-up period of self and of order lifetime could be in question. This requires the occurrence of what might be called a p-adic phase transition to higher level self with much longer subjective memory: this view is in accordance with the vision about the physical death as a birth to a life in 'other world'. p-Adic phase transition could mean that the p-adic magnetic mirrors after the geometric time after physical death correspond to higher value of p and quite concretely, have lengths which are longer than during the physical life. This makes possible both geometric and subjective memories in much longer time scale.

7. Positive emotions

With the motivation coming from the OBEs associated with the temporal-lobe epilepsy, it has been suggested that brain-stress near NDE episode leads to the release of neuropeptides and neurotransmitters (in particular endogenous endorphins) which are responsible for positive emotional states like joy, peace, and love. Again the question concerns about the deeper mechanism. Presumably these neurochemicals are only correlates for the experiences in which extra-sensory component of the experience begins to dominate. It has been also suggested that the lack of oxygen is what gives rise to the NDE experiences [J48] . The observations of the Southampton team seem to exclude these explanations. Of course, one could claim that some core parts of brain are working even when the patient is clinically dead (no respiration, no heart beat, dilated pupils) and that these functioning parts of brain are able to generate NDE. If so, spiritual experiences would represent the lowest possible levels of consciousness, and even reptiles would have them: perhaps a vulgar skeptic could applaude here but I do not find this idea very convincing.

In TGD framework clinical death naturally implies that extrasensory component of the conscious experience begins to dominate. This picture is consistent with the view about brain as p-adic–real transformer rather than the seat of the entire conscious experience. The dominance of the positive emotions would simply mean that the negative emotions coming from sensory input would be absent.

8. Other worlds

The experiencing of 'other worlds' requires a considerable amount of hand weaving in the standard neuroscience framework. Blackmore claims that imagined worlds are experienced as real because these experiences are the most stable. I believe that Blackmore is right in the sense that mental images (sub-selves) correspond to self-organization patterns which are stable asymptotic states of self-organization. I do not however believe that this is an essential point, and certainly Blackmore's explanation fails if the interpretation of the Southampton team about NDEs is correct.

In TGD framework the other worlds might correspond to the emergence of magnetic mirror structures which correspond to higher value of p-adic prime than during the physical life. They would have much longer lengths and give rise to much longer subjective and geometric memories. Note that the MEs associated with magnetic mirrors are classical representation for light (which brings in mind Tibetan book of death!) so that one could say that the deceased becomes a light being in a well-defined sense. The meeting of the light being might mean an ability to communicate with and sensorily experience the presence of other light beings, natural if the deceased herself has transformed to a light being (but having still 4-D body in the geometric past, this is perhaps why angels have human body!).

Note also that the absence of sensory and corresponding cognitive mental images during NDE is analogous to the empty mind free of mental images which is the goal of the meditation practices. Perhaps soul could be identified as a self having no sub-selves, 'irreducible self' as suggested in [K75] .

9. After effects

The after effects induced by the spatio-temporally extended consciousness in which one sees one's own life from outside are often dramatic. It is difficult to reduce these after effects to brain pharmacology.

My own "great experience" had many aspects common to NDEs and induced profound (not at all pleasant!) changes in my own life. In my case the direct experience of the higher levels of reality made possible the realization how magnificent the almost-boring everyday reality really is when seen through sharpened senses, how pathetically narrow the zone of wake-up consciousness is, and how ridiculously little the celebrated big science tells about reality. This realization resulted in a strong conviction that I am on a right track, and has given the courage to work these fifteen years as a ridiculed scientific dissident in a country in which vulgar skepticism is in the role of a scientific state religion and vulgar skeptics have taken the role of the mind police of science.

10.5 Conscious hologram and remote mental interactions

The notion of conscious hologram allows also a unified description of remote mental interactions.

10.5.1 Big vision

The notion of conscious hologram, which is based on the generalization of the notion of Feynman diagram, provides a general view about remote mental interactions.

1. Brain can be seen as a part of a gigantic dynamical and fractal brain consisting actually of the entire universe. The same mechanisms that work at the brain level work also at larger length and time scales. Brains/bodies serve as 'neurons' for the magnetospheric selves receiving information from several brains/bodies. In particular the fusion of the mental images defined by similar structures can give rise to stereo-consciousness, and the notion of species consciousness and even multi-organ consciousness associated with various kinds of organs makes sense.

2. The notions of super-genome and hyper-genome provide a concrete view about how transpersonal levels of self-hierarchy are realized. Super genes are magnetic flux sheets containing sequences of genes like text lines at the page of book. Hyper genes are flux sheets containing sequences of super-genes belonging to different organisms as genetic text lines. This picture conforms nicely with and generalizes Sheldrake's species memory and 'alike likes alike'

rule. It also suggest a concrete realization of remote biological mental interaction based on activation of gene expression and nerve pulse activity.

The flux sheets associated with super-genome and hyper-genome have fields strengths of magnetic field of Earth. The correlation of the quality of remote cognition performance with sidereal time [J148] leads to the hypothesis that also the flux quanta of galactic magnetic field couple somehow to living matter.

3. Besides time mirror mechanism charge entanglement realized in terms of W MEs is a basic mechanism of remote mental interaction. The simplest model for the generation of nerve pulse is based on quantum jump leading to a state in which Bose-Einstein condensate of Ca^{++} and/or Mg^{++} becomes exotically ionized and generates charge flow through cell membrane. Quite generally, charge entanglement would be part of the ordinary bio-control realized in terms of Ca^{++} waves. Charged entanglement provides also a mechanism for the sharing of mental images between magnetic body and biological body. There is no reason why this mechanism could not work also at the level of other remote mental interactions than those that we are too familiar with to realize that remote mental interactions are in question. The typical time 13-15 seconds associated with the remote realization of intentions by Qigong masters [J89] could correspond to a typical duration of W entanglement.

The models for bio-photons bio [I37] and Gariaev's findings [I52] suggest a tentative model for how remote mental interactions proceed. Charged entanglement via W MEs makes possible sharing of mental images. After a reduction of entanglement the generation of positive and negative energy MEs occurs and involves time mirror mechanism making possible remote metabolism and communications of declarative memories. In the case of ordinary bio-control magnetic body utilizes the metabolic energy resources of biological body.

4. Association mechanism works also for remote mental interactions and is even in the case of brain based on MEs and magnetic flux tubes with neuronal firing and metabolic activities being side products of the this mechanism.

5. One of the strange findings about remote mental interactions is that remote viewer can receive information about an object for which she knows only coordinates, which as such are meaningless numbers to her. It is also commonly reported that erroneous readings or interpretations of the target tend to propagate to other viewers. These findings suggest that magnetospheric (earthly or galactic magnetosphere could be in question) dynamical multi-brained selves act as kind of relay stations mediating the remote contact between remote viewer and object. If some brain knows the meaning of the coordinates of the target, this is enough to connect remote viewer to the correct target.

Empirical support for the notion of multi-brained collective levels of consciousness comes from the experiments of Mark Germine [J107] . An operator and a subject person were involved. The stimulation of the subject person consisted of a sequence of identical sounds containing now and then an odd-ball stimulus (now silence). The odd-ball stimulus generated an event related potential (ERP) visible in EEG and reflecting the conscious reaction. The operator was in a second room and by simple toss of coin decided whether to observe the stimuli in the computer monitor or not. The stimuli appeared in the computer monitor one second before they were heard by the subject person.

What was found that when the operator saw the odd ball stimulus from the computer monitor, the ERP was weaker on the average. An 11 Hz periodicity was the major component in the difference profiles.

The simplest explanation is that the brains of both the operator and of the subject person belong to a larger multi-brained self and that the evoked response represented partially the reaction of this self. When this multi-brained self had already seen the stimulus through the operator's eyes, it was not so surprised to hear this stimulus again through the ears of the subject person, and ERP was weaker.

The appearance of the 11 Hz periodicity suggests that this frequency is an important correlate for the entanglement of the subject person's mental images with those of some multi-brained magnetospheric self. The cyclotron frequencies of most bosonic ions in Earth's magnetic field

are in alpha band so that the finding is consistent with the vision about a fractal hierarchy of generalized EEGs associated with the dark matter hierarchy [K20] . The notion of hyper-genome provides a detailed model for how transpersonal levels of self hierarchy control the behavior of groups of individuals. The hypothesis could be tested by looking whether the gene expressions of individuals having close personal relationship but not in a direct personal contact correlate.

10.5.2 Sketch for what could happen in a typical remote viewing experiment

Consider a situation in which a system consists of remote viewer A, person B knowing the position of target T and the coordinates XYZ for it. B gives the coordinates XYZ for person C in turn giving them to the remote viewer A. The following simplified sketch assumes that communication channels are permanent and that the intentions involved with the process are realized as p-adic space-time sheets in the brain of A, and very probably involve p-adic MEs as representations of the intentions.

1. Remote viewer A, person B knowing having target-XYZ association as two mental images in his brain, and target T have permanent bridges to a magnetospheric multi-brained self M. Therefore M knows the target-XYZ association via the brain of B.

2. Remote viewer A is a client of the multi-brained self M using the remote sensory services provided by M. A-M contact is more or less permanent: this is what it means to have the ability to remote view. Minimum requirement is the existence of magnetic flux quanta connecting A to M. The sharing of mental images requires generation of entanglement, say charge entanglement by W MEs. This would correspond the most primitive passive mode of remote viewing. W mode allows to share also mental images of primitive living systems like plants, and even those assignable to system regarded usually as in-animate. The reduction of charge entanglement makes possible remote mental interaction since resulting charge non-equilibrium generates currents: generation of nerve pulse and Ca^{++} waves would represent basic example of this kind.

3. One can imagine also active mode of remote viewing and this could be involved with telepathy: in this case M would not be involved. This mode involves intentional action (p-adic MEs are transformed to their real variants) and classical communications with the geometric past/future using neutral negative/positive energy MEs could realize declarative memories/"declarative" precognition as well as motor action based on classical communications using symbolic representations. The model for bio-photons suggests that Z^0 and em MEs are generated after the reduction of charge entanglement. The ability to predict reasonable well the personal future could rely on "declarative pre-cognition". The evolution from bicameral mind to modern consciousness [K77] could have proceeded from a mere sharing of mental images by W MEs to complex classical symbolic communications involving also neutral MEs.

4. Since M cannot be assumed to have anything comparable to a nervous system, A-M communications should rely on sharing of mental images. That is, the intention of A (p-adic space-time sheet in brain of A perhaps) to remote view and the questions of A about the target would be shared by M. T-M communications could involve classical communication with light velocity generating magnetospheric sensory representation about the target by self-organization. The 13-17 second delay of remote mental interactions [J89] could correspond to the typical duration of charge entanglement. Target could be also "non-living": it is quite possible that magnetospheric selves form sensory representations also about "non-living" matter. The finding that meteor sounds have frequency spectrum in the 40 Hz band of thalamocortical resonance frequencies, rather than in the predicted 20-20.000 Hz band, supports the view that magnetospheric sensory representations at 40 Hz resonance band are associated also with the non-living matter [K41] , [F4] . Also the vision about dark matter hierarchy conforms with the idea about Earth's magnetosphere as a living organism.

5. Remote viewing by the sharing of mental images means that there are no sensory receptors associated with the passive mode of remote viewing: no such receptors have been identified

[J66] . Various physiological correlates (say EEG patterns) of remote viewing should be reactions to the shared mental image rather than direct correlates of it. If primary sensory qualia are at the level of sensory organs, remote viewing differs from hallucinations in that there is no feedback to the retinas from cortex responsible for "qualiafication": this could provide be a clear-cut test. At least in the case of living targets the laws that govern the ordinary sensory perception should hold true for the remote viewing. For instance, the known correlation of the AC performance with the spatial and temporal entropy gradients of the target should hold true for living targets. Even in the case of a non-living target similar correlation holds true if the sensory perception of magnetospheric selves obeys same laws as that of ours: there is some evidence for the correlation of the entropy of non-living target with the AC performance [J66] .

10.5.3 About the physiological correlates of anomalous cognition

In the article "Physiological correlates of Psi cognition" of Charles Tart [J150] some apparently contradictory findings about physiological correlates of anomalous cognition are described besides the experimental findings of Tart. Changes in EEG, galvanic skin response, finger pulse, and basal skin resistance are examples of possible candidates for the physiological correlates of remote mental interactions.

The findings are following.

1. The first class of experiments involves two persons: subject and agent. The agent is subjected to various kinds of stimuli inducing emotional response: sudden sounds, painful stimuli as in the experiments of Targ, etc.. Subject person is typically in a sound proof room and tries to remotely cognize when subject person experiences these stimuli. Various candidates for the physiological correlates are measured. The physiological correlates typically express a heightened arousal. For instance, in the experiments of Tart [J150] galvanic skin response occurred more frequently, and EEG became more complex with more beta waves and fewer alpha, theta, and delta waves.

2. In the second kind of experimental arrangement remote viewing or telepathy is involved but the second person, if present at all, is not subject to any stimuli inducing emotional reaction. Now the physiological correlates tend to be characteristic for a relaxed state of mind. The increase of the basal skin resistance is one such correlate.

At first these findings might seem to be contradictory. The paradox disappears if sharing of mental images is in question and if the mental images induce same emotional response in the subject person as in the agent.

The remotely perceived (possibly sub-conscious) stimulus or remote anticipation of the stimulus induces in the subject person an emotional reaction having as a correlate the reduction of skin resistance. In the experiments of Tart [J150] both the real electrical stimulus experienced by the agent and the electrical stimulus guide by the operator to an electrical resistance instead of the agent, generates the arousal in the subject. This requires that both the operator, agent, and subject belong to the same multi-brained self so that the reaction of the subject can be interpreted as a kind of conditioned reaction of the multi-brained self expressed via the body of the subject.

10.5.4 Local sidereal time, geomagnetic fluctuations, and remote mental interactions

The article of J. Spottiswoode [J148] discusses two strange findings about remote mental interactions.

1. There is a statistical tendency of the anomalous cognition (AC) performance to concentrate in a 2 hour period around 13.30 of the local sidereal time (ST), which is the time measured using as a reference distant stars and thus running at a slightly different rate than the solar time: the lag is $\Delta T = 24/365$ hours ~ 3.7 minutes during 24 hours.

2. The anticorrelation between the level of geomagnetic fluctuations and AC performance has also a maximum during 2-hour period around ~ 13.30 ST.

The fact that AC performance is associated with the same sidereal hour suggests the identification of the galactic magnetosphere as a conscious involved with remote cognition. For interstellar and galactic magnetic fields cyclotron time scales correspond to the time scales of human consciousness so that also these magnetic flux quanta could receive sensory input from biosphere and control it.

Support for the role of magnetospheric consciousness

The so called ap index measures the intensity of the fluctuations of the Earth's magnetic field. If the magnetosphere is a conscious entity, ap index can be interpreted as a measure for the level of arousal of the magnetospheric mind. The negative correlation between ap and AC performance tells that AC is most probable, when the magnetosphere is in a "calm state of mind". This is natural since only in this kind of situation the noise masks minimally the signals from the galactic magnetosphere.

The local magnetic noise produced by the modern high tech environment is much stronger than the geomagnetic noise but this does not matter. If artificial magnetic fields correspond to $k_d = 0$ level of the dark matter hierarchy, they have no effect on higher levels of dark matter hierarchy. Note that the hypothesis is $h_{eff} = nh$, where n is product of distinct Fermat primes and power 2^{k_d}.

Is there an ELF signal from the special direction masked usually by the geo-magnetic noise?

The obvious question is why the anticorrelation between anomalous cognition effect size and ap index is highest at 13.30 ST? What this finding means that a particular portion of the sky defined by a definite longitude is above the head of a successful anomalous cognizer independently of the time of year. Thus there should be something special in a direction at this longitude.

The simplest explanation for these findings goes as follows.

1. Suppose that there is a higher level conscious entity at the direction 13.30 ST at the galactic magnetic body such that various cyclotron frequencies involved with the communications with this entity correspond to a typical time scale of the anomalous cognition. This conscious entity could have size of galaxy or it could correspond to a flux tube of galactic magnetic body using the cognizer and target as sensory receptors and motor instruments just as our magnetic body might use neurons of our brain or our body parts.

2. Anomalous cognition could involve positive and negative energy signals to this magnetic body and back so that essentially instantaneous AC events would be possible.

3. The information transfer between two kinds of flux tubes is made possible by the topological condensation of the flux tubes of B_E or its dark variant at those of the galactic magnetic field or its dark variant and would be maximal when both are nearly vertical. Also geomagnetic noise would be transferred via wormhole contacts to the flux tubes of the galactic magnetic field and perturb these communications. Both AC and its anticorrelation with geomagnetic noise would be maximal when the flux tubes of of magnetic fields in question are approximately parallel. Since the flux tubes of B_E are approximately vertical, this the case when the galactic center is directly above the head. This would explain the special value of sidereal time. One can say that the magnetic flux tubes of the interstellar magnetic field define kind of cosmic umbilic cord which might serve as a correlate for the tunnel experience associated with NDEs.

4. If signals to geometric past and back are involved the time and length scales would measured using 10^5 years as unit. The signals themselves would be coded using frequencies characterizing time scales of neural consciousness as kinds of ripples to the very slowly oscillating background signal just as perturbations due to nerve pulses interfere with EEG rhythms. Since remote psychokinesis and anomalous cognition should rely on the same mechanism, the first guess for the time scale involved with these signals is as the time lag of 13 to 17 seconds involved with the remote realization of intentions by Qigong masters [J89] : the interpretation as a typical duration of charge entanglement was already proposed. It would

not be surprising if the time scale of entanglement would determine also the scale of cyclotron frequencies. This would mean the importance of the frequencies in the range .06 to .08 Hz for anomalous cognition.

The following scenario suggests a possible manner to understand the time scale of remote PK.

1. If protonic cyclotron transitions generate the low frequency MEs in the range $f_1 = .06$ Hz to $f_2 = .1$ Hz, the strength of magnetic field must be in the range 13 to 17 nT (nanotesla). The magnetic flux tubes of an interstellar magnetic field in a direction with a longitude defined by 13.30 ST should be in question.

2. The ends of the magnetic flux quanta attached to structures within the inner magnetosphere co-rotate with Earth. The resulting twisting presumably tends to induce additional noise to the interstellar magnetic field or Earth's magnetic field or both.

3. The strengths of the typical disturbances of Earth's magnetic field are in the range 50-200 nT [J148] . The average strength for a given frequency component for the fluctuating part of the Earth's magnetic field increases at low frequencies. At the alpha band the strength of the Fourier component of fluctuations is about $\sqrt{B^2(f)} \simeq 1\ pT/\sqrt{Hz}$ at alpha frequencies. Interestingly, the magnetic perturbation produced by brain at alpha band has a peak, which is slightly above the fluctuations of the Earth's magnetic field. This is perhaps not an accident in light of the expected role of the alpha band in remote mental interactions. The strength for the Fourier component $B^2(f)$ for the fluctuations of $B^2(t)$ [J34] is roughly $\sqrt{B^2(f)} \simeq .1\ nT/\sqrt{Hz}$ at $f_2 = .01$ Hz, and about $\sqrt{B^2(f)} \simeq 10\ nT/\sqrt{Hz}$ at frequency $f_1 = .06$ Hz.

   What puts bells ringing is that the noise level 50-200 nT is by a a factor 4 to 15 higher than the required interstellar static magnetic field at the lower limit corresponding to the 17 second period. These findings suggests that magnetic fluctuations tend to mask the positive effect of the interstellar magnetic field on AC. Only when the strength of the fluctuations of the Earth's magnetic field at the cyclotron frequency of the interstellar magnetic field reduces sufficiently below the strength of the interstellar magnetic field, the masking effect is small enough.

What is the origin of the interstellar magnetic field?

The idea about the magnetic umbilic cord connecting distant astrophysical objects to a single quantum coherent whole is sensible in the many-sheeted space-time. The TGD based model for the galaxy formation assumes that the ordinary matter results from the decay of cosmic strings, which are objects carrying extremely strong magnetic fields (magnetic flux tubes and these objects belong to the same solution family of field equations). These cosmic strings form a complex network. For instance, this model explains gamma ray bursters [K80] .

The huge energy production of gamma ray bursters is consistent with their huge distance only if one assumes that the energy is liberated in jets. In TGD framework the gamma ray bursts can be identified as jets resulting in the decay of split cosmic strings giving rise to the ordinary matter. The bursts are indeed known to originate in the regions, where new stars are born. This picture supports the idea about the existence of a fractal magnetic flux tube network connecting different astrophysical objects, and left as a remnant from cosmic strings, when their magnetic energy transformed to the ordinary matter and gave rise to the birth of stars. This network could give rise to galactic nervous systems in turn combining to the central nervous system of the Universe.

Surprisingly, this picture might be consistent with the constraints on the direction and magnitude of the interstellar magnetic field.

1. According to the online lecture of S. Oliver [E5] , the measured values of the interstellar magnetic fields depend somewhat on the method with which they are measured (this might be a signal of the many-sheetedness). The interstellar magnetic fields vary in the range $B_u = 1$ mGauss– $B_l = .1\ \mu$Gauss [E10] , which means that both electronic and protonic cyclotron time scales for all interstellar magnetic fields correspond to time scales relevant for human consciousness. The minimal values of k_d are $k_d = 53$ for B_u and $k_d = 66$ for B_l from

thermal stability: .1 second time scale of alpha band is mapped to 50 s for B_u and to ~ 3 days for B_l.

2. The synchrotron radiation associated with the diffuse emission from the whole sky but concentrated towards galactic plane corresponds to a field strength $\sim$ .6 nT. Zeeman splitting for hydrogen 21 cm line from condensing clouds gives fields in 1-2 nT range. In the plane of the galaxy the field is roughly parallel to spiral arms and its strength is .1-1 nT and too weak to correspond to the proposed magnetic umbilic cord. Also the direction of the spiral arm is different from the direction of the required magnetic umbilic cord.

3. The second guess is that the magnetic umbilic cord is orthogonal to the galactic plane. The direction of the galactic Norh Pole has the right ascension (identifiable as the sidereal time at the meridian of the rotating observer) RA=12.49 $\delta = 27.4$ degrees: RA is not too far from 13.30 so that this guess might make sense. Taking into account that the rotation axis of is tilted by 23.5 degrees towards Sun this would mean that the direction of the magnetic umbilic cord is with accuracy of 3 degrees in the plane defined by the orbit of Earth around Sun. Interestingly, the magnetic field associated with the solar wind varies in the range $.2 - 80$ nT and average value is 6 nT.

   According to [E10] , galactic center carries a dipole like field with a strength of order 100 nT, not too far from 10-30 nT. Also this field has filament like structures (flux tubes), which might extend to long distances [E10] . The flux tubes of this field should intersect the galactic plane orthogonally. If the strength of the magnetic field inside the flux tubes stays constant rather than varying like dipole field strength, these flux tubes could give rise to the magnetic umbilic cords connecting us directly to the center of the galaxy. Galactic center, perhaps the immense black-hole region there, could be an monstrous brain having galaxy sized central nervous system! That the model for magnetospheric consciousness would generalize to the scale of entire galaxy would conform with the fractality of consciousness.

4. According to [E10] , supernova remnants are accompanied by radial filament like structures carrying magnetic field in 1-10 nT and it seems that supernova wind might carry this field around galaxy: very natural if flux tubes carry the field. According to [E5] , for individual sources such as supernova remnants like Cas A Minor, the field strength is 10-30 nT. This corresponds to the interval 5.6 to 17 seconds. That the field strength is of the same order of magnitude as the dipole field at the galactic center conforms with the idea about magnetic nervous system of galaxy connecting the center of the galaxy to the stars. This magnetic field would be easy to observe in case of supernovae because super nova explosion has packed magnetic flux tubes to a very dense bundle.

Connections with other effects?

There might be fascinating connections with other strange findings.

1. In Comorosan effect [K101] , [I33] the irradiation of a bio-matter with a laser irradiation lasting for a multiple of 5 seconds has anomalous effect on a catalyst action. 5 seconds corresponds to to $n = 3$ cyclotron transition for proton in a magnetic field of 10 nT. Comorosan effect occurs also in a non-living matter and suggests that the magnetic umbilic cord serves as a kind of cosmic clock.

2. The strength of the Earth's magnetic field in far-away in the plasma sheet is about 10 nT. Could this cosmic magnetic umbilic cord be connected with the plasma sheet and be in a synchrony with what happens there? Plasma sheet is known to be highly self-organizing structure containing in the velocity distributions of charged particles features like "wings" and "eyes" [F5] . In [K43] I have proposed that plasma sheet defines the "self model" of magnetospheric brain and is thus in a role analogous to the insula in the human brain. It would rather natural for the cosmic umbilic cord to couple with that part of the magnetospheric brain which corresponds to the highest level in the self hierarchy associated with the magnetic Mother Gaia.

3. Lungs contain magnetic particles giving rise to magnetic field of about 10 nT. The theory of magnetospheric sensory representations inspires the speculation that the moment of physical death is decided by magnetospheric self sending to lungs stopping signal at proton's cyclotron frequency associated with 10 nT magnetic field.

10.5.5 Could magnetic flux tubes make possible effective holograms?

What conscious holograms really are? Are they genuine holograms or are they holograms only in the sense that the scattering of light beams from them is very much like scattering on ordinary holograms - that is like scattering from the original object. Could one imagine mechanism making possible scattering from the original object effectively represented by the hologram like structure?

To proceed notice that there is rather general belief that just some objects possessed by the patient is enough for healer- in some sense this object are holograms of the patient. Usually this belief is of course regarded as primitive pars pro toto magic. This belief might however have some justification in terms of negentropic entanglement expected to be fundamental aspect of remote mental interactions. In principle negentropic quantum entanglement can take place via arbitrary number of relay stations and magnetic flux tubes connecting the entangled objects would be the quantum correlate for it. Negentropic entanglement would serve as a correlate for attention, experience of understanding, etc., and it would correlate closely with metabolism: generation of ATP and associated high energy phosphate bond would generate negentropically entangled electron Cooper pair or add electron to negentropically entangled existing many-electron system and its decay to ADP would liberate metabolic energy quantum and destroy the negentropic entanglement.

Negentropic entanglement could actually mean that objects of the external world - say living beings - can act like parts of our biological body. There is a wide variety of psychological experiments which show how illusory is our view about what our body is. Quantum entanglement of object with its target having magnetic flux tubes as geometric correlates making object a relay station. The object - call it O - would only serve as a relay station connected to say person, call it P, possesses the object. The light scattering from the O could actually transform to dark photons and travel along flux tubes to P, where it is scattered back- say from DNA- and returns back along flux tubes and leaves O. Effectively this is like scattering from a hologram of P represented by object O. The flux tube connection would make various objects in our vicinity effective holograms. This is something that one actually expects since attention- both visual and auditory - has flux tubes connecting perceiver to the target of attention as correlates.

One can consider two options since the radiation to object could transform to positive or negative energy photons. In the first case scattering could be seen as ordinary scattering from P. Negative energy photons would however represent signals traveling to the geometric past (analogs of phase conjugate laser beams) and scatter back from P as positive energy photons traveling to O. TGD based models of memory as communications with the geometric past and intentional action as a process in which negative energy signal to geometric past initiates neural activities (Libet's findings about active aspects of consciousness) involve similar mechanism. Also the remote metabolism based on sending of negative energy signals to a energy storage (analogous to population inverted laser) relies on the same mechanism.

Peter Gariaev's experiments irradiating DNA with red laser beam generate broad of radio waves, which in TGD Universe could correspond to photons with same energy but with large Planck constant. These photons have biological effects on organisms of the same species and even on closely related species. TGD based proposal is that the scattered laser beam defines a collection of frequencies serving as addresses for parts of DNA activating gene expression.

If this represents a basic mechanism of genetic expression, one can quite well imagine that an organism- call it A - whose DNA is somehow damaged, could utilize the healthy DNA of another organism - call it B - by sending to it the counterpart of laser beam which scatters and generates the superposition of dark photon beams serving as an address activating the DNA of A. A would effectively use the DNA of B and B would effectively become part of A:s biological body. This mechanism could explain why the mere presence of healthy organisms of the species can induce the healing of organism which is not healthy. It could be the basic mechanism of healing: patient could remotely use the healthy DNA of the healer to generate signals activating her own genes.

Some further comments and questions are in order.

1. The relay station mechanism could universal in biology. The transformation of ordinary photons to dark photons at flux tubes defining the magnetic body of DNA is assumed in the model explaining the photos taken by Peter Gariaev and his group about DNA sample showing the presence of what looks like macroscopic flux tube structures [K1].

2. The mechanism could also explain phantom DNA as real DNA connected by flux tubes to the chamber that contained the original DNA. The laser beam arriving to the empty chamber would travel along flux tubs to the place, where the removed DNA is, scatter and return back. This would create the scattering pattern assigned with the phantom DNA.

3. One can even ask whether the basic mechanism of homeopathy relies on relay station mechanism. Homeopathically treated water would be a collection of flux tube connections to the molecules, which were present in the first stage of the preparation process of the homeopathic remedy. Since the dark photons travel with light velocity, the times for travel of photons would be so small that the scattering of incoming light via the relay station mechanism would almost instantaneous so that the original molecules would be effectively present.

4. For instance, the de-differentiation of cells which looks to my rather mysterious phenomenon, means rejuvenation. Could one imagine that the genetic programs are replaced with those in geometric past and similar mechanism is at work. Could the rejuvenation mechanism involve scattering of the counterpart of phase conjugate laser light from non-differentiated healthy cells of the geometric past? If so, one should try to achieve the same effect directly at the level of cells. One could try to induce de-differentiation of the cells of the owner of the object serving as a relay station in the same manner. Healing of say cancer cells by de-differentiating them to omnipotent state. In the experiments involving Becker's DC current just this happened. In this microscopic situation might be can demonstrate the effect really convincingly.

10.5.6 Two attempts to understand PK

In quantum theory context one can try to explain retro PK (psychokinesis) and perhaps even PK using quantum measurement theory. It seems however that quantum theory is not enough and feedback loop to past allowing to observer to affect the quantum system generating random number. In TGD framework intentional action based on negative energy signal to geometric past would be a rough manner to state what this feedback to geometric past is. For instance, intentional generation of motor action would involve a negative energy signal - say in EEG frequency range - from the "personal" magnetic body to the brain of geometric past, where it would initiate neural activity leading to motor action.

My attempt to concretize this picture in TGD framework - inspired by an unpublished article by Brian Millar relying on the observational theory of PK first proposed by Walker [J162, J163] (for an earlier article discussing his vision see [J26]) - led to following two options restricting the consideration on PK in which operator tries to increase or decrease the number of 1:s or 0:s in a random sequence of bits generated by transitions of microscopic quantum system to two alternative final states labelled by bit.

1. For the first option observer (operator of experimenter) performs state function reduction for the quantum superpositions of two states resulting in quantal microscopic process and entangled with bits in data file: one can say that before the reading of the file it contains qubits. This requires further entanglement with observer's quantum states.

   Standard quantum measurement theory alone does not suggest any PK effect since the entanglement with observer does not affect the probabilities of the outcomes of microscopic quantum process. To achieve a non-trivial effect the measurement interaction generating entanglement with the observer must be able to modify the probabilities of the outcomes. This interaction could be called feedback loop in time. This picture seems to me more or less equivalent with that of Brian Millar.

2. "Too-good-to be-true" option would be that the observer's intent transferred backwards in geometric time (feedback loop using the terminology of Brian Millar) can affect directly also

the bits in data file so that they become superpositions of the originally quantum measured (read) bit, and then perform the quantum measurement as above. In this case PK effect could be observed directly by comparing the file subject to PK with its unaffected copy. The size of the effect would be characterized by the induced mixing. Of course, this kind of idea would have looked completely crazy for few years ago and perhaps even now.

The fact however is that quantum entanglement and quantum superposition have been now demonstrated for increasingly larger systems. Of course, the observer-bit interaction might be be extremely weak due to the large energy needed to change the direction of bit classically.

I am a dilettante as a parapsychologist and in order to compare the two options in more detail I have used as background the article "Correlations of Random Binary Sequences with Pre-Stated Operator Intention: A Review of a 12-Year Program" [J29] tells about experiments of Jahn and others in which operator tried to affect the RNG output by intentional action: single cycle consisting of an attempt to increase the number of 1s, an attempt to decrease it, and no intention to either direction. Retro PK experiments have been also done: see the articles PK Effect on Pre-Recorded Targets [J25] an Addition effect for PK on pre-recorded targets [J27] of Schmidt. In these experiments the background philosophy seems to be conform with the first option.

There is also a report [J30] about an experiment in which chicken was labelled to a robot preprogrammed for months ago to wander randomly around the room: the path of robot was claimed to change so that it stayed near the chicken. Also Libet's experiments [J122] support propagation of intent backwards in geometric time in time scale of about .1 seconds.

In the sequel I will consider the quantum measurement theory option and the "too-good-to-be-true" option in more detail. I will also discuss a possible mechanism for intentional action changing the direction of bit represented as a magnetized region.

Quantum measurement theory option

PK selects the outcome of a quantal microscopic process such as radioactive decay producing a superposition of two states (mapped to superposition of bits by entanglement - qubit in fact) and later to bit by state function reduction. Data file can be said to contain quantum superpositions of bits corresponding to the two outcomes of quantum process and observer (experimenter or operator in PK experiment) entangled with these state pairs in PK experiment and observes/state function reduces the state with click telling whether the outcome was desired.

This stage should bring in the effect of intention and change the probabilities for the outcomes. Standard quantum measurement theory does not allow this: experimenter acts as a passive selector of the outcome. Therefore some kind of feedback interaction propagating to geometric past and affecting the probabilities of outcomes in quantum superposition is needed.

If the data are read before experiment state function reduction takes place qubits become bits. One can also copy the file to a second one and check that the two files are identical. In this case standard measurement theory tells that the effect of observer cannot change the situation and null effect is obtained. This can be of course tested experimentally. Maybe this have been done.

If this option explains the experiment with chicken and robot, the reading of the random number sequence determining the path of the robot before the experiment implies that the labeling of the chicken to robot would have no effect on robot. The interpretation of Libet's findings about neural activity beginning before conscious decision could be that quantum superposition of neural states corresponding to "I do it" and "I don't do it" is generated a fraction of second before the conscious decision which selects either of these options. Does the intentional action propagating to geometric past generate this superposition? Conscious decision "I shall do this or that" would followed by the choice between "this" and "that".

"Too-good-to-be-true" option

Suppose that the data file is copied and second copy is read by human observer to guarantee state function reduction (according to the standard quantum measurement theory: in TGD framework state function reduction does not require human observer).

In this case the feedback loop of the observer (operator or experimenter) realized as negative energy signals to geometric past must be able to modify the states of the binary digits directly

and induce a superposition of binary digits presumably containing a very small contribution of opposite binary digit for a given original digit. After this state function could take place just as in the experiment above. Now the test would be direct: compare the data file with its copy not subject to the action of observer. Statistical procedures would not be necessary and direct demonstration of PK would become possible.

In chicken and robot experiment the chicken could affect the path or robot even if it the file or its copy have been read by human observer. In Libet's experiment decision "I do it" would first generate quantum superposition of options "I do it" and "I don't do it" ("Should I do it?") and select "I do it".

I do not know whether this option even deserves to be killed. Certainly this should be very easy.

How the intention to increase/decrease the number of 1:s or 0:s could be realized?

Can one imagine in TGD framework any mechanism allowing to increase the number of 1:s or 0:s? The basic vision is following.

1. One can consider magnetic fields or their wormhole counterparts accompanying necessarily elementary particles. Ordinary magnetic fields would correspond to single sheeted magnetic flux tubes carrying conserved magnetic flux. Wormhole magnetic fields consist of a pair of flux tubes carrying opposite monopole fluxes at different space-time sheets and have wormhole contacts at their ends transferring the monopole flux between the sheets. Flux tubes or pairs wormhole magnetic flux tubes play a key role in TGD inspired quantum biology and proposed also to be a basic space-time correlate of intentional action. In the recent case flux tubes would connect the observer (operator or experimenter) to the device storing the bits. For wormhole flux tubes the flux tubes at the two sheets could have M^4 projections, which do not overlap at all so that bits could interact with either flux tube but not with both simultaneously.

2. If bits are realized as magnetized regions, the magnetic interaction between bits and the magnetic field carried by flux tube (or either of the opposite fluxes associated with the wormhole magnetic field) is a natural candidate for the interaction defining quantization axis of spin, and also for the interaction inducing a small mixing of the bits by Larmor precession induced by a small perturbation of the flux tube magnetic field. This perturbation could be the TGD counterpart of Alfven wave inducing geometrical oscillation of the flux tube and therefore the direction of the magnetic field. State function reduction after the perturbation has ceases would produce either value of the bit. The strength and duration of perturbation determines how large the probability of bit reversal is.

If one assumes that magnetic interaction is in question, the most natural choice for the representation of bit is as magnetized region of data tape with direction of magnetization determining the value of the bit. This restriction can be criticized but will be made in the following.

1. The energy needed to turn the bit must be above thermal energy but the minimization of energy costs requires that this energy is not much above it and is therefore larger than 5×10^{-2} eV which by the way is also the order of magnitude for the energy gained by elementary charge in the electric field of cell membrane. This energy is considerably smaller than metabolic energy quantum with nominal value of .5 eV. Therefore metabolic energy of observer could provide the energy needed to turn the bit. Note that p-adic length scale hypothesis strongly suggests a hierarchy of metabolic energy quanta coming as octaves.

2. Classically the effect of the small perturbation of the external magnetic field on spin is Larmor precession [D3] due to the torque $\tau = -\mu \times B$. A simple model is obtained by assuming that the magnetic moments in magnetized region is simply the sum of elementary magnetic moments of (say) electrons, which in magnetized state are parallel: $\mu = N_e \mu_e$, where N_e is the number of electrons in the magnetized region defining the bit. The mutual interaction of spins forces them to have same direction so that they are not free.

Classical torque is time derivative of angular momentum and one has total angular momentum $J = (Nm/ge)\mu_e$, where g is so called g-factor not too far from unity. This gives $dm\mu_e/dt =$

$\mu_e \times B$, $mu_e = (ge/m)s$, where s is the spin of the electron. The situation reduces to single electron level and the oscillation of the magnetized regions takes place with the Larmor frequency $\omega = egB/2m$ of electron.

This model is of course highly oversimplified but gives a good idea about what happens. The Larmor frequency of electron is given by $\omega = egB/2m$ and in the "endogenous" magnetic field of .2 Gauss proposed to explain [K66] the effects of ELF em fields on vertebrate brain [J46] (2/5 of the nominal value of the Earth's magnetic field) is $f = 6 \times 10^5$ Hz. One expects that the flux tube magnetic fields and their perturbations are considerably weaker so that the perturbation gives rise to a rather slow change in the direction of the magnetic moment classically.

At quantum level the evolution of the magnetic moment reduces to a unitary evolution of electron's spin by standard Hamiltonian defined by magnetic interaction energy $E = -\mu \cdot B$ and if perturbation acts only a finite time the final state contains a small contribution from opposite value of spin.

3. If all magnetized regions representing bits interact simultaneously with flux tube, the net effect to the spin/ bit average is zero since the probabilities for the inversion of magnetic moment are same for the values of bit. Therefore it is not possible to realize the intention to increase or reduce the total number of 1s/0s in this manner.

4. Wormhole magnetic fields provide a possible solution to the problem. If the M^4 projections of the two flux tubes involved do not overlap energy minimization favors the attachment of the magnetized region with the flux tube for which the energy $E = -\mu \cdot B$ is smaller - that is negative. Since the fields of flux tubes are in roughly opposite directions, bits 1 and 0 tend to condense at different flux tubes. Hence a small short lasting perturbation associated with either flux tube can only reduce the number of 1s or 0s but not both and it would be possible to realize the intention "reduce the total number of 1:s or 0:s" equivalent with the intention "increase the total number 0:s or 1:s". This if the observer's intention boils down to a selection of the wormhole flux tube carrying the perturbation so that wormhole flux tubes would represent bits at the fundamental level.

The consideration of the energetics for the flip of the magnetization direction brings in naturally the hierarchy of effective Planck constants $\hbar_{eff} = n\hbar$ implied by the vacuum degeneracy of Kähler action [K24] [L29].

1. For ferromagnets the Weiss mean field theory predicts that in absence of external magnetic field both magnetization directions have same energy. External magnetic field splits the degeneracy. One could say that the if one regards the magnetized region as big spin, both spin directions have same energy and external field - now emerging from the observer as flux tubes - removes the degeneracy and defines direction for the quantization of spin. The mean field theory of Weiss [D7] based on the expression of free energy as function of magnetization as $F = aM^2 + bM^4 - HM$ is minized and gives M as function of $H = B/\mu$ representing the external magnetic field. For $H = 0$ one obtains remanent magnetization and clearly both signs of remanent magnetization correspond to the same free energy. This theory is of course thermodynamical theory and it is not clear whether it applies to the recent situation (zero energy ontology quantum theory at least formally a "square root" of thermodynamics).

2. The energy needed to turn the spin of single free electron (for ferromagnet electrons have strong exchange interaction and are not free) must be above thermal energy but the minimization of energy costs requires that this energy is not much above it and is therefore larger than 5×10^{-2} eV, which by the way is also the order of magnitude for the energy gained by elementary charge in the electric field of cell membrane. For electron Curie temperature is 843 K, which corresponds to thermal energy $E \sim 6 \times 10^{-2} eV$. This energy is considerably smaller than metabolic energy quantum with nominal value of .5 eV. Therefore metabolic energy of observer could provide the energy needed to turn the spin direction of single electron (note that there is a strong exchange interaction with other electrons). p-Adic length scale hypothesis allows to consider a hierarchy of metabolic energy quanta coming as octaves.

3. Suppose that magnetized region behaves like single big spin so that the magnetic field of flux tube manages to change the directions of all spins simultaneously so that the contribution of exchange interactions is not affected and the change in the energy of the system in external field is due the change of single electron energies only. The large value for the number N_e of electrons gives for the total energy needed to turn the bit $E_{tot} = N_e geB/m$. For micrometer sized region N_e is of order $N_e = 10^{12}$ for one conduction electron per atom. The magnetic field associated with the flux tube is expected to be much weaker than the remanent magnetization of order 1 Tesla. For $B = 1$ nT one would have $E_{tot} = .3$ eV, which is of the order of metabolic energy quantum. The electronic cyclotron frequency is in this field 30 Hz and in EEG range.

4. Magnetic flux tubes are identified as carriers of dark matter and dark photons. This suggests that dark photons representing metabolic energy quanta are involved with the effective value of Planck constant $\hbar_{eff} = N_e \hbar$ (for TGD based view about dark matter see [K24] and [L29]), and that the transition can be regarded as an absorption of single dark photon turning the entire magnetized region. In terms of singular covering of the imbedding space, dark photon can be regarded as a pile of sheets of covering of space-time sheet each containing single ordinary photon. These photon space-time sheets should be somehow attached to the electrons of the magnetized region.

5. The attempt to imagine how multi-sheeted photon/magnetic flux tube interacts with the conduction electrons responsible for ferromagnetism, forces to ask whether also they are dark with the same value of effective Planck constant and reside at various sheets of the singular covering having the size of the magnetized region. Only the first sheet associated with the double sheeted structure describing electron would multi-furcate and second sheet would carry external magnetic field, and perhaps also the TGD counterpart of the Weiss mean field interpreted as effective description of quantum mechanical exchange forces and having order of magnitude of 100 Tesla. Weiss mean field could allow an identification as return flux of the magnetic field generated by the multi-sheeted electron state. If so, the multi-furcations of space-time sheets predicted by the vacuum degeneracy of Kähler action and predicting hierarchy of effective Planck constants comings multiples of $\hbar$, would play a crucial role in the condensed matter physics. Also the TGD inspired model of fractional quantum Hall effect [K61]) encourages to consider this possibility seriously.

   The signature for the many-electron states associated with multi-sheeted covering is a sharp peak in the density of states due to the presence of new degress of freedom. In ferromagnets this kind of sharp peak is indeed observed at Fermi energy [D7]. Sheets of multi-sheeted covering could also carry Cooper pairs and this could give rise to effective Bose-Einstein statistics of Cooper pairs. In TGD photons emerge from fermions as wormhole contacts with throats carrying fermion and anti-fermion. This raises the question about realizability of Bose-Einstein statistics in Bose-Einstein condensation. If Bose-Einstein condensate corresponds to multi-furcation of space-time sheet, one obtains Bose-Einstein statistics effectively.

As such this model says nothing specific about the temporal direction of the intentional action although it is clear that the situation is four-dimensional in accordance with basic assumptions of TGD inspired theory of consciousness and with zero energy ontology. Most naturally, the negative energy signal to the geometric past could induce a magnetic perturbation propagating along either flux tube.

Summary

Both models are consistent with the general vision discussed by Brian Millar and thus leave open the question whether it is experimenter or operator, who is responsible the PK effect. Experimenters are not completely objective robots, and successful experimenters could have a dream about demonstrating PK convincingly whereas the operators are chosen in "Big Pot" approach randomly. Skeptic experimenters trying to replicate the experiment would tend to produce null result. Experimenters could prove PK by producing it themselves (not my original suggestion)! Taking this seriously, one faces the question whether similar situation could prevail also in other experiments than those of parapsychology.

10.6   TGD inspired model for OBEs

It is good to develop the model for OBEs by first summarizing what OBEs are and then listing the basic TGD specific ingredients of the model and then proceed by making questions (I hope that reader does not feel them to be leading).

10.6.1   OBEs, autoscopy, heautoscopy, and other strange experiences

Phenomenological characterization

The phenomenological characterization of OBEs [J15] has been discussed in [J129] . A precise definition of OBE is to have sensation of being outside the body. Autoscopic experience involves a also a sensation of seeing a mirror double of the body or part of it or at least experiencing its presence. There is a form of AS in which some internal organs are perceived. In one form form of AS only the presence of double is experienced. AS experiences are often accompanied by physical difficulties such as migraine episodes and epilepsy.

Heautoscopy refers to an experience of meeting one's alter ego, doppelganger. The main differences to AS is that in AS the double is mirror image and that alter ego is experienced to have also duplicated features of psychological self.

OBEs are classified to parasomatic and asomatic experiences according to whether the person experiences of having body or not. In aparasomatic experience a detachment from both the physical and parasomatic body is experienced. Blackmore suggest that OBE starts when sensory input from the body ceases while person remains conscious [J47] . This brings in mind the notion of subtle body of spiritual practices identified as the body experienced during lucid dreaming [J164] . The notions of guardian angle and ba-ka double of ancient Egypt, could relate to the double body too.

There is also a classification of OBEs to asensory, naturalistic and supernaturalistic ones. Asensory experience lacks sensory percepts about environment, naturalistic one involves perception of familiar surroundings, and supernaturalistic other-worldly realms like heaven or visits to other planets and contacts with aliens.

One can distinguish between natural and enforced OBEs. Natural OBEs are triggered by exhaustion, illness, traumatic events, NDEs, meditation, etc.. Enforced experiences can result from intoxication, anesthesia, hypnosis, etc..

OBEs induced by electric stimulation

Relatively recently OBEs and AS experiences have been produced by an electric stimulation of the angular gyrus [J91] . Angular gurus is located in the parietal lobe, near the superior edge of the temporal lobe, and is involved in processes related to verbal communication and cognition and also with the transformation of written language to internal monologue. The experience developed to a full fledged OBE as the intensity of electric stimulation was increased. The electric stimulation induced responses in vestibular and sensory-motor systems, two of three systems which govern body balance.

According to experimenters, OBE and AS frequently involves what they call pathological sensations of position, movement and perceived completeness of one's own body. These include vestibular sensations such as floating, flying, elevation and rotation, visual body-part illusions (illusory shortening, transformation or movement of an extremity) and the experiences of seeing one's body only partially during OBE or AS. Authors believe that these experiments yield neurological evidence about the common neurological mechanism behind OBEs and AS experiences.

[J129] [J16] has criticized the interpretation of experiments.

1. Only single subject person was studied. She suffered from temporal lobe epilepsy and the epileptic region was at distance of about 2 cm from angular gyrus. Hence one can ask whether genuine OBEs were in question and whether the results generalize to healthy persons.

2. The OBE was not typical. For instance, body was seen only partially and the conscious attempt of the subject person to examine it more closely led to its disappearance. The environment was not perceived.

3. The claimed localization of the spot inducing OBEs to angular gyrus might be an illusion. Same researchers have represented results in which the OBE is induced in a different manner. Interestingly, the experience is associated with the generation of 4 Hz theta wave, which corresponds to the dominating EEG band during sleep.

4. The reductionistic conclusion that OBEs can be reduced to neuropathology and are thus "only" hallucinations is not justified. What has been shown is that electric stimulation of angular gyrus helps to induce the OBE and this leaves a lot of room for theorizing.

Explanations of OBEs and related experiences

The explanations for OBEs can be divided to two classes.

1. Something is assumed to leave the body.
   This something could be something physical or non-physical ("astral"). In some cases people who have had OBE share reported of having perceived objects that were actually there and having experienced events and dialogue that truly happened. Charles Tart has documented the case of Miss Z [J151] who in controlled experiments was able to deliver the randomly selected five digit number which was in a position which could be seen only from the position out of her body. Telepathy would be an alternative explanation for this.

2. Nothing leaves the body.
   Parapsychological explanations involve remote sensing and hallucinations. Psychological explanations regard OBEs as basically hallucinations. The observation that electrical stimulation generates both AS and OBE could be seen as a support for this interpretation. Of course, one can ask what hallucinations really are. Furthermore, the reports about seeing internal organs during AS experience [J41] are not easily explainable as hallucinations.

TGD based model does not fit into either category. The model involves the notion of magnetic body serving as the third person receiving visual stimulus from the body and reflecting it back to the brain where its is processed. In this model the conflict between hallucinatory character of AS and OBEs and a real perception of body from outside is only apparent. The basic mechanism allows to develop also a more detailed model for dreams, hallucinations, third person aspect of wake-up consciousness, and directed attention.

10.6.2 Questions

In the following the model is developed by posing questions about OBEs.

Where the information processing giving meaning to what is seen is carried out?

Seeing is much more than just receiving the photons on retina, since a lot of information processing is needed to give meaning to what is seen. This essentially involves a decomposition of visual input to recognized objets having relations to each other and to the past of perceiver. This applies also to the visual percepts during OBEs. The most natural candidate for the system processing the visual stimulus and giving it meaning is the brain of the subject person.

Sharing of mental images allows to consider an alternative interpretation based on telepathy. The sensory organs in other bodies receive the visual stimulus and and other brains do the information processing. For instance, "unconscious" victim of accident could share the fused mental images of people around the place of accident. This would explain the case of Miss Z studied by Tart [J151] as telepathy.

Are OBEs "only" hallucinations?

In TGD framework the first possibility is that the sensory stimulus is always artificial and comes from brain to eyes and other sensory organs by back projection. OBE would be a dream like cognitive representation, simulation rather than a real percept. REM is expected to always accompany OBEs in this case.

There is an objection against this idea. If person is unconscious or has NDE, it is questionable whether she is able to construct such high level cognitive representation as the representation of the state of her own body as seen by outsider is, and even transform it to a sensory representation. One can also ask what hallucinations really are. In TGD framework hallucinations must be generated by an artificial sensory stimulus so that hallucinations and genuine OBEs might involve the same basic mechanism.

Does OBE originate from an actual sensory stimulus?

The well-known fact that body parts indeed contain holograms about other body parts [I59] (see the discussion in [K37]) and the TGD view about the relationship between dark and living matter [K19] allows to consider seriously the possibility that OBE originates from an actual sensory stimulus.

The dark photon laser beams emanating from the body would be received by a magnetic body containing dark matter at some level in the hierarchy of magnetic bodies and would be reflected back to the receiving sensory organs along MEs possibly parallel to magnetic flux tubes rather than space-time sheets along which ordinary visual input arrives.

It is quite possible that several magnetic bodies in the hierarchy are involved. The magnetic bodies involved need not always correspond to a personal magnetic body and could receive input from several biological bodies and remote vision and telepathy might involve signals from brain reflected to a second brain via multi-brainy magnetic body. Magnetic bodies could be associated also with "dead" matter.

In this picture the case of Miss Z could be understood in two alternative manners. A dark photon beam possibly created by the visual representation of the random number (does "dead" matter generate sufficiently intense beams of this kind?) and reflected by personal magnetic body could be in question. Alternatively, the magnetic body involved could receive the information about random number from the brain of the experimenter and reflect it to the brain of the subject person.

Why does electrical stimulation induce OBEs?

Electrical stimulation of angular gyrus induces OBEs just as the stimulation of neurons of temporal lobe induces long term sensory memories. In neurological "brain only" approach the interpretation would be that the responses in the vestibular and somatosensory system induce the AS and OBE as hallucinations. In TGD framework the response in vestibular and somatosensory system would be interpreted as a response to an actual experience of being in a detached position and orientation, and brain would processes genuine sensory data about being in detached position.

One might think that the temporal ordering between the experiences and these responses would allow to decide which causes what. In TGD framework negative energy signals propagating backwards in the geometric time are however a basic element of brain functioning and this criterion need not be apply.

One imagine two mechanism generating OBEs.

1. The mechanism inducing visual OBE and related experiences could simply turn off the ordinary sensory input so that only the dark photon beams from the magnetic body and reflected back from biological body would contribute to the visual stimulus. This would occur automatically during dreams and NDE experiences.

2. The sensory input from the magnetic body could be amplified. Time mirror mechanism (see fig. `http://www.tgdtheory.fi/appfigures/timemirror.jpg` or fig. 24 in the appendix of this book) could be responsible for this amplification [K95] . During epilepsy strong electric fields generated by brain during epilepsy induce starvation of neurons and the electrical stimulation of angular gyrus could have the same effect. Starving neurons would generate a beam of phase conjugate (negative energy) dark photons received by magnetic body in order to get metabolic energy. The magnetic body would be in a state analogous to a population inverted (possibly many-sheeted) laser defining a hologram like representation of the body. The receival of negative energy photons would induce a cascade like induced return to the ground state and amplify the dark photon beam arriving from magnetic body so that it would not be masked by the ordinary visual input anymore and would give rise to a percept.

10.6.3 Dark matter hierarchy, zero energy ontology, negentropic entanglement, OBEs

Dark matter hierarchy, zero energy ontology, and the notion of negentropic entanglement lead to new insights also about OBEs.

Basic ingredients of the TGD inspired model

The model of OBEs involves several ingredients that are specific to TGD.

1. Magnetic bodies and field bodies are excellent candidates for the "third person" seeing the ordinary body. Magnetic body could receive a visual stimulus from ordinary body and reflect it back as a visual stimulus during OBE processed by the brain of the subject person. Thus body would see itself from the perspective of the magnetic body. Also dreams and hallucinations might involve the same mechanism. In the case of hearing sounds created by subject person could be reflected back to her ears or more plausibly, microwave hearing [I43] could be involved.

2. Topological light rays ("massless extremals", MEs) are an element of TGD having no counterpart in Maxwell's ED and play a key role in TGD inspired theory of consciousness. The interpretation of MEs has remained somewhat obscure. The development of TGD based model for dark matter residing at magnetic flux tubes and characterized by large value of Planck constant implying quantum coherence in even macroscopic length and time scales changed the situation in this respect. The model for dark matter as macroscopically quantum coherent phase is discussed briefly in this book in chapter [K59] and more extensively in the book "Genes, Memes, Qualia, and Semitrance" [K19] . MEs can be identified as space-time correlates of Bose-Einstein condensates ("laser beams") of dark photons. It is however still unclear whether ordinary laser beams actually correspond to dark photon Bose-Einstein condensates and become visible only in de-coherence to ordinary photons. Negative energy MEs can be identified as correlates for phase conjugate laser beams of dark photons. The so called time mirror mechanism is universal building block of basic biological and brain functions [K95] .

3. Bio-systems as conscious holograms is one of the key ideas of TGD approach [K10] . Bio-holograms [I59] suggest themselves as primary sensory stimuli quite generally. Biological body could generate dark photon "laser beams" received by magnetic bodies and reflected back to retina or perhaps to pineal gland [J125] , the "third eye". This would explain AS as well as the images of internal organs [J41] . Also other systems, at least living systems, could be seen from the perspective of the magnetic body. Remote vision hypothesis testable by using living targets not visible in ordinary sense. This would give also rise to telepathy if reflection occurs from magnetic bodies of another person.

4. In TGD framework sensory organs are identified as seats of primary sensory experience and brain only constructs symbolic representations about percept, in particular identifies objects of perceptive field. This does not exclude a considerable back projection to sensory organs modifying the sensory input. Dreaming involves back projection to sensory organs inducing artificial sensory experiences as simulation. One possibility is that dreams and hallucinations represent direct back projection to sensory organs along neural pathways. An alternative view is that the projection involves dark photon beams generated by brain and reflected back from the magnetic body. If OBEs are hallucinations, the visual sensory memories of the subject person about herself could serve as building blocks to generate simulation about what person looks like when seen from outside.

5. Sharing and fusion of mental images is one of the basic notions of TGD inspired theory of consciousness [K95, K10] . One can ask whether OBE involves sharing of the visual experience of other persons involved about subject person. If this were the case, the presence of other persons would be necessary to have OBE. Sharing of mental images would explain the case of Miss Z as telepathy.

Dark matter hierarchy

The identification of dark matter as a hierarchy of quantum phases labeled by the values of Planck constant [K24] provides additional insights about OBE experiences. Planck constant is quantized and can have arbitrarily large values and since Compton length and other analogous quantum lengths and times scale as Planck constant, this means macroscopic and macro-temporal quantum coherence and a reduced rate of dissipation.

Also the magnetic body controlling biological body (actually onion-like hierarchy of them) is assumed to carry dark matter and (forgetting ontological delicacies) dark matter could be seen as the agent responsible for the quantum control of ordinary matter in living systems. The value of Planck constant becomes also a measure for the evolutionary level of the living system and great leaps in evolution can be identified as transitions increasing the maximum value of $\hbar$ in "personal" hierarchy of magnetic bodies [K20] .

Zero energy ontology and causal diamonds

Zero energy ontology is second new element of quantum TGD and states that all physical states have vanishing net values of conserved quantum numbers. Zero energy ontology provides a firm justification for the notion of negative energy signals consisting of (say) phase conjugate photons propagating to the geometric past. These negative energy signals are crucial element of the time mirror mechanism playing a central role in the general mechanism for intentional action, remote metabolism, and long term memory.

Causal diamond (CD) defined roughly as the intersection of future and past directed light-cones serves as an imbedding space correlate for zero energy state. Space-time sheets representing zero energy states are inside CD and the future *resp.* past boundaries of CD carry positive *resp.* negative energy parts of zero energy states.

What is important from the point of view of consciousness theory is that CDs serve as imbedding space correlates of selves and sub-CDs as those for sub-selves (mental images). Sub-CDs are very much analogous to music instruments in the sense that the frequencies which come as harmonics of the fundamental frequency defined by the proper time distance between tips of CD (coming as powers of two) resonate with the geometry of CD and put it to "ring". Sub-CDs could be seen as an analog of radio receiver as far as sensory representations are considered and sending antenna as far as the motor control of biological body is involved. This allows to communicate sensory data from brain to sub-CDs at magnetic body CD in a highly selective manner. MEs (massless extremals) mediating the communications between magnetic body and biological body are also very much like strings of a music instrument. This picture generalize the earlier music metaphor applied to axonal pathways.

A more precise definition of CD is as the Cartesian product of the intersection of future and past directed light-cone with CP_2. The hierarchy of Planck constants brings in additional structure. There is identification of preferred $M^2 \subset M^4$ defining a preferred time direction (rest system/quantization axis for energy) and spin quantization axis. The preferred geodesically trivial sphere $S^2 \subset CP_2$ and the selection of point assigned with CP_2 at the future and past boundaries of CD gives rise to a selection of quantization axes of color isospin and hyper charge.

Sensory representations are a key element of the consciousness theory and the moduli space of CDs charactering what kind of CDs are possible brings in new representational resources.

1. The moduli space of sub-CDs involves the position for the either tip of the sub-CD and the naive expectation is that this position could code for the position of the perceptive field. If so the representation would be very concrete and since the size of CD is already for electron with .1 lightseconds the representations is realized automatically in astrophysical scale.

2. The moduli space of sub-CDs assignable to the mental images with another tip fixed could represent geometric qualia. Without any further restrictions this space corresponds to proper time constant hyperboloid of future light cone. The values of time parameter come in powers of two. One can however quite well consider the possibility that only a discrete lattice of the hyperboloid is realized- at least in the intersection of real and p-adic worlds.

3. A Lorentz boost for sub-CD induces scaling of frequency and scaling of the object in the direction of the boost. Therefore boost coded to the fundamental frequency of CD could

code for various shapes of a figure obtained by scaling. Boost of sub$-CD$ leaving the other tip of sub$-CD$ invariant could also code for the velocity of object. Also the velocity of the object of the perceptive field could be coded to the shape of sub-CD by performing corresponding Lorentz boots to it [K68] .

4. The moduli space of CDs contains also the choice of quantization axes of energy (preferred rest system) and spin as well as the choice of quantization axes of color isospin and hypercharge identifiable as flag manifold $SU(3)/U(1) \times U(1)$. Mathematician Barbara Shipman has proposed that this flag manifold is involved with the representation of geometric data in honeybee dance [A27] and I have proposed a model for what might be involved [K32] .

The moduli space of CDs is thus highly relevant for the representation of the geometric data associated with the objects of the perceptive field and the this data would be communicated using MEs with harmonics of the fundamental frequency of sub-CD so that sub-CD would act like radio receiver. This includes the position of the real object codable to the position of sub-CDs at magnetic body, the velocity of the object of the perceptive field codeable to the Lorentz boost changing the shape of sub-CD and represented as scaling of the frequency assigned with the stationary object. Also the shape of perceptive field would represent this kind of geometric data. This picture supports the interpretation of sub-CDs as spotlights of attention giving information about many-sheeted space-time inside the regions defined by the sub-CDs. It would seem that sub-CDs are dynamical objects created, destroyed, and shifted in quantum jumps. This picture is also consistent with the explanation for the arrow of psychological time based on zero energy ontology [K94] .

Negentropic entanglement

The third new element is the notion of negentropic entanglement (see fig. http://www.tgdtheory. fi/appfigures/cat.jpg or fig. 21 in the appendix of this book) making sense when entanglement probabilities are rational or even algebraic numbers. Negentropic entanglement makes sense in the "intersection of real and p-adic worlds" consisting of partonic surfaces whose mathematical representations make sense both in real sense and p-adically. Negentropic entanglement is possible also between different number fields in accordance with the idea that cognition corresponds to p-adic number fields and cognitive representations are realized in the interactions of realities and p-adicities. Living matter is identified as matter in the intersection between real and p-adic worlds. This view together with zero energy ontology allows precise definition for the idea that intentional acts transform p-adic space-time sheets to real ones and for the reversal of this transformation [K49] .

It is natural to assume that negentropic entanglement is what makes living matter living and is involved with the sharing of mental images and with the formation of sensory representations by entanglement. Negentropic entanglement can be also time-like. MEs are excellent candidates for mediating this kind of entanglement whereas magnetic flux tubes would naturally mediate space-like negentropic entanglement. The sequence of negentropic entanglements would have as its upper ends sub-CDs at highest layer of the magnetic body and sensory organs as its lower ends. Even sensory organ could have negentropic entanglement with the real object of the perceptive field and this might be crucial element in the construction of the sensory representations. For instance, the deduction of distance of the object of perceptive field might rely on interferometry using the dark variants of visible photons with wave length which is is of the order of the distance to the object.

OBEs in more general framework

A general model for the remote mental interactions follows from a model for the living matter by assuming that also other biological bodies can serve as targets for the control action of the magnetic body or communicate sensory information to the magnetic body. The notion of negentropic entanglement favors biological systems as targets but it is of course an open question whether also "dead" matter could have negentropic entanglement with its magnetic body. Ordinary intentional action would represent a particular case of remote mental interaction in this framework.

Consider now OBEs in this general framework.

1. During OBE experiences the mental images constructed by brain about biological body could be absent due to the absence of the metabolic energy feed to the appropriate parts of brain taking care of the construction of cognitive mental images about biological body and communications of them to the magnetic body. The simplest representation would be in terms of bit sequences with bit 1/0 represented in terms of population inverted state/ground sate of many-sheeted laser. Negative energy signals to the geometric past would be used to read these signals by inducing partial reduction of the population in inverted states. In absence of metabolic energy feed 1:s would gradually transform to 0:s. It is however essential that time-like negentropic entanglement is involved besides classical communications. This would make it possible to share the mental images.

2. In absence of these cognitive mental images to the magnetic body, magnetic body would not anymore provide strict cognitive representations of biological body and virtual world experiences would result. Since only magnetic body would contribute to the bodily experience, the low rate of dissipation due to large value of $\hbar$ would explain the pleasant experience about the absence of the sensory noise.

3. This general picture could also explain why OBEs seem to correlate with neural disorders such as epilepsy and disorders relating to perturbed body image. During this kind of disorders the feedback provided by the sensory and cognitive input would be lacking from the brain regions suffering the neural disorder and magnetic body would be solely responsible for the body image. The lacking strict correspondence between the conformations of magnetic body and biological body would mean that the experience is hallucination from the point of view of biological body. At the imbedding space level the "conformations" of the magnetic body could be rather abstract and represented in terms of positions and other moduli of sub-CDs.

10.6.4 A more detailed model for OBEs

In the following a more detailed model for various aspects of OBEs is developed.

Do bio-photons result from the de-coherence of dark photon beams?

Bio-holography provides support for the body as a hologram (more precisely, dark photon hologram). For instance, an electric stimulation of ear during Kirlian imaging of a finger tip creates a Kirlian photo from which it is possible to abstract a hologram of ear [I59] (for a TGD based model see [K10, K37]). This suggests that body parts can in some sense "see" each other. In particular, brain can "see" body parts (note that bacteria possess a primitive IR vision based on micro-tubules): this of course need not correspond to a conscious vision at our level of self hierarchy.

The biological function of bio-photons [I37] is poorly understood, and they are an excellent candidate for ordinary photons resulting when dark photon beam de-coheres. TGD based model of bio-photons can be found in [K39] and the identification as dark photons is discussed in [K19] . The findings of Peter Gariaev about the effects of visible laser light on DNA [I52] and so called phantom DNA effect [I50] provide a further support for the biological importance of bio-photons (see the discussions in [K19, K39]).

What is the mechanism of out-of-body hearing?

Mechanism could be even more general and work also in the case of other qualia. In particular, hearing might involve similar reflection of sound waves at larger space-time sheets from the magnetic body and heard as "other-worldly" sounds.

A more plausible option is that the auditory sensation is generated by dark microwave photons reflected back from magnetic body. Microwave [K65] [I43] is indeed a well-known but poorly understood phenomenon and the generation of microwaves by plants after sunset correlates also with taos hum [I102] (see the discussion in [K41]) which does not generate any response in microphones but reflects the features of the acoustic environment.

The auditory and visual hallucinations of schizophrenic persons would represent in this framework a genuine sensory input. The notion of bicameral mind introduced by Jaynes [J119] discussed

in TGD framework in [K77] would fit also nicely with this picture. The "god" controlling the behavior of bicameral by giving explicit commands would correspond to some magnetic body, not necessarily that of the subject person, but a magnetic body receiving input from several brains in the social group and representing collective consciousness.

Where are the sensory receptors giving rise to the primary sensory experience?

The simplest guess is that the visual stimulus from the magnetic body is received by eyes. The fact that REM accompanies visual dreaming supports this view in the case of dreams. The receiving sensory organ could be also pineal gland [K14, K69] , "third eye", the seat of the soul according to Descartes [J125] . Pineal gland is known to contain retinal pigments and its counterpart in more primitive animals is known to function as a genuine eye. A simple test in the case of artificial OBEs is to look whether the electric stimulation of OBEs generates also REM.

If OBE hearing is indeed microwave hearing, the identification of the primary sensory receptors is not obvious, although their existence cannot be denied.

The insect olfaction relies on infrared light as discovered by Callahan [I32] (see the discussion in [K32]). One might therefore wonder whether also humans possess olfactory receptors sensitive to IR light, and whether the emission of dark IR photons reflected from magnetic body could play some role in olfaction and in the generation of olfactory hallucinations. One can even ask, whether the molecular recognition mechanism underlying chemical senses relies on IR light. It is known that human nose contains so called vomeronasal organ [J1] sensitive to odors having sexual or social meaning but that these odors do not give rise to a conscious experience.

It is known that blind persons can learn to "see" when their skin is stimulated by electromagnetic fields representing the environment. Perhaps dark photon beams could induce also tactile sensations. Quite generally, the earlier proposal that information in all sensory modalities can be transformed to field patterns represented by MEs could sharpen to the hypothesis that the information in various sensory modalities allows a representation as dark photon beams inducing corresponding sensory qualia in the interaction with appropriate sensory receptors.

What is the mechanism causing the kinesthetic sensations during OBEs?

The model should also explain sensations of lifting, flying experiences, and the experiences of being in translational or rotational motion. The motion of the magnetic body with respect to the physical body should induce this kind of sensations. The basic idea is simple: generalize the mechanism allowing to hear the motion of a sound source. Generalizing from sound waves to dark photon beams, the sensation in question would be basically due to the Doppler shift of the dark photon beams travelling between biological body and the moving magnetic body. The change of the dynamical hologram resulting in the interference of a bodily reference beam and Doppler shifted reflected beam in quantum jumps could be responsible for the sensation.

This model could also resolve an objection against the hypothesis that sensory receptors experience the primary qualia. The objection is based on train illusion. When you sit on a train and look at second train which starts to move, you can have an illusion that it is your train that moves. The illusion is not a mere belief but involves a sensation of acceleration in the entire body. There are two options.

1. The sensation is a response to various bodily activities induced by the belief of being in an accelerated motion.

2. The sensation is caused by a primary sensory input induced by the acceleration. This sensory input must be produced artificially in the case of train illusion.

Consider first a genuine accelerated motion of the biological body. One could argue that in absence of visual, auditory or other sensory information about being in accelerated motion, there is no belief about being in accelerated motion so that acceleration is not perceived at all for option a). This makes option a) implausible. For option b) the acceleration of the biological body with respect to the object defining the rest system is directly perceived. The Doppler shift of the dark photon beams radiated from biological body and reflected back from the rest system would induce

the sensation. Reflection could occur either from the rest system or a magnetic body associated with it.

One can imagine two mechanisms creating an illusory acceleration for option b).

1. If the fixation of the attention to the moving train means the presence of dark photon laser beams connecting biological body and train or a magnetic body associated with it, the Doppler shift of dark photon beams could induce the sensation of acceleration.

2. Directed attention could cause a personal magnetic body to mimic the motion of train so that the relevant part of it deforms in the direction of moving train to keep the distance to the moving train fixed. This would induce train illusion by the same mechanism as in case 1).

For both mechanisms the reflection of dark photon beams becomes the fundamental mechanism of directed attention. Attention would mean a formation very concrete bonds between subject and object or a representation of object at the personal magnetic body: the rays connecting the eyes of cartoon characters would represent a very profound idea about consciousness. Both views about attention mean a clear-cut deviation from the prevailing neuro-scientific thinking according to which the experienced world is virtual and completely detached from the real world.

Cliff illusion might be an appropriate name for the disgusting feeling in stomach which one feels on the brink of a precipice. Sensory imagination about falling down is in question and could be induced by the deformation of the personal magnetic body such that it mimics free fall.

The floating sensations and strange deformations of personal body during OBEs could also correspond to the deformation dynamics of the magnetic body which could be also caused by external influences. If the size of the magnetic body is measured using Earth radius as a natural unit and if the personal magnetic body co-rotates with Earth, the variation of the effect of the solar wind could induce periodic deformations of the magnetic body as in the case of Earth's magnetic field. This could reflect itself as diurnal alterations in the shape of the body experienced during OBEs: a contraction during day time and an elongation during night time. Sunspot maxima induce magnetic storms and these could have strong effects on the shape of the body perceived during OBEs.

What is the mechanism making possible to see internal organs?

Becker tells in his book "Cross currents" [J41] about a young cancer patient who told that he can see the interior of his own body. The patient could also locate the remnant of the tumor correctly. The simplest explanation is that magnetic body at some level of hierarchy reflects the dark photons emitted by the internal organs.

Usually this does not occur and one should understand why the emission occurred in the case of the cancer patient. There is evidence that bio-photons leak out from non-healthy organs [I37] : this might mean that organs send more intense dark photon beams reflected at the magnetic body.

Time mirror mechanism involving time reflection instead of ordinary reflection suggests itself as an alternative explanation. The cells suffering starvation generated phase conjugate dark photon beams in order to get metabolic energy. This in turn induced a cascade like emission of positive energy dark photon beams from the magnetic body instead of mere time reflection.

10.6.5 The role of the magnetic body in the case of other brain functions

During the construction of the model of OBEs it became clear that the reflection of dark photon beams from the magnetic body could serve as a building block of several ordinary brain functions. If has been already found that dark photon beams could define a fundamental mechanism of directed attention.

Dreams and hallucinations and magnetic body

The reflection of dark photon beams from the magnetic body could be involved also with dreams and hallucinations so that the neurological similarity of AS experiences and OBEs does not mean that both are hallucinatory. The "subtle body" assigned by many spiritual traditions with the

dreaming state (for a nice summary see [J164]) would correspond to the magnetic body. In this case mental images constructed in brain would induce dark photon beams sent to magnetic body and reflected back. The mechanism would also naturally explain autoscopic and heautoscopic experiences, in particular the ability to see internal organs.

The relationship of EMDR experiences to OBEs

Near-death experiences are not the only manner to get convinced about life after death. So called eye-movement de-sensitization and reprocessing (EMDR) discovered by Francine Shapiro [J52] induces what could be interpreted as after-death communications (see the discussion in [K67]). The experiences of subject persons are claimed to be induced by this therapy in a highly reliable manner: according to [J52] 98 per cent of patients willing to participate the therapy had after death communication experience. It does not matter what the religious convictions of the subject person are and the experiences are actually rather easy to induce. It does not matter if the loss is traumatic or not or whether it is recent or occurred for decades in past.

The experiences resemble near death experiences (light tunnels, beautiful landscapes) and involve spiritual contact with the deceased. The EMDR technique involves getting the patient to move his or her eyes in a particular rhythmic fashion while at the same time attending to a particular aspect of the traumatic memory. How EMRD works is poorly understood as yet: possibly the fact that the shifting of eyes leads to increased brain processing is of importance. Notice that rapid eye movements REM are also involved with dreams.

A possible explanation is that EMDR experiences involves visual communication using dark photon beams and/or their phase conjugates with the 4-D magnetic bodies of the deceased ones located possibly in the geometric recent or past via the magnetic mirrors associated with them. Essentially the same mechanism as involved with long term episodal memories could be in question: the only difference would be that the magnetic mirrors now mediate information not from own 4-D body from the 4-D body of the deceased.

Third person aspect of conscious experience

Our conscious experience involves so called third person aspect giving a symbolic bird's eye of view about ourselves. Magnetic body could could take the role of the third person. At the fundamental level this representation could be based on sensory stimuli originating from body and reflected back to sensory organs. It would be completely masked by the ordinary sensory input in wake-up state but distilled by brain from the dominating sensory input and coded to a cognitive representation to minimize the amount of irrelevant information. A strong interference of this kind of sensory representation with ordinary sensory input would be obviously highly undesirable. The third person aspect could be present always and be based on the reflection of dark photons along MEs parallel to magnetic flux tubes.

Feedback to primary sensory organs via reflection from magnetic body

One objection against the hypothesis that primary sensory organs are seats of sensory qualia is that that sensory stimuli are only the raw material sculptured into actual sensory perceptions and that directed attention chooses what aspects of sensory stimulus are amplified and which neglected. I have proposed that there is a feedback by projections to the primary sensory organs from brain generating artificial sensory stimuli modifying the primary sensory input. This feedback could be realized also as a reflection of artificial dark photon beams generated by brain from the magnetic body and received as such by eyes or received by brain and channelled to eyes via MEs parallel to visual pathways.

Does imagination involve feedback via magnetic body?

One can wonder, whether also imagination could involve reflection of dark photon beams from the magnetic body. In TGD framework the hypothesis that sensory qualia are generated at primary sensory organs and brain constructs only symbolic representations about experiences circumvents the basic objections such as the experience of phantom leg. In this framework imagination and cognition can be identified as symbol generating activities which are not initiated at sensory organs

but at some higher level of the hierarchy starting from sensory organs and ending at the associative areas of cortex.

Imagination could however involve also transformation of symbolic representations to dark photon beams reflected back from the magnetic body. This input would not contribute to sensory input but might be abstracted from the sensory input and might serve as a kind of feedback. In absence of ordinary sensory stimuli the input from the magnetic body would dominate and imagined mental images would transform to dreams or hallucinations.

Sensory memories and magnetic body

In some exceptional cases often associated with a serious damage in cognitive areas of brain the feedback from the magnetic body could give rise to a genuine sensory representation making possible direct sensory memories. Examples are autistic persons with ability to remember visual scenes music pieces in every detail and also reproduce them.

One explanation is sharing of sensory mental images of geometric past. An alternative explanation is that the information about sensory memory is communicated from the geometric past in symbolic form and transformed to a dark photon beam reflected back from the magnetic body. The fact that angular gyrus is involved with the translation of written language to internal speech and the abstraction of meaning of visual metaphors supports the view that a transformation of linguistic statements to concrete images projected to the magnetic body occurs in this process.

I have proposed a mechanism [K68] explaining synesthesia. The association of different sensory modalities could also occur via a transformation of sensory input in given modality to dark photon beam reflected from magnetic body and generating a sensation in another modality. Synesthetes are also known to be capable of amazing sensory memory feats [J61] and I have proposed an explanation based on time mirror mechanism [K68] . Also in this case neurons in certain region of left brain hemisphere suffer starvation which should be lethal by standard wisdom.

As a matter fact, the starvation mechanism seems to be a very general mechanism: Callahan has found evidence that insects find more easily the plants suffering from under nutrition [I31] (see the discussion in [K36]). Even the fasting common in spiritual practices could be seen as a method to get body entangled with magnetic bodies by using time mirror mechanism.

10.6.6 Psychedelics induced experiences and magnetic body

There is a book about psychedelic induced experiences titled as "Inner paths to outer space" (`http://www.amazon.com/Inner-Paths-Outer-Space-Psychedelics/dp/159477224X`) written by Rick Strassman, Slawek Wojtowicz, Luis Eduardo Luna and Ede Frecska [J93]. It took some time to realize that I have actually have met the Luna and Frecska.

Some background about psychedelics

Phychoactive drugs can be classified into three basic types. Some raise the activity level, some calm down, and some change the character of consciousness profoundly. Hallucinogens/psychedelics [J93] belong to the third group. Psychedelics (such as psilobin, psicylobin, DMT, LSD) [J93] are molecules containing aromatic rings and many of them (such as psilobin, psicylobin, DMT, LSD) attach to serotonin receptors.

As the official term "hallucinogens" implies, psychedelic induced experiences are regarded as hallucinations in the materialistic world view although the denial of the reality of subjective experiences themselves requires a really hard-nosed skeptic. The title of the book reveals that the question posed in the book is whether these experiences could be about real world, kind of sensory input from distant parts of the Universe. The indigenous people using ayahuasca and similar psychedelics have regarded these experiences involving meeting of representatives of other civilisations as perceptions about real worlds. Also Terence and Dennis McKenna, who are pioneers of systematic study of the effects of various psychedelics, shared this view. In the materialistic ontology of standard physics this kind of interpretation is of course excluded. That hallucinations are in question is "obvious", too obvious actually!

The classical psychedelics LSD, psilocybin, DMT, and mescaline are derivatives of two basic chemical groups: tryptamine and phenetylamine which in turn derive from the amino-acids trp

and and phe. DMT is endogenous psychedelic and there is pumping of DMT blood-brain barrier so that DMT must have important function in brain. The action of classical psychedelics is on serotonin receptors and affects the serotonin intake so that the effect is stronger. The amount of serotonin in brain is not large but manifest in all functions. According to the book, the situation might be different for pineal gland which is the only nucleus of brain which does not appear as left-right pair. Descartes regarded it as the seat of soul. Pineal gland is also known as "third eye" and in lower species it indeed serves the function of eye. Taking the title of the book seriously, one can ask whether this eye is able to see but to cosmic distances possibly using large h_{eff} photons.

Could instantaneous communications in cosmic scales be possible in TGD Universe?

In TGD inspired ontology the notion of magnetic body with astrophysical, galactic or even super-galactic size changes the situation completely. The basic communication tool would be touch of magnetic bodies generating reconnections and making possible signalling from the biological body member of distant civilization. The perception of the biological body of alien would differ in no manner from that of my neighbour since the mechanisms would be the same as involved with the transfer of sensory data to my personal magnetic body and control commands from there to biological body (at least through genome).

The basic objection against the possibility suggested by the title of the book is that finite light velocity poses absolute upper bound for the distance of objects with it is possible to be in contact during "trip". One must be however very cautious here: the assumption that signals propagate only to singlet direction of time is essential also and derives from classical thermodynamics. In TGD framework second law continues to hold true but the arrow of geometric time for zero energy states changes in each state function reduction occurring to the either boundary of CD. Hence instantaneous communications ("remote seeing"!)using reflection in time direction become possible even over cosmological distances and define among other things the mechanism of memory in TGD Universe.

I have proposed earlier that UFO experiences [K99] could be induced with the mediation of primitive plasmoid like lifeforms taking the role of mediums making possible flux tube connections and entanglement with representatives of distant civilisations. Time consuming and expensive space travel would become un-necessary: our magnetic body giving us cosmic size together with zero energy ontology making possible instantaneous "seeing" of both future and past by reflection of photons in time direction would be enough. This view would also resolve Fermi paradox. We would be actually in a continual contact with the distant civilisations but without realizing it. Similar contacts could take place in psychedelic induced experiences. Memories and future plans would be examples of "seeing" in time direction. The continual re-creation of the Universe by quantum jumps would of course mean that the actual future/past need not be same as those which are "seen". Shamans identify various plants as conscious entities teaching them - in TGD framework this would translate to magnetic bodies of representatives of distant civilisations remotely teaching the representatives of more primitive civilisations.

If the claims of shamans and true, one must ask whether our brain has well developed tools available for building contacts with distant civilisations and what these tools might be. The receptors of neural transmitters are obviously the natural candidates for the pathways to cosmos. One can argue that evolutionary pressures have forced living matter to develop highly standardized connections to various parts biological body, of the personal magnetic body and possibly also other magnetic bodies. Personal magnetic body has astrophysical size and EEG frequencies would correspond to communications in Earth size scale.

Neurotransmitter receptor complex as plug-ins to cosmic internet and new perspective on remote seeing

If the claims of shamans and true then one must ask whether our brain has well developed tools available for building contacts with distant civilisations and what these tools might be. The receptors of neural transmitters are obviously the natural candidates for the pathways to cosmos. One can argue that evolutionary pressures have forced living matter to develop highly standardized connections to various parts of the personal magnetic body and possibly also other magnetic

bodies. Receptors serving as Josephson junctions emitting Josephson radiation with frequency characterised by h_{eff} are natural candidates for plug-ins.

The model for cell membrane as Josephson junction leads at the microscopic level to the view that the proteins associated with various ion pumps, channels, and receptors (of also neurotransmitters in postsynaptic junction) define Josephson junctions to which magnetic flux tubes are associated and characterized by local value of Josephson frequency, that is membrane potential and Planck constant h_{eff}. As the information molecule is attached to a receptor, a connection to some part of some magnetic body would be generated and split as the molecule is not present. These connections are possible in the scale cell, organelle, organ, organism, population and maybe even in the scale of cosmos. Psychedelics affect serotonin receptors so that serotonin spends longer time in receptor.

The simplest picture is that the connection corresponds to a pair of flux tubes. As the connection is broken, the pair has suffered reconnection cutting it to two U-shaped closed flux tubes. When molecule is attached to the receptor, these U-shape closed flux tubes reconnect. The actual situation is of course expected to be more complex but the basic principle would be this.

In this framework psychedelics would be molecules associated with the reaction pathways facilitating the binding of neurotransmitters responsible for building connections to certain parts of the magnetic bodies characterised by passwords defined by collections of cyclotron frequencies corresponding to a hierarchy of space-time sheets. The Josephson frequency associated with the receptor is inversely proportional to h_{eff}. The natural guess is that it corresponds to the cyclotron frequency of the magnetic body part for electron, proton, or some ion associated with it. Josephson frequency should serve as kind of passwords and receptors would be in one-one correspondence with these passwords defining gateways even to the outer space if the value of Planck constant is large enough.

One might be able to test this crazy hypothesis. Pineal gland could still serve as the "third eye" but utilizing large h_{eff} photons. Fishes and birds are able to navigate to their birth places: could this miracle involve "remote seeing" by pineal gland using the dark light coming along flux tubes or even active variant of this process by sending light which is reflected back in time direction (blue and red light are necessary for the ability to navigate). What about remote seeing in the usual sense: could psychedelics help also in this process?

10.7 Connection to the work of researchers in forefront

Here some examples about the work of other researchers possibly relevant for understanding remote mental interactions in TGD framework is discussed briefly.

10.7.1 Simon Shnoll

Shnoll and collaborators [E2, E7, E6, E3, E9, E4] have discovered strange repeating patterns of random fluctuations of physical observables such as the number n of nuclear decays in a given time interval. Periodically occurring peaks for the distribution of the number $N(n)$ of measurements producing n events in a series of measurements as a function of n is observed instead of a single peak. The positions of the peaks are not random and the patterns depend on position and time varying periodically in time scales possibly assignable to Earth-Sun and Earth-Moon gravitational interaction.

These observations suggest a modification of the expected probability distributions but it is very difficult to imagine any physical mechanism in the standard physics framework. Rather, a universal deformation of predicted probability distributions would be in question requiring something analogous to the transition from classical physics to quantum physics [K5].

The hint about the nature of the modification comes from the TGD inspired quantum measurement theory proposing a description of the notion of finite measurement resolution in terms of inclusions of so called hyper-finite factors of type II_1 (HFFs) and closely related quantum groups. Also p-adic physics -another key element of TGD- is expected to be involved. A modification of a given probability distribution $P(n|\lambda_i)$ for a positive integer valued variable n characterized by rational-valued parameters λ_i is obtained by replacing n and the integers characterizing λ_i with so called quantum integers depending on the quantum phase $q_m = exp(i2\pi/m)$. Quantum integer

n_q must be defined as the product of quantum counterparts p_q of the primes p appearing in the prime decomposition of n. One has $p_q = sin(2\pi p/m)/sin(2\pi/m)$ for $p \neq P$ and $p_q = P$ for $p = P$. m must satisfy $m \geq 3$, $m \neq p$, and $m \neq 2p$.

The quantum counterparts of positive integers can be negative. Therefore quantum distribution is defined first as p-adic valued distribution and then mapped by so called canonical identification I to a real distribution by the map taking p-adic -1 to P and powers P^n to P^{-n} and other quantum primes to themselves and requiring that the mean value of n is for distribution and its quantum variant. The map I satisfies $I(\sum P_n) = \sum I(P_n)$. The resulting distribution has peaks located periodically with periods coming as powers of P. Also periodicities with peaks corresponding to $n = n^+n^-$, $n_q^+ > 0$ with fixed $n_q^- < 0$, are predicted. These predictions are universal and easily testable. The prime P and integer m characterizing the quantum variant of distribution can be identified from data. The shapes of the distributions obtained are qualitatively consistent with the findings of Shnoll but detailed tests are required to see whether the number theoretic predictions are correct.

The periodic dependence of the distributions would be most naturally assignable to the gravitational interaction of Earth with Sun and Moon and therefore to the periodic variation of Earth-Sun and Earth-Moon distances. The TGD inspired proposal is that the p-adic prime P and integer m characterizing the quantum distribution are determined by a process analogous to a state function reduction and their most probably values depend on the deviation of the distance R through the formulas $\Delta p/p \simeq k_p\Delta R/R$ and $\Delta m/m \simeq k_m\Delta R/R$. The p-adic primes assignable to elementary particles are very large unlike the primes which could characterize the empirical distributions. The hierarchy of Planck constants allows the gravitational Planck constant assignable to the space-time sheets mediating gravitational interactions to have gigantic values and this allows p-adicity with small values of the p-adic prime P. A Possible Explanation for Shnoll Effect [K5]

What makes Shnoll effect so interesting is that it involves interaction of very long length scales with microscopic scales - even nuclear physics length scale as in the experiments of Shnoll. Similar situation prevails machine-mind interaction involving intention to affect sequences of random numbers generated by microscopic systems via quantum transitions. The proposed model suggests a mathematical description of the statistical distributions modified by the intentional action but leaves the interaction mechanism open. A possible mechanism could be a realization intentions as actions via a mapping taking p-adic space-time sheets representing them in long length scales to real space-time sheets in short length scales. In the recent case the field patterns would represent space-time sheets carrying classical fields inducing the desired effect at microscopic level on particles that have topological sum contacts to these sheets. Classically gauge forces would be in question and at quantum level modifications of various reactions rates caused by these fields.

This map would be carried out by the quantum counterpart of canonical identification or its variant [K85]. The map would be characterized by resolution defined by power p^N of prime p. For powers of p^n, $n > N$. the map would be continuous from p-adics to reals and for $n < N$ it would be discontinuous and would correspond to the identification of reals and p-adic numbers via common rationals. I have discussed this kind of option based on ordinary canonical identification - actually one of the first ideas related to p-adic physics - in [K104, K105]. The main objection was that this map is not general coordinate invariant. This could however make sense since cognition breaks General Coordinate Invariance via a selection of a preferred coordinate system and bringing in the number theoretic anatomy of coordinate variables. I have also proposed [K48] that the generation of cognitive representations and realization of intentional actions using canonical identification and its inverse could define the analog of T-duality of string theories, which also maps long and short scales to each other.

A more concrete model for the intentional action is obtained if one requires consistency with the model based on time mirror mechanism (see fig. `http://www.tgdtheory.fi/appfigures/timemirror.jpg` or fig. 24 in the appendix of this book) as a key element of intentional action. Canonical identification maps p-adic space-time sheet representing the intention and having the size of CD assignable to intentional agent and characterized by a typical macroscopic time scale (actually astrophysical since already electron corresponds to Earth sized CD with time scale of .1 seconds) to a much smaller space-time sheet representing a flux tube connection and possible accompanying massless extremal connecting the biological body of the operator and and target. The classical fields carried by these space-time sheets would induce the microscopic effect realizing the intention.

10.7.2 Michael Persinger

Anyone - atheist or believer - wanting to learn about Persinger's work and the basic insights of neuro-theology should listen the extremely inspiring talk *God and the Brain - The Persinger 'God Helmet', The Brain, and visions of God* by Todd Murphy [J9]. Persinger's work (for references to the articles by Persinger and collaborators see the Wikipedia article about God helmet) suggests that the temporal pattern of the modulation of magnetic field strength (FM would be in question for slow variations) is important. We do not however know the "code". Also the strength of the magnetic field can be important. Note that the effects of very weak ELF em fields on vertebrate brain take place in amplitude windows [K20].

The modulation of magnetic field would probably induce FM of cyclotron frequencies. The model for hearing suggests this kind of modulation as a manner to represents the frequencies of the sound wave. Also phase information is very important: time reversed speech sounds very different as normal speech but has the same power spectrum. Modulations would be slow in the time scales defined by the audible frequency range. .1 seconds would represent lower limit for the variation rate of modulation. Audible frequencies above 20 Hz.

The article TGD Based View about Classical Fields in Relation to Consciousness Theory and Quantum Biology contains a section considering a model for the findings of Persinger and collaborators using "God helmet". The spiritual experiences induced by "God helmet" could be interpreted as subjective experiences generated when the personal magnetic body receives an additional layer. For instance, manic-depressive bipolar cycle might be understood as a cycle in which euphoric period means the emergence of a new layer appears to the magnetic body and depressive period means its disappearance. I have also commented other findings of Persinger. God helmet might provide a technical tool to test the notion of magnetic body.

10.7.3 William Tiller

William Tiller in Stanford University has carried out impressive experimental work with what he calls intention imprinted electronic devices (IIED), and his results challenge that standard assumption that the intentions of experimenter do not affect the experimental apparatus [J153, J154, J155] .

Experimental arrangement

The goal was to try to imprint a specific intention into a simple, low tech electronic device so as to influence the companion, specific, well-designed, target experiment. The intentional imprinting was attempted in a meditative state. The intentionally imprinted device, IIED, was sent to a laboratory located at distance of about 1500 miles where colleagues had set up the experiment. The device was placed about 6 inches from a continuously running and computer-monitored target experiment and switched on (total electrical power rate was less than 1 microwatt). Over a time period of about 1-4 months the recorded results from the target experiment changed in the directions of the specific intention and the change eventually reached the selected magnitude of the specific intention. Also an identical, but not intention imprinted device was used and the results were compared in order to achieve more objective measurements about the effects of human consciousness on electric devices.

The targets used were purified water, some bio-molecules, and larvae of flies. These targets where either unshielded or shielded from radiation. For the latter purpose they were closed inside a grounded Faraday cage (FC), which screened rather effectively the radiation coming at microwave frequencies whereas for ultra low frequency (ULF) fields the screening is virtually absent (skin depth behaves as $1/\sqrt{\pi\sigma f}$ at low frequencies and $f = 2\pi\sigma$ (in units $\hbar = c = 1$) defines kind of critical frequency above which screening occurs effectively). The targets could be affected by control device (CD) or by identical IIED generating microwave radiation. Radiation was generated either at single frequency (7.3 MHz) or at three frequencies (5.0, 8.0 and 9.3 MHz) [J161] .

In the case of purified water the spatial distributions of physical parameters like pH, temperature, and conductivity were measured as a function time. In the case of bio-molecules the possible effect on thermodynamical activity, which measures the thermodynamical energy of single molecule, was measured. In the case of fly larvae the effect on the larval development time was studied. The results from various arrangements were compared with control targets (no FC, no CD, no IIED).

I have discussed a TGD based model for Tiller's findings the chapter Biosystems as conscious holograms. [K10]. The basis idea is that a connection between the magnetic body of operator and target is formed and the intentional imprinting involves magnetic fields and possibly also corresponding cyclotron frequencies. If one accepts the canonical identification as a map taking intention represented by p-adic space-time sheet to action represented by real space-time sheet in much shorter scale then the space-time sheets create would be microscopic space-time sheets carrying magnetic fields giving rise to the cyclotron frequencies.

The basic experimental results were two-fold. First of all intended effects were achieved. Secondly, the "conditioning" of the laboratory resulted as an unexpected effect and continued even after the removal of the target and IIED.

Direct effects of the intentional action

1. IIED imprinted by intention to increase/decrease the pH of water gradually induced a shift in the pH of purified water to the intended value, increased the in vitro thermodynamic activity of bio-molecules, and a reduction of larval development time.

2. For bio-molecules and larvae four simultaneous side-by-side treatments were tested: i) an unshielded sample, ii) a shielded sample, iii) a shielded sample with an "on" control device, iv) a shielded sample with an "on" IIED. Just the shielding of em radiation affected the thermodynamic activity of the bio-molecules, and just adding less than about 1 microwatt of microwave radiation via control device reduced the thermodynamical activity and lengthened the developmental time. Thus the microwave radiation acted as a stressor having entropic effect. When the control device was replaced with IIED, the degradation caused by microwave radiation was overcome.

"Conditioning" of the laboratory

Quite unexpected phenomena arose from a repeated conduct of IIED in a given laboratory space. By simply continuing to use IIED in the laboratory space, it became "conditioned in some very fundamental way". Three signatures heralded the onset of the "conditioning" process.

1. Oscillations of air and water temperature, and of pH and electrical conductivity of water with large amplitudes with the periods of oscillations in 10-100 minute range developed. The amplitudes of pH- and temperature oscillations was $\sim \Delta pH = .1$ pH-unit and $\Delta T \sim 1-3$ K units respectively. Even more remarkably, the oscillations were sustained in the locale even after the removal of the IIED suggesting kind of phantom effect analogous to phantom DNA effect. Oscillation amplitude had peaks at the harmonics of fundamental frequency $f_l = 1/T_l$, $T_l = 36.6$ minutes with three lowest harmonics being very clearly visible [J155] . Also $T_l = 51.2$ minutes appears as fundamental period in some experiments. The ratio of these periods is 1.4 and rather near to $\sqrt{2} = 1.41$, which might relate to p-adic length scale hypothesis.

2. When an pH-increasing IIED with intention to increase pH by one unit was turned on in an almost unconditioned space located several hundred feet away from a strongly conditioned space, a well-defined pattern of pH-oscillations in an unconditioned space emerged. This pattern was accompanied by a highly correlated pattern of oscillations in strongly conditioned space. This kind of highly correlated oscillations were not observed in several unconditioned spaces - also located several hundred feet away.

3. The targets were subject to the action of a vertically aligned magnetic field in the range of $10^{-2} - 5 \times 10^{-2}$ Tesla, such that the direction of the field could be reversed. In an unconditioned space the change of the direction of the magnetic field did not affect the pH. In the strongly conditioned space the effect on pH was different for the opposite directions of the applied field and the difference in pH values was about .6 units. One can say, that the target had become sensitive to the effects of external magnetic fields.

TGD based model for intentional imprinting

The model obtained by combining the model for Shnoll effect based on the canonical identification as a map taking intentions to actions with time mirror mechanism would suggest that intentional imprinting generates flux tubes between the target and magnetic body (MB) of operator and also those between target and biological body (BB) of the operator. These flux tubes would correspond to the images of p-adic space-time sheets representing the intention and having astrophysical size scale (or the order of the size of CD associated with operator). These flux tubes would connect BB and MB also to the nearby environment of IIED. The fact that nearby environment remains intentionally imprinted when target and IIED are moved away could explain why the effect remains as oscillations even when IIED is removed and why synchronous oscillations take place.

Negative energy signals would tend to generate negentropic effects eliminating the entropic effects if microwave radiation. This could explain why IIED reduces the entropic effects caused by microwave radiation. Cyclotron frequencies define natural candidates for the time scales involved. The magnetic fields in question would be of order 10-100 pT. The mechanism of compensation of the effects of cyclotron photons remains open. The simplest possibility is that microwave photons generated by IEED correspond to large $\hbar$ phase conjugate photons with energies in the range of energies of microwave photons. The effects of negative energy large $\hbar$ photons, which have suffered phase transition to ordinary positive energy microwave photons could induce the negentropic effects.

Chapter 11

How to test TGD based vision about living matter and remote mental interactions?

11.1 Introduction

The proposed theory of living systems and remote mental interactions involves a large number of general ideas which represent something new and one should be able to invent tests. Since the basic mechanisms of remote mental interactions are same as those of TGD inspired model of living matter, there is no special reason to restrict the tests to remote mental interactions. The emphasis is on new physics predicted by TGD. The following is an attempt to list the most important ideas and imagine possible tests. Most tests are tests of the proposed new physics suggested to be crucial for living matter. I do not possess the required background to propose any detailed experimental protocols and my hope is that I would be able to represent the basic ideas so clearly that others could invent manners to test them.

Chi (life energy) and Yin (intent) provide a good example about what is involved. Usually one just tries to find correlates chi and intent by using various kinds of detectors [J57]. The detector for a given speculative effect could be physical detector measuring fields, particle currents etc., chemical methods could be used to detect the effects, biological materials and even human body could serve as a detector. If one takes TGD seriously, one can reduce the test for chi and intent to a tests for its new physics correlates. The general vision also suggests optimal choices of targets of remote mental interactions.

While preparing this chapter I learned about two articles providing reviews about empirical testing of notions of chi and intent. The first article by Kevin Chen - titled *An analytic review of studies on measuring effects of external Qi in China* [J57] - summarizes the various methods of measuring external Chi (EQ). Second article is by Lian Sidorov and Kevin Chen and titled *Biophysical Mechanisms of Genetic Regulation: Is There a Link to Mind-Body Healing?* [J146]. The main message of the article is that intent has a direct effect on DNA and that electromagnetic fields play an important role in both communication and energy metabolism. It would be interesting to combine existing general ideas with the experimental input discussed in these articles.

The appendix of the book gives a summary about basic concepts of TGD with illustrations. There are concept maps about topics related to the contents of the chapter prepared using CMAP realized as html files. Links to all CMAP files can be found at `http://www.tgdtheory.fi/cmaphtml.html` [L35]. Pdf representation of same files serving as a kind of glossary can be found at `http://www.tgdtheory.fi/tgdglossary.pdf` [L36]. The topics relevant to this chapter are given by the following list.

- Magnetic body [L52]

- Basic Mechanisms associated with magnetic body [L39]

- Hierarchy of Planck constants [L50]

11.2 Zero energy ontology

Zero energy ontology (ZEO) is one of the cornerstones of TGD and has become part of TGD during last six years. Zero energy states are identified as superpositions of pairs of positive and negative energy states assigned with the future and past boundaries of causal diamonds (CDs) and correspond in ordinary ontology to physical events with positive and negative energy parts of the state identified as counterparts for the initial and final states of the event. Effective 2-dimensionality allows a further reduction to the level of partonic 2-surfaces: also their 4-D tangent space data matter. Symmetry considerations lead to a beautiful view about generalizations S-matrix to U-matrix having as its rows orthogonal M-matrices which in turn are expressible as products of square root of density matrices and unitary S-matrix. One can say that quantum theory is "complex" square root of thermodynamics.

Therefore one should try to find tests for ZEO.

11.2.1 The hierarchy of CDs

The basic assumption is that the sizes of CDs come as integer multiples of CP_2 scale R and for prime multiples of R correspond to secondary p-adic length scales $L_{p,2} = L_{p,1}\sqrt{p}$, $L_{p_1} = R\sqrt{p}$, where R denotes CP_2 scale. For electron with $p = M_{127} = 2^{127} - 1$ one has $T_{p_2} = .1$ seconds and defines a fundamental bio-rhythm. This time scale should have preferred role in physics. More generally the secondary p-adic time scales assignable to elementary particles should define time scales relevant to macroscopic physics. The corresponding size scale can be assigned to the magnetic body of the elementary particle. Also it should be possible to assign to quark mass scales special biological time scales as has been indeed done [K7]. h predictions could be tested.

11.2.2 Generalization of standard conservation laws in ZEO

ZEO together with sub-manifold geometry provides a new view about conservation laws and re-solves the problem posed by the fact that gravitational interactions do not seem to respect energy conservation in cosmological time scales. Conservation laws holds true only in the scale associated with given CD, not universally (this would allow only single infinitely large CD).

Superconducting coherent states involve quantum superposition of states with different numbers of Cooper pairs and therefore break the super-selection rule associated with fermion number in ordinary ontology. In ZEO they could be understood without giving up the superselection rule associated with fermion number.

Experimental tests should try to prove that quantum number conservation is a length scale dependent notion. For instance, creation of matter from vacuum is possible in ZEO, and one might hope that its occurrenece could be in some scale for CDs aritficially.

11.2.3 Breaking of second law in standard form

In standard physics second law states that all systems are entropic but a system can reduce its entropy by feeding its entropy to the environment. Negentropic entanglement carries genuine information and life can be seen as islands of negentropy in the sea of entropy. This forces to generalized second law. The proposed generalization [L23] [K49] can be characterized as maximally pessimistic.

The generation of negentropic entanglement is assumed to be accompanied by generation of compensating entropic entanglement. The modified form of second law is suggested by the mechanism of directed attention based on negentropic entanglement assignable to magnetic flux tube connecting self and and target. Negentropic entanglement prevails during the attention but disappears after state function reduction giving rise to entropy at the level of ensemble. Second law would hold true above time scale assignab le to the duration of negentropic entanglement.

There are also other reasons to reconsider second law. The breaking of second law in standard form since the arrow of geometric time can change locally. Living systems are indeed accompanied by syntropic effects as realized by Italian quantum physicist Fantappie [J103, J58]. These effects could be understood as entropic effects but with a reversed arrow of geometric time. The mechanism would be based on negative energy signals. Phase conjugate laser waves are known to obey second

law in reversed direction of geometric time. Cooling effects due to the absorption of negative energy signals inducing the breaking of the standard form of the second law are predicted to be possible. One can also imagine a spontaneous excitation of atoms generating radiation in the return to ground state in a situation when there is a target able to receive negative energy signals emitted in spontaneous excitation.

Standard form of second law assumes that quantum coherence is absent in the scales in which it is applied. Both the hierarchy of Planck constants and negentropic entanglement however make possible macroscopic quantum coherence characterized by the scale involved and the natural guess is that the time scale associated with causal diamond in question defines the scale above which one can expect second law to hold. There is evidence for the breaking of second law in time scale of .1 seconds [D11].

11.2.4 Negative energy signals

Zero energy ontology allows to assign to zero energy states an arrow of time naturally since one can require that states have well defined single particle quantum numbers at either upper or lower boundary of CD. Also the spontaneous change of the arrow of geometric time is possible. The simplest possible description for U-process is that U-matrix relates to each other these two kinds of states and state function reductions occur alternately at upper and lower boundaries of CD meaning reduction to single particle states with well defined quantum numbers. The precise correlates for the generation of geometric arrow of time are not completely understood.

Negative energy signals to geometric past would serve as counterparts for time reversed states in the case of radiation and phase conjugate laser waves are natural counterparts for them. The signal property requires a dissipative process proceeding in preferred time direction and this kind of process has been assigned to sub-CDs and should proceed as state function reduction sequence in preferred direction of time determined by the quantum arrow of time for the zero energy state. This process would be essential for the experience of flow of time in preferred direction and for generation of arrow of geometric time as explain in previous chapter and also in [K6]. For phase conjugate laser beams the reversed time direction for dissipation is observed.

Negative energy signals make possible remote metabolism as sucking of energy from remote energy source provided resonance conditions for transitions are satisfied. The counterpart of population inverted laser could serve as ideal source and the the negative energy signal could serve as a control switch inducing phase transition like process taking the excited atom like systems to ground state (induce emission). This process should occur in living matter. Anomalous excitation of atomic state by absorbing energy by remote metabolism and subsequent generation of radiation could also serve as a signature. It could also lead to cooling effects breaking second law.

Negative energy signals would also make possible realization of intentional action by initiating the activity already in geometric past. This would be very desirable in rapidly changing circumstances. The time anomalies of Libet for active aspect of consciousness could be interpreted in terms of time mirror mechanism [J122] and further experiments in longer time scales might be perhaps carried out.

Negative energy signals could be also essential for the mechanism of long term memory. They would induce a breakdown for a system analogous to population reversed laser via induced emission meaning generation of strong positive energy signal [K70].

11.3 p-Adic physics

11.3.1 p-Adic length scale hypothesis and Mersenne hypothesis in living matter

p-Adic length scale hypothesis states that favored primary p-adic length scales proportional to square root of p-adic prime correspond to primes which are near powers of two: $p \simeq 2^k$. Favored secondary p-adic length scales would correspond to favored CD sizes coming as octaves. Mersenne primes are in special position. This leads to rather specific predictions in the case of living matter since the length scale from 10 nm to 5 μm contains as many as four electron Compton scales $L_e(k) = \sqrt{5}L(k)$ characterized by Gaussian Mersennes, which correspond to ordinary primes with

$k = 151, 157, 163, 167$. This can be seen as a mathematical miracle and it is interesting that it associated with the biologically most interesting length scale range. This leads to Mersenne hypothesis [K7] stating that in living matter the p-adic length scales associated with both ordinary and Gaussian Mersennes are important. Besides this the hypothesis states that those values of Planck constant come as proportional to

$$r = 2^{k_i - k_j} \quad ,$$

where k_i and k_j are primes characterizing two Mersenne primes. This predicts a large number of preferred time and length scales which might be relevant in living matter. Also this hypothesis could be tested.

11.3.2 Negentropic entanglement

Negentropic entanglement is suggested to be a basic characteristic of living matter whereas the hierarchy of Planck constants would make possible macroscopic quantum coherence. Negentropic entanglement (see fig. `http://www.tgdtheory.fi/appfigures/cat.jpg` or fig. 21 in the appendix of this book) and dark matter hierarchy allow to circumvent the basic objection against viability of computation: even technological applications can be dreamed of. At this moment the only support comes from proposed applications to particle physics and from the modelling of living matter and is only indirect. The basic challenge is to learn whether Nature has chosen negentropic entanglement and hierarchy of Planck constants as its tools. The next challenge would be to develop technological tools for handling them.

For instance, phase transitions changing Planck constant from ordinary to larger one would effectively mean disappearance of ordinary matter and this could serve as a signature. Negentropic entanglement makes possible abnormally long duration of entangled period resembling that appearing in Orch Or of Hameroff and Penrose [J113] and anomalously low dissipation could serve as a signature of both negentropic entanglement and of hierarchy of Planck constants.

Negentropic entanglement could be associated with many-particle states at magnetic flux tubes. Either non-local single particle excitations of Bose-Einstein condensates of bosonic states (Cooper pairs of electrons say) or many-fermion states can be considered [K107]. Metabolic energy quantum liberated in ATP$\rightarrow$ ADP would generate the excitation. NMP does not tell whether a transfer of negentropic entanglement from high energy phosphate bond to flux tube takes place or whether the negentropic entanglement is created in the process. Exactly the same process would take place in photosynthesis as a first step and there is evidence for non-local excitations of electrons [I24]. Whether electrons or their Cooper pairs are in question will be known probably very soon. The general prediction is that metabolic energy transfer always takes place via a transfer of dark photon. The decays of these photons to ordinary photons should produce bio-photons with energy around .5 eV and IR photons with this energy could have biological effects.

11.3.3 p-Adic-real phase transitions and intentional action and formation of cognitive representations

Canonical identification $\sum x_n p^n \rightarrow \sum x_n p^{-n}$ maps p-adic numbers to real numbers in continuous but non-smooth manner and its inverse is also continuous for p-adic irrationals but two valued for rationals. The original proposal - which was temporarily given up - was that cognitive representations could be mediated by canonical identification mapping real partonic 2-surfaces to their p-adic counterparts. Since p-adic and real numbers have rationals as common the canonical identification maps rational points which correspond to large real scales to small real scales and vice versa. This property is analogous to the T-duality [A3] of string models and I have indeed proposed that T-duality generalizes to map governing formation of cognition representations and realization of intentional action. Intents would correspond in real sense to large scales and p-adically infinitesimal literally to something of size of entire Universe [K48]. Their realizations in real sense would correspond to small size scales.

In Shnoll effect [E2] the expected probability distribution with single peak develops several peaks and the effect depends on periods assignable to solar system. The effect is very general and appears even for atomic nuclei. There exists no standard physics explanation for it.

1. The TGD inspired model of Shnoll effect [K5] as a statistical effect is based on the interpretation of probability distribution having integer valued argument as p-adic valued distribution and the replacement of the parameters and variables with their images under canonical identification. For electron the magnetic body has size scale of the Earth so that this effect should be mediated by the magnetic body assignable to the CD and could be seen as evidence for these notions.

2. The oscillatory character of the effect with periodicities assignable to solar system inspires the question whether the transformation of intention to action mediated by canonical identification might be involved. If so this mechanism would apply also to experimental situations involving effect of intent on both living and inanimate systems. The prediction is the appearance of characteristic number theoretical signatures in the form of probability distributions.

11.4   Magnetic body as carrier of dark matter

Magnetic body carrying dark matter is certainly a central concept.

11.4.1   Dark matter as a hierarchy of phases with large value of Planck constant

1. Dark matter is identified as a hierarchy of phases with effective value of Planck constant coming as a multiple of ordinary Planck constant. A more stringent hypothesis inspired by spin glass degeneracy is that given multiple of Planck constant correspond to an effective local singular covering of the imbedding space. In biological systems the values of Planck constant could be rather larger: the condition that a photons with given frequency correspond to energies above thermal energy at physiological temperatures allows to estimate $\hbar$ as ratio of thermal energy with the photon energy for ordinary value of $\hbar$. This dark matter must be distinguished from galactic dark matter (which could be actually magnetic energy) assignable to long flux tubes like structures around which galaxies concentrate like pearls in necklace. The values of Planck constant proposed for flux tubes mediating gravitational interaction between bodies with masses M and m is gigantic: $\hbar > GMm/c$ and can be assigned to dark energy rather than to dark matter.

   It is assumed that at partonic 2-surfaces the sheets of multiple covering become completely degenerate and partially degenerate at two kinds of preferred 3-surfaces. n_1-fold branching occurs both at space-like ends fo space-time surface assignable to CD boundaries and n_2-fold branching at light-like orbits of wormhole throats at which induced metric changes its signature. At partonic 2-surfaces branching to $n_1 n_2$ surfaces occurs. There is mathematical analogy between 3-surfaces and partonic 2-surfaces with 2-branes which are also obtained as piles of copies of surfaces which degenerate to single one. Now the degeneration of 3-branes would occur only at the 3-D boundary of the brane.

2. Living matter would be ordinary matter controlled by dark matter at magnetic flux quanta assignable to living system. Magnetic body would have onion-like layered structure. For instance photons with energies in EEG range would correspond to parts of magnetic body with the scale of wavelength which is now of the order of Earth radius.

 Tests for the presence of dark matter.

1. The basic prediction is the existence of scaled versions of standard model physics. Particles with large Planck constant would have same masses as ordinary ones but scaled up Compton wave lengths would make gpossible macroscopic quantum phases in much lower densities as usually. The proposal is that living matter involves scaled variants of electroweak physics and hadron physics. Also p-adically scaled variants with scale mass spectrum can be considered and resonant interactions between members of the two fractal hierarchies are natural when the scales co-incide.

(a) The scaled variant of QCD like physics is needed if color qualia are due to quark color. This is achieved by coding A,T,C,G to spin states of u quark pairs assignable to flux tube pairs in the model of DNA as TQC. Findings of mathematician Barbara Shipman [A27] suggests that the mathematics of colored quarks are involved with the honeybee dance via so called flag manifold $SU(3)/U(1) \times U(1)$ parametrizing different choices of color quantization axis. Could the presence of dark u quarks at the ends of flux tubes attach to DNA and lipid layers be tested? For instance, could it be detect the presence of quark charge equal to 2/3?

(b) The prediction would be that at space-time sheets corresponding to given value of Planck constant long ranged color and/or electroweak interactions are present meaning the presence of new long range forces. Could these be partially responsible for the coherence of living matter: could color confinement play an essential role? Elementary particles are pairs of magnetic monopoles separated by Compton length: could also second monopole containing only neutrino pair be made visible by a suitable experimental arrangement? Maybe even ordinary condensed matter physics could involve Z^0 force below atomic length scale [K21].

2. One motivation for the hierarchy of Planck constants was the evidence that water behave as $H_{1.5}O$ in atto-second scale. The explanation was that 1/4 of hydrogen nuclei (protons) are dark. Could these experiments be carried out in other time scales and living matter? I have proposed that the rich anomaly spectrum of water above freezing point could be understood if it is a multiphase system containing also dark components [K21]. Could one test this hypothesis by concrete model building and comparison with experimental facts?

3. Dark nucleons correspond to the states of DNA, RNA, tRNA, and amino-acids and vertebrate code has simple realization for dark nucleons. Could one prove experimentally the existence of dark nucleons? Perhaps as a dark plasma like phase?

4. Quantum coherence in unexpectedly long scales is predicted to be possible for dark matter. For instance, super-conductivity at temperatures at which it should not exist, becomes possible [K12, K13, ?]. I have proposed a model of high T_c superconductivity and also its biological variant based on electron pairs with large Planck constant and Compton length of order cell membrane thickness. Josephson current through cell membrane is one testable prediction. EEG would be partially determined by these Josephson currents. It is now known that photosynthesis involves macroscopic quantum coherence in unexpectedly long length scale. The model is in terms of large $\hbar$ electron Cooper pairs. Also this model should be testable.

5. With inspiration coming from the model of quantal effects for ELF photons on vertebrate brain, EEG photons are identified as dark photons and bio-photons as their decay products [K7]. This identification predicts that the energies of these photons are in visible and UV range. Could it be possible to see the emission of dark EEG photons with these energies in metabolic book keeping?

11.4.2 Tests for the notion of magnetic body

What kind of tests can one imagine for the notion of magnetic body?

1. The existence of magnetic bodies.

(a) Could one photograph dark matter at magnetic bodies? The mechanism would be transformation of ordinary photons to dark photons scattering from dark charged particles and transformation back to ordinary photons. Peter Gariaev might have already done this [K1]. This kinds of experiments might be continued and refined.

(b) How the existence of magnetic flux tubes connecting two objects - say living organisms - could be tested? What happens to flux tubes when the cells of living organism are taken far away from the organism. The experiments of Cleve Backster who introduced

the notion of primary perception in the study of electrical reactions of plant which was harmed or threatened to be harmed suggest that this connection continues. Do the flux tubes remain intact and imply correlations between the distant cells and organism or - in the case that they are loops - are they split by reconnection mechanism? Could the flow of biologically important ions occur between the ends of flux tubes (it could also be that only electrons and protons and perhaps some dark nuclei - even quarks participate the flow). Could one use markers for the ions to test the existence of this kind of flows.

(c) How to measure the presence of the flux quanta of magnetic fields of magnetic bodies via the interaction of ordinary matter with classical electromagnetic fields created by dark partcles? The description of this interaction is in terms of topological condensation to multiple space-time sheets [K108]. Now imbedding space effective covering and space-time has sheets analogous to those of Riemann surface of function $z^{1/n}$. This multi-sheetedness does not correspond to ordinary many-sheetedness. If all physics reduces to that associated with partonic 2-surfaces then classical fields carrying different values of Planck constant should interact since different sheets co-incide at partonic 2-surfaces. The (effective) value of Planck constant defined as the number of sheets of covering can depend on the region of 3-surface. Are there rules governing this change?

(d) Could one demonstrate the presence of magnetic monopoles at flux tube ends? Even elementary particles should possess magnetic body with largest flux tubes having length scale defined by the p-adic secondary p-adic length scale characterizing particle and characterizing the size scale of CD assignable to elementary particle. Also smaller layers of magnetic body should be present: in particular that corresponding to the primary p-adic length scale of orer Compton length. Secondary p-adic length scale corresponds to a time scale of .1 seconds for electron, the fundamental biorhythm. Could one identify bio-rhythms assignable to quarks which are more massive than electron. The QCD estimates for u and d quark masses are about 5 MeV and 20 MeV and this gives an idea about secondary p-adic time scale which should be a negative octave of .1 seconds. 12.5 ms (80 Hz) and 2.5 ms (400 Hz) are the estimates for the secondary p-adic time scales.

(e) Magnetic body having fractal onion-like structure would play a key role neuroscience. The effects of ELF em fields on vertebrate brain at multiples of cyclotron frequencies were the original motivations for introducing the hierarchy of Planck constants. EEG would serve as communication and control tool in the system defined by magnetic body and biological body. EEG frequencies should correspond to linear combinations of harmonics of Josephson frequency for cell membrane as electronic (at least) super-conductor and harmonics of cyclotron frequencies for dark ions. This leads to a rich spectrum of quantitative predictions about EEG spectrum and attempts have been made to understand the dependence of EEG spectrum on state of consciousness. For Calsium ion the cyclotron frequency is 15 Hz.

(f) Also magnetic body has dynamics - highest layers of body can disappear or reappear or completely new layer can emerge- and one can ask whether this dynamics could be experienced directly. The effects induced by Persinger's God helmet [?]ould have inter-pretation in terms of dynamics of magnetic Also OBEs could be understood as effects related directly to magnetic body [K87]. One can also ask whether astrophysical phe-nomena could effect directly the magnetic bodies and therefore conscious experiences. Effects of solar storms and auroras represent basic examples of this kind of effects. Maybe this could be tested?

2. The dynamics of flux tubes.

(a) Phase transitions changing Planck constant would induce shrinking of magnetic flux tubes. These could correspond to volume changing transitions of gel phase in living matter. Bio-catalysis would rely on these phases transitions and they would allow bio-molecules in the dense soup of bio-molecules to find each other [K7].

(b) Reconnection of magnetic bodies second fundamental dynamical process playing key role in living matter. ATP↔ADP process would be involved with reconnection. ATP as a molecule of consciousness would accompany negentropic entanglement. Information molecules attaching to receptors would represents of ends of flux tubes attaching to receptors and forming longer connected flux tubes. This would be basically generation of qualia in the length scale defined by the distance of the cell sending the information molecule and the cell receiving it. Remote sensory perception would rely on the same mechanism. One should be able to test the hypothesis that the stretching of flux tubes accompanying the diffusion of information molecule from sender to target represents deeper level of the dynamics of information molecules? The transfer of dark particles along the flux tube could be one possible signature.

If it is possible to demonstrate the existence of magnetic flux tubes t by studying the flow of dark particles between two systems, one could try to test whether changes in the flow pattern by reconnection could become manifest via the flows.

(c) Also remote mental interactions should involve generation of flux tubes between the biological and magnetic bodies of the target and operator and reconnection for loops could be the mechanism. Quantization of magnetic flux is necessary for this mechanism to work. Particle flows between target and operator would be one signature. For living target the coherence of counterparts of EEG would be second signature.

11.4.3   Bio-superconductivity

TGD inspired model of high T_c superconductivity

TGD inspired view about high T_c eletronic superconductivity and its biological counterparts are discussed in [K12, K13, **?**] . Also the TGD inspired model for ordinary high T_c electronic super-conductivity relies on flux tubes assigned with stripes found to serve as kind of highways carrying supra currents. High T_c super-conductivity involves two critical temperatures: T_c and T_{c_1}. Below the higher critical temperature T_{c_1} Cooper pairs with large Planck constant are assumed to be present but magnetic flux tubes are assumed to be rather short and closed (the phase is antiferro-magnetic) so that macroscopic supra currents cannot flow. Around the lower critical temperature T_c flux tubes fluctuate and form by reconnection longer flux tubes and percolation type process giving rise to macroscopic supra currents becomes possible. By p-adic length scale hypothesis the basic dimensional parameters could correspond to cell membrane thickness (10 nm) and cell nucleus length scale (2.5 μm) even for ordinary high T_c super-conductivity.

An analogous mechanism is expected to be at work for cellular system and give rise to electronic supra current. Also biologically important bosonic ions should give rise to cyclotron Bose-Einstein condensates with large value of Planck constant. In the case of fermionic ions Coooper pairs would be required. Another possibility is formation of exotic ions when some neutral color bonds between nucleons in nuclear strings become charged. The energy change should be relatively small- of order keV- and there is evidence for this kind of states: nuclear reaction rates vary with a period of year explainable in terms of the variation of the distance from the Sun effecting also the intensity of X ray radiation from Sun.

Leakage of supra currents as basic mechanism

The basic element of the proposed vision is remotely induced leakage of supra currents from magnetic flux tubes to atomic space-time sheets. This same mechanism works for both endogenous biological self-organization and remote mental interactions which would form a standard element in the construction of our sensory representations. The most economic experimental strategy would be a direct verification of this basic mechanism.

An especially dramatic effect would be the appearance of ions from magnetic flux tubes to the target of remote mental interaction not present in the target initially. Sue Benford has found evidence for the appearance of S, Mg, and Al in X ray films which were exposed to the radiation coming from so called torsion generator [I28] . Intentional effort was involved with the experiment. What happened was that dots and tracks with typical size scale of one millimeter appeared in the X ray film. The dots dots and tracks did not allow identification as tracks of charged particles, and

the exposed regions contained S, Mg and Al not present elsewhere. The leakage of energetic super-conducting ions to atomic space-time sheets dissipating their energy by emitting electromagnetic radiation and ionizing the atoms is the natural explanation for the effect [I28, I48]. Note that both X ray films and nuclear emulsions contain gelatin which is an organic compound and might increase the sensitivity of the system.

Time reversal for the leakage of supra currents

The time reversal of the mechanism generating the leakage of supra currents could be especially important for healing. This mechanism is consistent with the presence of remote bound state entanglement and anomalous production of metabolic energy when binding energy is liberated.

The mechanism would be accompanied by a mysterious disappearance of marker ions in the tissue, and manifest as time reversed function of various molecular machines certainly detectable. Phase conjugates of (that is time reversed) microwaves at critical frequencies could induce the healing process. For instance, de-differentiation of cells might be induced in this manner.

As explained earlier, geometric time reversal could typically involve generation of anomalous radiation by excitation of atoms or molecules by emission of negative energy photons. Rotating magnetic systems (Searl machine) would be especially interesting for proving that time reversal indeed occurs. One could try to demonstrate that biological rhythms correspond to dissipation-healing cycles (wake-up sleep period and metabolic cycles being basic examples).

11.4.4 Direct supra currents along magnetic flux tubes

Direct supra currents along magnetic flux tubes are also predicted besides Josephson currents. Direct supra currents would be excellent candidates for the direct currents of Becker [L27]. This model assumes that living matter is a semiconductor having underlying regular liquid crystal like structure.

The lipid layers of cell membranes are indeed liquid crystals and the braiding of magnetic flux tubes induced by the flows of the 2-D liquid formed by lipids is central in the model of DNA as topological quantum computer. According to Mae-Wan Ho liquid crystal patterns provide memory representations: in TGD one would achieve the same by the storage of liquid crystal flow patterns to the braidings of flux tubes. For the direct quantum currents the assumption of actual semiconductor structure might be un-necessarily strong.

Magnetic flux tubes can also carry longitudinal electric field and one can construct a simple model for the quantum states of charged particles in this kind of electric field. Large value of Planck constant is natural for long flux tubes. Flux tubes could have size scale of body or of even magnetic body. The model provides unexpected insights about character of quantal currents, allows to understand the amplitude windows for the effects of ELF em fields on vertebrate brain, the effective semiconductor property of living matter, and the effect of needles in acupuncture as metabolic effect. Disease as a loss of negentropic entanglement, healing as a regeneration of negentropic entanglement, the association of negentropic entanglement with ATP and high energy phosphate bond perhaps assignable to a Cooper pair like state, vacuum zero point kinetic energies as fundamental metabolic quanta, and loading of metabolic energy batteries by acceleration of charged particles in electric field so that they can be kicked to smaller space-time sheets are the basic of the model (it is essential that the currents are non-ohmic!). The challenge is to test the model for DC currents and the models of healing and acupuncture.

The model also proposes that the interaction of radiation fields is based on acceleration of charged particles on flux tubes having also topological sum contacts to "massless extremals" representing space-time correlate for radiation fields. The optimal situation is achieved when the electric field of ME is parallel or antiparallel to flux tube and ME therefore orthogonal to it. If the flux tube is near critical voltage for the generation of quantal DC current, the perturbation caused by the radiation field can induced by the quantal DC current accelerating charged particles and loading metabolic batteries by kicking them to smaller space-time sheets. This would directly correspond to the generation of ATP responsible for negentropic entanglement and generating eventually liberating metabolic energy. The killer prediction is that the biological effects are caused only at the second half of the cycle. In the case of EEG theta waves there is indeed evidence for this [J166].

11.5 TGD view about consciousness and biology

In the following TGD based view about consciousness and biology is summarized with emphasis on mechanisms. Proposals for tests are made when possible.

11.5.1 The notion of conscious hologram

Living system as conscious hologram is a metaphor emphasizing the fractal structure of sensor and cognitive representations. The model to be discussed relies heavily on the notion of magnetic flux tube and negentropic entanglement.

Attention

What is attention? What are its characteristic properties? What could be the quantum physical correlate for it. The naive view western view is that attention and perception is directed: there is observer and observed. The "Eastern" view says that observer and observed are one and same thing and this distinction applies only to memory about attention.

The proposed identification for the correlate of attention as negentropic entanglement (see fig. http://www.tgdtheory.fi/appfigures/cat.jpg or fig. 21 in the appendix of this book) having as space-time correlates magnetic flux tubes corresponds to the "Eastern" view: I have made also an attempt to explain how asymmetry between perceiver and perceived could emerge [K23]. Directing attention to an object of external world means formation of flux tubes connecting perceiver to the object. Qualia prevail as long as this attention continues. There is a resemblance with Orch Or of Hameroff and Penrose [J113] and with active information of Bohm [J3]: attention is the activity.

This view about attention means that ordinary sensory perception is a non-local process involving in an essential manner also the target.

The test would be finding whether (for instance) visual attention implies "intentional imprinting" in the object of attention. This relates directly also to the proposed mechanism of remote mental interactions. In the case of hearing our ability to tell whether the sound comes from external world or not is a mystery if one believes that qualia are product of some neural activity. The flux tube model would assign also to hearing flux tubes which are attached to some object oscillating with the sound wave, even molecules of air. How it is possible to identify the sound source "correctly" if anything that oscillates with sound wave can serve as target of attention? The natural definition of source is in terms of intensity maximum. Both ears are needed to identify the direction of maximum intensity.

Model for qualia

Directed attention involves qualia. The qualia correspond to quantum number increments during the process leading from ZEO counterpart of initial prepared state to the final entangled states (identified as states at lower and upper boundaries of CD). State function reduction which eventually happens reduces the negentropic entanglement at the upper end of CD and after this there is possibly a memory of qualia, not genuine qualia anymore. Flux tubes connecting observer and observed are the correlates for the sensory perception and generation of qualia. This leads to sensory capacitor model in which the analog of dielectric breakdown amplifies the polarization between the ends of flux tubes. Besides this the process involves scaling up the lengths of the sensory capacitor flux tubes: perhaps by a phase transition increasing the value of Planck constant.

Various electrets and strong electric fields characterizing biomatter could relate to sensory perception at molecular and cellular level. Cell membrane could give rise to sensory perception of external world during nerve pulse which indeed involves dielectric breakdown. One might hope of finding at test for the generation of polarization in longer length scale during generation of qualia.

Fractality of sensory percepts and EEGs

The model of qualia suggests fractal sensory percepts. Sensory perception would be a process propagating from long to short length scales and generating qualia transforming to memories about qualia. Cell membranes and DNA cold be end points of this process and lipids of the cell membrane liquid crystal would form pixels for a representation of external world analogous to

that provided by computer monitor. In case of ordinary cells this representation would be about chemical environment, in the case of neurons about the external world. How this representations relates to our conscious experience?

It might be that negentropic entanglement in the scale of magnetic body is involved so that the process generating qualia begins from the level of magnetic body and proceeds downwards.

EEGs consisting of dark large $\hbar$ photons with energies in visible and UV range are used to communicate sensory data to magnetic body as Josephson radiation from cell membranes with frequencies characterized by the vale of Planck constant. The radiation would propagate along flux tubes and flux sheets. What is the precise meaning of this communication? Is it communication of symbolic representation constructed by brain and therefore communication of memories?

The fractal onion-like structure of magnetic body requires fractal hierarchy of analogs of EEG which could be called XYGs. Even weak bosons and gluons could give rise to the analog of EEG in appropriate length scales if dark matter hierarchy is realized. Biophotons are tentatively identified as decay products of large $\hbar$ EEG photons and their scaled variants. Could this be tested somehow?

Fractality of memory representations would mean that scaled down "stories" lasting much shorter time than the real episode are formed and could be formed as several copies. This could be one of the key elements of intelligent behavior. There is evidence for this has been found by Yamaguchi et al [J166, J167] in the case of theta waves. TGD based explanation in terms of phase transitions generating scaled versions of the real time representation of the event is discussed in [K23]. It might be possible to test this aspect of memory representations in terms of EEG waves as in the work of Yamaguchi.

Fractality of sensory representations

The notion of conscious hologram means that practically any part of body can represent any other part of body or even external world. Concerning the notion of conscious hologram at the length scale of body, Kirlian imaging with simultaneous electrical stimulation of other body parts, in particular ear, is very promising manner to test the hypothesis [I59] . It is also known that ear forms kind of fractal miniature of body with respect to acupuncture points so that stimulation of particular part of ear electrically creates sensation that particular part of body is stimulated [J130] .

PLR spectroscopy [I52] provides a precise and accurate manner to prove the viability of the notion of conscious hologram empirically. What is needed is the analysis of the frequency spectrum: does it really contain the predicted differences of cyclotron harmonics. If this approach and its variants really work it it becomes possible to determine experimentally the densities of superconducting ions and Cooper pairs at parallel space-time sheets.

At the level of remote mental interactions the stimulation of brain electrically could induce in other brain nerve pulse pattern or even experience correlating with the nerve pulse pattern or even experience in the stimulated brain. Even water near criticality could provide this kind of representations. In Imaging laboratory at Hilversum, Holland the following experiment has been performed with success. The experiment involves water droplet near freezing point. A person with abilities of a healer asks for Universe to express something in the structure of the droplet. What results are beautiful fractal patterns representing say plant leaves, even a picture about the laboratory's architecture has been generated in this manner. Also the work of Emoto [I104] and work carried out in Aerospace Institute in Germany [I21]

11.5.2 TGD view about metabolism

TGD view about metabolism involves two new elements. First of all, TGD leads to the idea of universal metabolic quanta. These would make possible metabolism before the development of a complex chemical machinery which also would rely on universal metabolic energy quanta. Secondly. ATP seems to have two roles as a molecule of consciousness and as a metabolic quantum? These roles are very closely related and the connection with the modification of second law of thermodynamics is suggestive.

Many-sheeted space-time and universal metabolic energy currencies

The dropping of particle to a larger space-time sheet liberates energy which is the difference of the energies of the particle at two space-time sheets. If the interaction energy of the particle with the matter at space-time sheet can be neglected, the energy is just the difference of zero point kinetic energies. This energy depends on the details of the geometry of the space-time sheet. Assuming p-adic length scale hypothesis one obtains a general formula for the difference of zero point kinetic energies. These energy increments define ideal candidates for universal metabolic currencies and under certain additional conditions (say resonance with energies of some important molecular transitions) these currencies could be predecessors of the standard metabolic currency of order .5 eV. There is a more detailed treatment of universal metabolic currencies in [K7]. A model for how universal metabolic currency .5 eV assignal to the dropping of proton from atomic space-time sheet is discussed in [K39].

In many-sheeted space-time particles topologically condense at all space-time sheets having projection to given region of space-time so that this option makes sense only near the boundaries of space-time sheet of a given system. Also p-adic phase transition increasing the size of the space-time sheet could take place and the liberated energy would correspond to the reduction of zero point kinetic energy. Particles could be transferred from a portion of magnetic flux tube portion to another one with different value of magnetic field and possibly also of Planck constant h_{eff} so that cyclotron energy would be liberated. In the following only the "dropping" option is discussed.

The hypothesis predicts the existence of anomalous lines in the spectrum of infrared photons. Also fractally scaled up and scaled down variants of these lines obtained by scaling by powers of 2 are predicted. The wavelength corresponding to .5 eV photon would be $\lambda = 2.48$ μm. These lines should be detectable both in laboratory and astrophysical systems and might even serve as a signature for a primitive metabolism. One can also consider dropping of Cooper pairs in which case zero point kinetic energy is scaled down by a factor of 1/2.

Interestingly, the spectrum of diffuse interstellar medium exhibits three poorly understood structures [I9] : Unidentified Infrared Bands (UIBs), Diffuse Interstellar Bands (DIBs) [I4] , and Extended Red Emission (ERE) [I103] allowing an interpretation in terms of dropping of protons or electrons (or their Cooper pairs) to larger space-time sheets. The model also suggests the interpretation of bio-photons in terms of generalizes EREs.

It must be emphasized that the identification of metabolic energy quanta as increments of zero point kinetic energies is untested and allows variants. Magnetic flux tubes are in longitudinal degrees of freedom effectively one-dimensional boxes, and the energy increment for the longitudinal excitations could replace the increment of zero point kinetic energy in the transfer of the particle between space-time sheets. Also excitations in transversal degrees of freedom (increment of cyclotron energy) are possible. These excitation energies could define universal metabolic energy quanta. This option emerges in the model for the generation of negentropic entanglement giving also the connection with the findings about effects of ELF em fields on vertebrate brain. The model predicts that metabolic energy transfer always involves generation of dark photon absorbed by magnetic flux tube so that negentropically entanglement non-local single particle excitation is created. One expects that IR photons with energy around .5 eV (metabolic energy quantum) have biological effects. Also bio-photons resulting from the transformation of dark photons to ordinary photons at this energy are possible.

Plasmoids as prebiotic life forms

A natural conjecture is that plasmoids involving charged plasma at magnetic flux quanta define prebiotic life forms [K27]. The minimum prerequisites for life would be present if the proposal for universal metabolic quanta is correct. Even dark nuclei could be regarded as plasma like structures so that even genetic code and nuclear counterparts of basic biomolecules could be involved.

The model of high T_c super-conductivity and the general vision about dark matter hierarchy have led to a rather precise model for magnetic body as an intentional agent utilizing biological body or its part as motor instrument and sensory receptor [K20] . Dark matter plasmoids and plasma oscillation patterns as representations of control commands are one important aspect of the model. The prediction is that plasmoids should have been predecessors of ordinary life forms. There is laboratory evidence that plasmoids behave like life forms [I77, I36] . Very high temperatures

catastrophic for ordinary life forms could prevail at magnetic flux quanta associated with plasmoids. This forces a radical reconsideration of the question how pre-biotic life have evolved and forces to ask whether even the hot interior of Earth could have served or still serve as a seat of life.

The old Expanding Earth hypothesis explains the observation made already at the time of Wegener that all continents fit to a structure covering entire Earth if the radius of Earth where one half of the recent radius. A phase transition increasing the value of Planck constant for the space-time sheet of Earth by factor two could explain this finding and leads to a rather non-trivial vision about early life at Earth [K28].

ATP cannot serve as a correlate of negentropic entanglement during prebiotic period but this does not mean that negentropic entanglement would not be possible. One should understand why ATP makes possible negentropic entanglement. Negentropic entanglement allows states with negative binding energy which are not bound states in the usual sense. Why high energy phosphate bond would be example of this kind state? Understanding this might help to understand the conditions under which negentropic entanglement is possible. The laboratory evidence for plasmoids as prebiotic life forms [I36, I78] raises hopes that one could learn to create situtations in which negentropic entanglement prevails.

In situations in which the target is in-animate matter, universal metabolic quanta might be relevant for the realizations of remote mental interactions.

Controlling metabolism by IR laser beams and DNA functioning by maser beams?

One could also test the 'dropping' of ions to larger space-time sheets. If the dropping ions have dissipated their energy this means that system acts like a maser at wavelength defined by the reduction of the zero point kinetic energy liberated in the dropping of the ion. The pumping process would correspond to the leakage of the supra currents to atomic or some other space-time sheet, and induced emission to the dropping induced by the photons already present.

1. The effectiveness of metabolic energy production in which proton drops and absorbs a negative energy photon of energy about .5 eV could be amplified by a beam of coherent IR light "kicking" protons back to the atomic space-time sheets. The irradiation by phase conjugate beam would "steal" energy from living system by inducing the dropping without locally usable energy. Whether living systems can "steal" energy from other life-forms in this manner could be tested. The "stealing" of the metabolic energy (there is probably a fractal hierarchy of "energy currencies")from cancer cells by phase conjugate laser light might be the first principle explanation for why Priore's machine works.

2. The dropping of ions from say $k = 151$ space-time sheet to larger space-time sheets creates microwaves with frequencies corresponding to zero point kinetic energies about $2^{-15}/A$ eV, A atomic number. For electron the energy is about $1/16$ eV. These processes could define exotic forms of metabolism, perhaps at the level of DNA. This process could be amplified by an external microwave beam or its phase conjugate and phase conjugate beam could induce the correction of genetic errors.

   The transformation of photon energy to metabolic energy could be following. Suppose that the electric field of IR photon is parallel to the flux tube which carries an electric field and is near criticality for the generation of quantal DC currents. If the direction of polarization is correct, the additional contribution to electric field induces direct current and acceleration of electrons and protons and their transfer to smaller space-time sheets and therefore loading of metabolic batteries. This could also make generation of ATP possible.

3. The scaling law of homeopathy [J147] states that high and low frequencies accompany each other and are in a constant ratio for which TGD predicts several values determined as ratios of zero point kinetic energies and cyclotron energies at magnetic flux tubes. The scaling law can be understood as follows: dropping of ions to cyclotron states generates with the zero point kinetic energy and cyclotron photons. Low frequency photons can interact resonantly with the system for which the internal excitations have same low frequency. This generates internal excitation with wavelength which is of the order of system size and this excitation couples resonantly to photons with wavelength equal to system size: thus high frequency photons result.

Thus one might achieve the above proposed effects using also low frequency irradiation. For instance, irradiation by kHz waves in order to achieve generation of bio-photons and irradiation by ELF waves in order to achieve generation of microwave photons. In fact, I started to develop the vision about living system as a macroscopic quantum system from the finding of Blackman [J46] and other pioneers of bio-electromagnetism that ELF radiation has delicate effects in the functioning of living matter. It seems that the basic mechanism might be the dropping of ions between space-time sheets or its time reversal. This mechanism could be tested also for remote objects.

11.5.3 The new view about DNA

The new view about DNA and cell involves several aspects.

1. The first vision about DNA was inspired on many-sheeted space-time alone and on the idea about the role of magnetic body of DNA. There was also a proposal about hierarchy of codes containing as a successors of genetic code memetic code assignable to Mersenne prime M_{127} characterizing electron [K36]. The codewords of this code could be represented as sequences of 21 DNA codons.

2. DNA as topological quantum computer model [K23] introduced a completely new level of information processing as counterpart of topological quantum computation made possible by magnetic flux tubes connecting DNA nucleotides and lipids of nuclear or cell membrane defining braiding. A realization of genetic code is involved. Perhaps the most convincing realization is in terms of 3+1 spin states of fermion pairs assignable to pairs of flux tubes. The realization using u quarks allows to stabilize DNA carrying 2 units of electric charge per nucleotide. The positive charge 4/3 at the end of flux tube pair serves as possibly testable experimental signature for the proposal. Introns would be optimal for the topological quantum computation and the increase of the intronic fraction of DNA with the increase of evolutionary level conforms with the idea that the evolution of magnetic bodies distinguishes between us and our cousins.

   The notion of magnetic body inspires also the proposal that magnetic flux sheets traversing through DNA make possible integration of genomes to higher level structures: this leads to the notions of super genome and hypergenome. Could these higher level genomes manifest themselves as coherent gene expression in the scale of organism and even of population? The development of collective levels of consciousness and cultural evolution would reflect directly the presence of this level of information processing. One implication is the failure of genetic determinism. For this there already exists empirical support. Already the fact that the genomes of humans and of rather primitive life forms do not differ much (apart from intronic portion) suggests that an unidentified level of information processing is involved.

3. Dark DNA as sequences of dark nucleon strings is a fr completely unexpected twist in the development of ideas related to DNA and genetic code [L10, K37]. The theoretical challenge is to understand the relationship with ordinary DNA and its companion molecules. Is the transcription between dark nucleon counterpart of DNA, RNA, tRNA, amino-acids to their chemical variants possible? How could one make dark protons and nuclear strings "visible". Scattering of photons from dark proton strings would involve transformation to dark photons and back. Also classical em fields created by the dark nuclei are in principle observable.

   The presence of dark DNA could make possible active genetic engineering using the "virtual" world of dark DNA, and its companions and one can imagine that biology applies the analog of R&D in industry. This is obviously in conflict with the dogma that evolution is solely due to random change and selection.

4. What is amusing that the model for water memory and homeopathy led to this proposal [K37]. In the succussion process water clusters would "steal" the magnetic bodies of dissolved polar ions and representations of the magnetic bodies as dark nucleon sequences would be generated. There could be also evolution driven by repeatedly occurring mechanical agitation implying increase of Planck constant associated with the magnetic bodies involved. All polar molecules have representation as a DNA sequence. The fundamental mechanism of immune system would be reconnection of magnetic flux tubes associated with the polar ions and the

structures representing them so that the cyclotron radiation propagating along them could not interact with the biomolecules. Immunity would the outcome from this "stealing of attention". If the transcription of dark nucleon sequences to the biochemical counterparts exist this could make possible to automatically generate genes coding for proteins which in turn "catch" the polar molecules that they represent.

A fascinating possibility is the transfer of genes homeopathically. Genes would be dissolved into water and succussion process could be used to induce evolution of the magnetic bodies of the dark DNA associated with genes. These could be transferred to cells and germ cells and transcription to ordinary DNA would make possible genetic engineering.

11.5.4   Model of cell membrane as almost vacuum extremal

The model for cell membrane as almost vacuum extremals brings in additional new physics predicted by TGD. Vacuum extremals are basic solutions of field equations and their small non-vacuum deformations are expected to be important for quantum TGD. For instance, the long length scale limit of the theory in gravitational sector is expected to rely on almost vacuum extremals. 4-D spin glass degeneracy is also due to vacuum extremals and allows to have classical space-time correlates also for the non-deterministic aspects of quantum theory as a failure on standard form of classical determinism. Vacuum degeneracy also implies the realization for the hierarchy of Planck constants in terms of effective multiple coverings of the imbedding space.

Since quantum criticality is expected to be key attribute of sensory receptor, one expects that cell membrane is almost vacuum extremal. This would also imply that large values of Planck constant and dark matter are involved.

The model for cell membrane as almost vacuum extremal involves an assumption that Weinberg angle in this phase differs from its value for elementary particles, which are in many respects diametrical opposite of almost vacuum extremals. The model makes precise predictions about preferred photon energies in visible and UV range and these photon energies correspond to peak frequencies for the photoreceptors.

11.6   General model for remote mental interactions

The assumption that the notion of magnetic body and hierarchy of Planck constants defines key element in remote mental interactions reduces the tests at the level of physics to tests for these notions.

11.6.1   Direct metabolic correlates for remote mental interactions

The proposal is that ATP is the molecule of consciousness in the sense that it presence as relay in flux tube connection carrying negative entanglement entropy. ATP would be also the molecule of attention if negentropic flux tubes connecting perceiver and attended system serve as correlates of attention. There is complete symmetry between the two systems which conforms with the "Eastern" vision that there is no distinction between observer and observed during observation. The distinction emerges only after the observation is over and sensory percept has become a memory.

Also remote mental interactions should have ATP as a correlate of intentional action at the end of the operator and the rate of metabolism might be used as a correlate for the remote mental interaction such as psychokinesis or intentional imprinting or human-machine interactions.

11.6.2   How to choose senders and receivers?

In the above discussion only the new physics phenomena suggested to be essential for both biology, neuroscience, and remote mental interactions are considered, and many experiments could be carried out without operator and target as they are used in remote mental interaction experiments. One might however hope that the model could give some idea about optimal planning of experiments related to remote mental interactions.

In these experiments an important aspect of testing is optimal choice of targets and the persons acting as sender.

1. Quite generally, the optimal target system for demonstrating these effects would be a critical system very sensitive to small perturbations. Any critical system would work, and one might even consider that the critical systems used to detect elementary particles might be used. Overcooled vapor or liquid or overheated liquid is one possibility. One could take register what happens in the system using same methods as in particle physics. Organic compounds might be by definition be this kind of systems.

2. One could also try to identify optimal 'senders'. Persons with strong will power or with firm belief on the effect, or persons with lower level of inhibition (children, actors, artists,...) could be considered as optimal 'senders'. One could find whether some drugs which remove inhibition, could enhance telepathic and psycho-kinetic abilities. The "blessed are the meek since they quantum entangle" prediction could be also tested. Indeed, one of the most dramatic experiments supporting psychokinesis was done using chicken which imprinted to a robot [J133] . The robot, whose behavior was programmed earlier by random number generator, tended to stay near the chicken, as if chicken had induced a quantum jumps changing the geometric past in macro-temporal time scales.

11.7 The tip of iceberg: placebo, experimenter expectation and interference phenomena in subconscious information flow

The answers to the questions discussed below require a summary of the recent view about basic notions of TGD inspired theory of consciousness. The vision of Jeff Hawkins about neocortex led to a considerable updating of the vision about quantum jump as a moment of consciousness, and also about the notion of self allowing rather concrete connection with what happens in brain and the basic notions of Hawkins have quantum parts in TGD based vision. The question by Jean Burns inspired a model for how the memories and expectations of future are read without affecting the memories by using interaction free measurement. Remote mental interactions can be seen as special case of those occurring between magnetic body and biological body in TGD based view about living matter and brain and the answers to the questions rely on this vision.

11.7.1 The vision of Jeff Hawkins about neo-cortex

The progress in these aspects came from working out a general model for quantum jump in zero energy ontology (ZEO) with inspiration coming from the book of Jeff Hawkins (for book see `http://blog.mohammadzadeh.info/media/blogs/snf/Resources/HTM/OWL_Books_-_On_Intelligence.pdf?mtime=129677404`).

1. Hawkins suggests a general model for how neocortex constructs sensory representations and motor actions. One of his key observations is that these two basic operations look like time reversals of each other a model for sensory perception gives a model for motor action.

2. Hawkins emphasizes the role of time: not only spatial patterns but temporal sequences of them are stored in memory. Hawking introduces also the notions of invariant representation, association, abstraction and its reverse process, and hierarchy of abstraction levels having interpretation in terms of structure of neo-cortex and the basic question os what are the (possibly quantum) physical correlates of these notions.

3. Pattern recognition is the basic process and is carried out at various levels of hierarchy by comparing sensory input with standard patterns stored in memory. If the pattern fails to be recognized at given level it is sent to higher level where it is represented in lower resolution and might be recognized as a part of a larger pattern.

11.7.2 A generalization to a vision about the anatomy of quantum jump in zero energy ontology

The vision seems to generalize to an interpretation of the anatomy of quantum jump by generalizing to various notions involved to quantum TGD context. This was to my a surprise. The basic observation and in zero energy ontology (ZEO) quantum jumps occur in two varieties: state function reduction to upper or lower boundary of causal diamond (CD). The interpretation for these two kinds of quantum jumps would be as generalizations for forming sensory representations and performing motor action. The processes would be carried out at various levels of the self hierarchy. Even at the level of elementary particles. I wrote a blog posting about this, see

http://matpitka.blogspot.fi/2013/04/a-vision-about-quantum-jump-as.html,

article at http://tgdtheory.com/public_html/articles/hawkins.pdf,

and new chapter at

http://tgdtheory.com/public_html/tgdlian/tgdlian.html#lianhawk

Sensory perception and motor action as time reversals of each other

In this framework sensory representations are not only (short term) memories but also predictions, symbolic representations for expectations and beliefs about future. Same applies to their p-adic counterparts defining cognitive representations in which sensory percept consists of objects. Motor actions correspond to sensory representations in reversed time direction and same statements apply to them as also their p-adic counterparts.

1. I assume the basic ideas about zero energy ontology (ZEO) and causal diamonds (CDs) known. Denote the light-like boundaries of causal diamond CD (cartesian product of the intersection of future and past directed light cones of M^4 with CP_2) by CD_{up} and CD_{low}. "Up" resp. "low" could be also taken to mean "future" resp. "past". Let us used small letters $a, b, ..$ for positive/negative energy states, which are state function reduced and thus look classical since particle numbers and quantum numbers are well-defined unless negentropic entanglement is present. Big letters are preserved for states which do not have this property. In any state of quantum jump sequence one has state of form (a,B) or (A,b) by the basic properties of state function reduction in ZEO. Note that state function reduction and state preparation are the same thing but occurring at opposite boundaries of CD in zero energy ontology.

2. Suppose first that CD_{low} is in a state function reduced state a with well defined single particle quantum numbers State a could be regarded as an outcome of sensory perception process (top-down cascade of state function reductions with standard arrow of imbedding space time) leading from perceptively fuzzy initial state to perceptively precise state. The state B at CD_{up} cannot be prepared/state function reduced if S-matrix is non-trivial and represents a superposition of states, something non-classical like qubit or Schrödinder's cat. State B could be seen as a fuzzily define goal, plan of future, or prediction resulting in sensory perception. This conforms with Hawkings vision that sensory perception defines also a plan of future, expectation.

   The p-adic variant of a→B obtained by cognitive map mapping real space-time surfaces in the superposition to p-adic counterparts (these surfaces represent among other things nerve pulse patterns) would be cognitive representation, kind of symbolic representation describing the goal, expectation, or prediction, intention. Its fuzziness corresponds to the fact that we cannot predict future precisely.

3. Let us now make state function reduction at the opposite boundary CD_{up}, which after this is in perceptively precise state function reduced state b. The interaction is as motor action identified as time reversal of sensory perception. b represents now an achieved goal. b is of course not completely predictable and only the probability of particular b can be known. CD_{low} is state A with is not anymore state function reduced and classical looking. It can be interpreted the initial fuzzy motor plan represented as quantum superposition of options without fixing the details. The cascade of state function reductions proceeding from top to bottom for given CD and its sub-CDs only fixes the details.

The p-adic of this zero energy state would be cognitive representation for the realized motor action leading to final state b: a realized intention, cognitive representation for how intention was realized.

4. If this picture is correct, the outcomes of quantum jumps in ZEO would universally organized into a sequence of pairs $(a_n, B_n), (A_n, b_n)$ of zero energy states corresponding to sensory perception and motor action and the basic structure for the functioning of conscious brain would be part of quantum theory. This decomposition would take place in various scales of the scale hierarchy (sheets of many-sheeted space-time with various time scales and CDs containing sub-CDs containing...). This picture is consistent with the vision of Hawking at the structural level and if true, brain would not be so special system as neuroscientists tend to think but could be seen only as a highly specialized and highly developed instrument for producing sensory and cognitive mental images and controlling the external world. Also the localization of contents of consciousness to brain along would be misleading in this framework.

Quantum counterpart of association

Association is key concept of neuroscience and should have quantum counterpart.

1. To explain the idea one needs first some words about Negentropy Maximization Principle (NMP). NMP is analogous to second law. It states that the information gain in state function reduction is maximal. One can define information gain as difference between informations of initial and final zero energy states. NMP implies standard quantum measurement theory for Shannon entropy as entanglement entropy. If entanglement probabilities are rational numbers or even algebraic numbers one can however define a hierarchy of number theoretic entanglement entropies corresponding to various p-adic numbers fields Q_p, p prime and in this case the entropy can be negative and thus describes information interpreted as information carried by the entanglement. The pairs in quantum superposition would represent instances of a rule. Entropy would in turn characterize the loss of information about the state of either entanglement system.

NMP is analogous to second law and its natural to imagine the analogs of temperature and various other parameters as characteristics of "thermal equilibrium" under some constraints with respect to NMP instead of second law. These would be macroscopic parameters characterising the state of consciousness, and one can easily imagine psychological counterparts of thermodynamical notions. Psychological pressure would not be a mere metaphor!

2. Negentropic entanglement (see fig. `http://www.tgdtheory.fi/appfigures/cat.jpg` or fig. 21 in the appendix of this book) provides a model for associations as rules in which superposition of tensor product states defines rule with entanglement pairs defining its various instances. This generalizes to N-fold tensor products. Associations would be realized as N-neuron negentropic entanglement stable against NMP. One could also think of realizing associative areas in terms of neurons whose inputs form entangled tensor product and when sensory inputs are received they form analogous tensor product in representative degrees of freedom.

Thus negentropic entanglement is necessary for mental images (having sub-CDs as correlates) to mental images representing spatial patterns. Negentropic entanglement in time direction for these patterns (zero energy states) is in turn necessary to bind them to sequences of mental images representing abstract memories as sequences of mental images. Negentropically entangled sequence would be a quantal counterpart for the original association sequence introduced as purely geometric concept.

3. Collective consciousness could involve formation of associative (tensor product) networks analogous to neuronal networks as this kind of negentropically entangled tensor products. They could be very relevant for remote mental interactions. Experimenter effect, effect of group to remote mental interactions such as healing, etc... They would form hierarchy and the communications between hierarchy levels would be important. The remote viewer or healer would be only part of a bigger structure.

Self or only a model of self?

The proposed picture however challenges the identification of self as quantum jump. Should the negentropically entangled sequences of mental images define selves so that self would be something characterizing zero energy state rather than something identified as quantum jump? Could they define a model of self to be distinguished from self identified as quantum jump? Or could one give up the notion of self altogether and be satisfied with model of self? At this moment it seems that nothing is lost by assuming only the model of self.

By definition negentropic entanglement tends to be preserved in quantum jumps so that it represents information as approximate invariant: this conforms with the idea of invariant representation and quite generally with the idea that invariants represent the useful information. There is however a problem involved. This information would not be conscious if the original view about conscious information as a change of information is accepted. Could one imagine a reading mechanism in which this information is read without changing the negentropically entangled state at all? This reading process would be analogous to deducing the state of a two-state system in interaction free measurement to be discussed below in more detail.

Could interaction free measurement be used to deduce information about self model?

The assumption that self model is a negentropically entangled system which does not change in state function reduction, leads to a problem. If the conscious information about this kind of sub-self corresponds to change of negentropy in quantum jump, it seems impossible to get this information. One can however consider a generalization of so called interaction free measurement as a manner to deduced information about self model. This information would be obtained as sequences of bits and might be correspond to declarative, verbal memories rather than direct sensory experiences.

1. The bomb testing problem of Elitzur and Vaidman gives a nice concrete description of what happens in interaction free measurement, see `http://en.wikipedia.org/wiki/ElitzurVaidman_bomb-testing_problem` for illustration of the system considered.

   The challenge is to find whether the bomb is dud or not. Bomb explodes if it receives photon with given energy. The simplest test would explode all bombs. Interaction free measurement allows to make test by destroying only small number of bombs and at idealized limit no bombs are destroyed.

   The system involves four lenses and two detectors C and D. In the first lense the incoming photon beam splits to reflected and transmitted beams: the path travelled by transmitted beam contains the bomb.

   (a) The bomb absorbs photon with a probability which tells the fraction of photon beam going to the path at which bomb is (is transmitted through the lense). The other possibility is that this measurement process creates a state in which photon travels along the other path (is reflected). This photon goes through a lense and ends up to detector C or D through lense.

   (b) If the bomb is dud photon travels through both paths and interference at the lense leads the photon to detector D. If C detects photon we know that the bomb was not a dud without exploding it. If D detects the photon, it was either dud or not and we can repeat the experiment as long as bomb explodes, or C detects photon and stop if the detector continues to be D (dud). This arrangement can be refined so that at the ideal limit no explosions take place and all.

2. The measurement of bomb property is interaction free experiment in the sense that state function reduction performed by absorber/bomb can eliminate the interaction in the sense that photon travels along the path not containing the bomb. One might say that state function reduction is an interaction which can eliminates the usual interaction with photon beam. State function reduction performed by bomb can change the history of photon so it travels along the path not containing the bomb.

   This picture is only metaphorical representation of something much more general.

1. In TGD framework the photon paths branching at lenses correspond to branching 3-surfaces analogous to branching strings in string model and photon wave splits to sum of waves travelling along the two paths.

2. Bomb could be of course replaced with any two-state system absorbing photons in one state but not in the other state, say atom. Now one would test in which state the atom is gaining one bit of information in the optimal situation. Two-state atom could thus represent bit and one could in principle read the bit sequence formed by atoms (say in row) by this method without any photon absorption so that the row of atoms would remain in the original state.

One can imagine several applications if the information to be read in interaction free manner can be interpreted as bit sequences represented as states of two-state system. Lasers in ground states and its excited state would be analogous many particle quantum system. In TGD framework the analog of laser consisting of two space-time sheets with different sizes and different zero point kinetic energies would be the analogous system.

For instance, a model of memory recall with memories realized as negentropically entangled states such that each state represents a qubit can be considered.

1. Reading of a particular qubit of memory means sending of negative energy photon signal to the past, which can be absorbed in the reading process. The problem is however that the memory representation is changed in this process since two state system returns to the ground state. This could be seen as analog of no-cloning theorem (the read thoughts define the clone). Interaction free measurement could help to overcome the problem partially. Memory would not be affected at all at the limit so that no-cloning theorem would be circumvented at this limit.

2. A possible problem is that the analogs of detectors C and D for a given qubit are in geometric past and one must be able to decide whether it was C or D that absorbed the negative energy photon! Direct conscious experience should tell whether the detector C or D fired: could this experience correspond to visual quale black/white and more generally to a pair of complementary colors?

3. ZEO means that zero energy states appear have both imbedding space arrows of time and these arrows appear alternately. This dichotomy would correspond to sensory representation-motor action dichotomy and would suggest that there is no fundamental difference between memory recall and future prediction by self model and they different only the direction of the signal.

4. Since photon absorption is the basic process, the conscious experience about the qubit pattern could be visual sensation or even some other kind of sensory qualia induced by the absorption of photons. The model for the lipids of cell membrane as pixels of a sensory screen suggests that neuronal/cell membranes could serve defined digital self model at the length scale of neurons.

This model can be applied also to telepathy and maybe also to ESP since the basic mechanism are expected to be the same.

What abstraction means in zero energy ontology?

A further central notion used by Hawkins is that of abstraction.

1. For sensory and cognitive representations abstraction means just a process of forgetting irrelevant details besides going to a longer time and length scales (example: sequences of music pieces in CD is the mental image instead of single piece).

2. The more abstract the representation the longer the corresponding time scale is. This suggests that the sequences of negentropically entangled mental images get longer as abstraction level increases. In state function reduction the quantum superposition of CDs with second boundary localized contains all scales for CDs and reduction localizes the opposite boundary but forces de-localization of the original boundary. This also means that the average size of

the CDs increases and the sequences of negentropically entangled sub-CDs become longer as new sub-CDs (mental images) are created. These sequences of sub-CDs would give rise not only to self but also self-model

3. Getting rid of details is the second aspect of abstraction. In TGD framework measurement/ cognitive/ sensory resolution is a natural concept in this respect and emerge unavoidably if one interprets cognitive representations as maps of real space-time surfaces to their p-adic counterparts. Only discrete set of rational (or perhaps algebraic) points of space-time surface can be mapped to their p-adic counterparts as such. The p-adic space-time surface is a completion obtains as a preferred extremal containing these points. There are in general very many preferred extremals with this property and their quantum superposition represents the cognitive representation in finite measurement resolution. Quantum superposition in given resolution defines therefore abstraction and increasing the level of abstraction means reduction of the resolution. Note that also the reverse maps from p-adic preferred extremals to real ones define reversals of cognitive maps and have realization as a transformation of intention to action.

Remote mental interactions as a special case

This general model applied also to remote viewing and psychokinesis assumed to be special cases of what happens when magnetic body interacts with biological body, could provide new insights.

1. The first conclusion would be that several levels (scales) are probably involved in both processes: not only various hierarchical levels of brain (various sensory and motor areas, and their 6-layered structure, various size scales in brain anatomy) but also the hierarchy of magnetic bodies would be present meaning that remote mental interactions involve collective levels of consciousness rather than only the operator and target. The presence of these collective levels suggests that the experimenter effect and many other analogous effects considered in the questions are real.

2. In the case of brain self hierarchy allows to understand various agnosias [J141] which look mysterious if one assumes only single level in the self hierarchy. One of the agnosias is blind sight: person sees but does not see consciously. The visual areas of the person are intact. Person indeed receives the visual information as but some other level of self level sees becomes clear from the fact that she can perform motor actions possible only if there is an access to the visual information generated in visual areas. Simplest explanation would be that the sub-selves representing mental images do not negentropically entangle with the other sensory mental images: associative areas would not work as they should. Agnosia would be disorder in tensor producting! The would entangle with unconscious-to-us motor mental images. The explanation would be that some other self in hierarchy enjoys visual consciousness, perhaps above, at same level, or several level below in the hierarchy.

   Could remote viewing be like blind sight: one sees but not consciously - some lower or upper level in the self hierarchy remote views consciously and and the remote viewer manages to guess some of this information? The presence of self hierarchy extending even to the level of magnetic bodies and collective levels of course complicate the modelling attempts. For instance, one must ask how can one know that remote viewer does not read the thoughts of some person in the experimental group instead of remote viewing. In any case, the presence of the hierarchy and the crucial role of attention would also explain the difficulties related to the interpretation of experiments.

3. Ironically, various experimenter effects and placebo effect might provide the strongest support for remote mental interactions and the effect of intentions and expectations to the future history. In ZEO sensory perception produces not only summary of what happened but also an expectation what will happen and one could interpreted the expectation also as a quantum fuzzy goal. The next quantum jump realizes this motor plan. In ZEO we are really re-creating our reality repeatedly by just sensorily perceiving in the two different time directions. If one believes on hierarchy of Planck constants, and negentropic entanglement, the effects need not be minor anomalies masked by thermal fluctuations but can become manifest in everyday scales.

11.7.3 Possible answers to the questions

Question 9: Both Dr. Solfvin and Dr. Moddel have conducted remote influence studies (on animal models, respectively random event generators; Solfvin, 1982; Moddel, 2012) in which participants expectation seemed to dominate the outcome. In the first case, animal handlers were told that half of their assigned mice were inoculated with babesia and half with sterile saline, and that half of each group would receive remote healing influence from an accomplished healer. In reality, all mice were inoculated with the same dose of babesia, and there was no remote healer. In spite of this, significant differences were recorded between inoculated and control groups, as well as between healer and control mice which, the paper concluded, could only be attributable to handlers expectations. In Moddels study, where a random event generator (REG) was set up to arbitrarily shut off the power to another, sequence-recording REG, eventual loss of interest by the experimenters invariably resulted in the initially spectacular PK effect size dropping to non-significance levels.

Are you aware of similar experiments corroborating these results? Can you think of a way to isolate the experimenter expectation effect from the overall outcome? How significant do you think experimenter expectations may be in mainstream clinical trials? Could a reduced level of emotional trepidation/ expectancy build-up on the part of principal investigators in post-marketing drug trials, when compared to pre-approval phase, mirror the steep decline noted with Moddels 2-REG experiments? What makes a system more susceptible to experimenter expectation?

Answer: One could understand these findings qualitatively in the proposed general vision. In particular, the loss of interest means that experimenter does not anymore direct attention to situation and there is no intention to achieve desired results. If emotions basically correspond to negentropy gradients then their lack means that attention is not directed to the target.

Question 10: Like the REG/DMILS studies above, the Schlitz/Wiseman experiments (Wiseman and Schlitz, 1998) suggest that the ganzfeld process is susceptible to experimenter expectation. However, these correlations are not consistent - successful remote viewing and PK have also been achieved in the presence of skeptics. Is there any supporting evidence for experimenter expectation in the GCP data or in other field-REG studies? Do you feel that some psi processes may be more robust in the face of experimenter expectation for example, that the spontaneous mass emotional response typically associated with the major events registered by the Global Consciousness Project is more likely to dominate the outcome than the motivation of a typical operator trying to affect a bench top random event generator in the classical REG experiment?

Answer: Ganzfeld process would seem to be almost by definition a process involving several collective levels of consciousness so that if the vision discussed in the beginning makes sense, one could expect the susceptibility. What I fail to understand is how mass emotional response could lead to coherent effect on REG since the intention to obtain definite deviation from true randomness is obviously lacking.

Maybe one could think some kind of effect - via say periodic perturbation of magnetic fields of the collective magnetic body (Schumann resonances?) transferred also to the magnetic body assignable to the recording. William Tiller has reported this kind of effects due to intentional action in his books. I have proposed a rather crazy idea of demonstration of PK leaving no doubt about its reality by comparing records of RG with affected by PK able person with those not affected in this manner (see `http://tgdtheory.com/public_html/articles/PKoptions.pdf`).

Question 11: In The Possible Role Of Intention, Attention And Expectation In Remote Viewing (May and McMoneagle, 2004) the authors argue that the sharply focused attention of all unit personnel on the one assigned task while doing operational remote viewing was likely responsible for the exceptional level of data produced. This seems to be corroborated by a series of experiments (Watt, 2003) in which subjects focus on a given task was shown to be significantly enhanced by a remote assistant concentrating their supportive attention on the operators. If these findings are correct, then it would seem that attention itself is a cumulative network phenomenon. Could that joint mass focus on the event being studied be a factor in the remarkable consistency of GCP results? **Answer**: To answer this question as a physicists one should have a physical model for

attention. My own model of attention relies on the identification of magnetic flux tube connections as a correlate of attention. Negentropic entanglement is present bringing in conscious information at this level of self hierarchy. Flux tubes create also quantum coherence in the sense that the systems connected by flux tubes form a single quantum coherent system in some degrees of freedom (dark matter with large value of $\hbar_{eff}$ at connecting flux tubes and systems themselves).

Sharply focused attention of all unit personnel means that the level of consciousness of the collective mind created in this manner is high and one can expected that remote viewing is more effective. Note that remote viewing as analog of sensory perception would involve information transfer between different levels of this hierarchy in both directions: to abstraction and back to more detailed view.

Question 12 (from B. Millar): Are there effects known in physics where three or more initially separate systems become quantum coupled or entangled? Do these have any consequences for remote mind-mind and mind-matter interactions?

Answer: There are. Quantum entanglement between electrons of atom and at molecular level are this kind of phenomena. Also quantum entanglement between valence quarks inside proton (N=3). 2-particle entanglement is however special. So called monogamy theorem states that system can have maximally entropic entanglement with single system only. Therefore maximal entanglement between A and B, A and C, and B and C is not possible in 3-particle entanglement. The really happy couple must isolate themselves from the rest of the world!

Question 13 (from J. Burns): We know through abundant evidence that ESP can travel without any physical signal to carry it. Up until recently the only way known, according to physical laws, to make a connection with no physical signal was through quantum entangled states. This possible method for the travel of ESP has the problem that quantum entanglement does not allow the transmission of information, but only correlations between certain events. However, it is thought that perhaps the extension of currently known quantum mechanics, which describes the interactions of matter, to incorporate interaction with consciousness might then provide an explanation.

However, recently a method has been proposed in which, according to the presently known laws of quantum mechanics, information can be transferred without a physical signal (see `http://physicsworld.com/cws/article/news/2013/apr/16/alice-and-bob-communicate-without-transferring-a` It differs from the latter method in that it uses the Zeno effect, which is produced through multiple instances of de-coherence, such as wave function collapse or interaction with the environment. Which method do you favor as a means by which ESP can travel? Why? If you favor a third method, please describe.

Answer: In the first section I already described the interaction free measurement realized in terms of lenses and photon beams. The bomb testing problem of Elitzur and Vaidman gives a nice concrete description of what happens, see `http://en.wikipedia.org/wiki/ElitzurVaidman_bomb-testing_problem` for illustration of the system considered.

The basic idea of interaction free measurement and its possible application to memory recall allowing to avoid destruction of the memory represented as a collection of negentropically entangled mental images (sub-selves, sub-CDs) was discussed in the first section 11.7.2. It was noticed that the absorption of photons could give rise to visual quale (black/white) as a representation for the bit that has been read and that the lipids of cell membrane could serve as pixels of sensory screen allowing to define mental images at neuronal level of self hierarchy.

One can imagine several applications if the information to be read in interaction free manner can be interpreted as bit sequences represented as states of two-state system. Lasers in ground states and its excited state would be analogous many particle quantum system. In TGD framework the analog of laser consisting of two space-time sheets with different sizes and different zero point kinetic energies would be the analogous system.

1. Mind reading - telepathy - might be possible using this mechanism if thoughts are expressible as qubit sequences or more general patterns. The mind reader sends a split beam of photons to the system which it wants to read. The target notices nothing at the idealized limit since

no photons are absorbed by the target but a pair of systems analogous to detectors C and D: mind reader must of course be able to see whether either of these systems detects a photon.

This mechanism would differ from TGD inspired model of telepathy based on TGD inspired notion of sharing of mental images. Sharing of mental images requires that entanglement of mental images is possible although systems having those mental images as sub-selves (sub-systems) are not entangled. This is possible if one accepts TGD based view about space-time and corresponding view about hierarchy of subsystems. One can have two disjoint space-time sheets containing topologically condensed smaller space-time sheets which are connected by flux tubes. In the resolution of larger space-time sheets there is no entanglement. In the resolution of smaller space-time sheets there is entanglement and shared mental images.

2. Could this model apply to ESP?

   (a) The recent TGD based model of ESP relies on much more classical picture. Magnetic flux tubes generated by remote viewer and serving as correlates of attention connect the remote viewer with the target (here macroscopic quantum coherence is required). Along the flux tubes travel the dark photon beams (photons with large $\hbar_{eff}$ and thus scaled up wavelength for given energy) and are reflected at the second end and return back. This is very much like ordinary seeing using lamp but forcing the light beams to travel inside flux tubes so that the intensity of beam is not reduced with distance.

   (b) There does not seem to be any compelling need for interaction free ESP as there is in the case of reading of negentropically entangled memories or future predictions.

   (c) Furthermore, visual perception does not seem to be a process in which qubits are read. Note however that in the above described model reading of memories involves photon absorption by system C or D: these systems code for the values of bit and one could assign to this process a visual quale.

Question 14: If PK is goal-oriented, independent of an operators understanding of the complex physical or biological mechanisms involved in achieving the desired effect, then should we assume that the operator is essentially interacting with the target at a future point in time, with causality apparently flowing backward to the present, to affect the target and all those connected to it ? Does the universe we share then find its probability course like a stream shaped by the resultant landscape of our collective intents, beliefs and expectations?

Answer: One could understand the possibility of PK without understanding how it is achieved, if the operator is only a part of collective mind. Although operator knows nothing about mechanisms, the higher or lower levels might know and could help to reach the desired effect. PK as any motor action would be a cascade proceeding from higher levels to lower ones with a lot of feedback if the lower level is not able to realize what higher level wants so that command is sent back for refinement.

In ZEO motor action can be indeed seen as a time reversal of sensory perception which also involves a lot of feedback between different abstraction levels (representations in given resolution with poorer resolution meaning higher abstraction resulting from forgetting the irrelevant details). Libet's findings support this picture in small time scales.

Also higher collective levels would be present (having magnetic bodies as correlates). This could mean that collective intents, beliefs, and expectations are indeed important and universe is reconstructed repeatedly even in macroscopic scales, as we indeed experience it to be.

Question 15 (B. Millar): Eminent parapsychologists are almost unanimous that understanding experimenter effect is crucial for the field. All this lip service has resulted in remarkably little experimental action. Why is this and what can be done to improve matters? **Answer**: I think

that the problem is that precise enough theoretical frameworks are lacking. The situation is also circular. Experimenter effect is itself remote mental interaction and it is remote interactions we try to understand by doing experiments!

Question 16: We are currently operating under the working assumption that any such consciousness - related anomalies are peripheral to our routine activities and small enough to be absorbed by the tolerances built into our systems. Is that a correct assumption and if not, which areas do you think are most susceptible to these poorly-understood effects? How critical could they become? **Answer**: If I take seriously the vision about quantum jump sequence as a universal

cognitive algorithm involving large number scales and self hierarchy, I must be also ready to consider the possibility that the effects are not always small. Understanding of anomalies of ordinary consciousness in terms of self hierarchy might help considerably also in this problem.

Chapter 12

Hypnosis as remote mental interaction

12.1 Introduction

In TGD framework one can argue that hypnosis represents an example about the fact that brain is not "private property": hypnotist uses the biological body and brain of the subject as instrument. Therefore remote mental interaction is in question. This idea generalizes: if one accepts self hierarchy, one can assign to any kind of higher level structure - family, organization, species, ... - a higher level self and magnetic body carrying dark matter, and these magnetic bodies can use lower level magnetic bodies as their instruments to realize their intentions. Biological bodies would be an important level in the hierarchy, which would continue down to cellular, molecular, and perhaps to even lower levels.

This view challenges the prevailing views about brain as a sole seat of consciousness and the assumption that conscious entities assigned with brains are completely isolated. Given magnetic body can use several biological bodies although one can assign to it the one providing the sensory input - at least during wake-up state. Note however that it is easy to produce illusion that some foreign object is part of biological body.

For more than decade ago I proposed a model for so called bicamerality based on the notion of semitrance [K76, K77]. In semitrance the brain of subject becomes partially entangled with a higher level self - in this case the self of family or more general social group uses the biological body of member for its purposes. Higher level self gives its commands and advice interpreted by the bicameral as "God's voice". The consciousness of schizophrenic might be basically bicameral. Also hypnotic state and dream consciousness are candidates for bicameral consciousness.

12.1.1 Hypnosis as hijacking of brain?

In TGD framework hypnotist and subject would partially share the biological body of the subject, and hypnotist could realize motor actions using the biological body of the subject and also induce sensory experiences by sending suggestions generating virtual sensory input to the sense organs of the subject (this if one accepts TGD view about the role of sensory organs).

One could see hypnosis as a kind of hijacking of some parts of the subject's brain. Could one identify these parts? The general finding is that there is no universal neural or EEG signature of hypnotic state and possible changes in neural activity can be interpreted as neural correlates of imagination. Only in the case of persons highly susceptible to hypnotic induction one can identify a change of neural activity pattern identifiable as a correlete of hypnotic state.

"Hijacking" can be of course criticized for its negative tone. A more positive manner to express the idea is to say that the subject is voluntarily provides part of her brain to the use of the hypnotist's magnetic body. This conforms with the acronym "TEAM" symbolizing the subject's orientation to hypnosis in terms of "trust", "expectation", "attitude", and "motivation".

The neurophysiological findings conform with the view that the really interesting phenomena take at the level of magnetic bodies. The changes - when they occur - take place in prefrontal

cortex (PFC) [J20] and anterior cingulate cortex (ACC) [J4]: this together what is known about methods of hypnotic induction provides hints about what might occur in the hijacking process. The almost-prediction would be a correlation between EEGs of the hypnotist and subject person reflecting the sharing of parts of the subject's brain. It would be therefore highly interesting to study the correlations of the EEGs of subject and hypnotist.

Strongly focused attention to hypnotic suggestion is mentioned as a basic aspect of hypnosis and distinguishes it sharply from sleep. This feature brings in mind various altered states of consciousness reached in meditation and it has been suggested that meditation is one form of self-hypnosis. In TGD framework personal magnetic body has layered onyon-like structure with layers characterized by p-adic length and time scales and the value of $\hbar_{eff}$. Therefore meditative state could be seen as a re-sharing of biological body and brain by these layers and even by foreign magnetic bodies.

12.1.2 Do social interactions share something with hypnosis?

More generally, one can also ask whether the phenomena of collaboration and synergy on one hand, and influence, "power" and fight for power on the other hand, could be modelled in terms of the partial ownership of the biological bodies by magnetic bodies identified as intentional agents.

Social structures and organizations are complex networks in which the arrows characterizing relationships between individuals in the simplest situations are uni-directional and static. The person at either end of the arrow is in command. In more complex situations members are connected by several arrows of this kind, their directions can vary, and need not be static.

Should one therefore give up what physicist would call "single-particle" view and replace it with "many-particle" view by bringing in the notion of magnetic body attaching to several biological bodies and organizing them to loosely bound states of individuals? Under what conditions this kind of partial fusion of conscious entities can take place? Does it occur only only when there is complete trust in either direction or can fear about consequences be enough? It would not be surprising if immune systems against hijacking of the biological body would have evolved: this would allow to understand why the reality of remote mental interactions is so difficult to demonstrate. They could however take place on daily basis in social interactions if the proposed picture makes sense.

The dynamical sharing of biological bodies can be seen also positively: this sharing would make possible collaboration and synergy at much deeper level than we have been used to think. This kind of shared use of biological bodies perhaps defines the direction to which human kind should proceed. Also the possibility to directly experience what it is to be "the other one" - something not allowed by the standard view about consciousness confined inside individual brain - is implicated.

The new view about influence and power might allow to understand better the often highly irrational looking behaviors of organizations and their members - in particular blind obediance of orders and fight for power. The hierarchy of magnetic bodies could serve as a physical correlate for the hierarchy of biological and social structures. In particular, the fight for power could be seen as fight between magnetic bodies for the ownership of biological bodies or lower level magnetic bodies. The dark matter realized as a hierarchy of phases with non-standard value of effective Planck constant would represent a new physics necessary for understanding the physical correlates of these phenomena.

In the sequel I will introduce some basic notions, ideas and theories about hypnosis: the Wikipedia article [J10] gives a good overall view about the subject. The techniques of hypnotic induction provide valuable clues if one wants to imagine what hypnosis is. I will also describe the classical test for hypnotic susceptibility using Chevreul pendulum (to me it was quite a stunning experience to find that I am highly susceptible to hypnotic induction!), and propose an explanation in terms of hijacking of PFC and ACC by the magnetic body of hypnotist. The model makes an assumption about the logic of brain functions. Imagined motor action "Don't (really) do this" is realized as "Do this" followed by "Don't" stopping the imagined motor action proceeding otherwise from the magnetic body to PFC to motor regions of cortex via ACC to a real motor action.

In TGD framework sensory perception and motor action are related by time reversal and therefore an analogous mechanism applies to imagination realized as a genuine hallucination unless "Don't" is realized. Hypnotist should therefore hijack the brain regions realizing "Don't" by catching their attention so that they cannot perform their function. ACC is a good candidate for the region in which "Don't" is realized under normal circumstances. This logic makes possible to

induce motor actions and sensory hallucinations analogous to dreams. Dreams would be realized in terms of virtual sensory input to sensory organs (REM) rather than only to higher levels in hierarchy of sensory representations at cortex, which do not carry visual qualia conscious-to-us.

The appendix of the book gives a summary about basic concepts of TGD with illustrations. There are concept maps about topics related to the contents of the chapter prepared using CMAP realized as html files. Links to all CMAP files can be found at `http://www.tgdtheory.fi/cmaphtml.html` [L35]. Pdf representation of same files serving as a kind of glossary can be found at `http://www.tgdtheory.fi/tgdglossary.pdf` [L36]. The topics relevant to this chapter are given by the following list.

12.2 Basic facts about hypnosis

The reader is recommended to read the Wikipedia article about hypnosis [J10] as a good introductory summary. The article begins by stating the basic big question about hypnosis: Can hypnosis be regarded either as a mental state (altered state of consciousness) or as an imaginative role-enactment? The first option conforms with the basic assumption of most existing theories of consciousness: consciousness is something completely private and in materialistic dogma reduces to the state of brain. Second option does not accept hypnosis as a genuine brain state and emphasizes the interaction between hypnotist and subject. Combined with standard neuroscience also this approach tries to understand hypnosis as single-brain phenomenon. In TGD view hypnosis is seen as a phenomenon involving two magnetic bodies interacting with single brain.

Also the heightened focus and concentration to a dominating idea (suggestion) blocking out sources of distraction is mentioned as characteristic of hypnosis and some theories emphasize this aspect instead of seeing hypnosis as a trance state.

The following discussion relies heavily on the Wikipedia article adding TGD inspired comments in the hope that they would help the reader to see the distinctions between TGD approach and more standard approaches.

12.2.1 Basic definitions

In the following basic definitions of hypnosis are considered. The discussion follows the Wikipedia article with TGD inspired comments.

Definition of hypnosis

Braid's original definition of hypnosis was following:

> [...] the real origin and essence of the hypnotic condition, is the induction of a habit of abstraction or mental concentration, in which, as in reverie or spontaneous abstraction, the powers of the mind are so much engrossed with a single idea or train of thought, as, for the nonce, to render the individual unconscious of, or indifferently conscious to, all other ideas, impressions, or trains of thought. The hypnotic sleep, therefore, is the very antithesis or opposite mental and physical condition to that which precedes and accompanies common sleep [...]

Braid defined hypnotism as a state of mental concentration that often leads to a form of progressive relaxation, termed "nervous sleep". Later, in his "The Physiology of Fascination" (1855), Braid concluded that his original terminology was misleading, and argued that the term "hypnotism" ("hypnos" refers to sleep) or "nervous sleep" should be reserved for the minority (10 %) of subjects who exhibit amnesia, substituting the term "monoideism", meaning concentration upon a single idea, as a description for the more alert state experienced by the others.

The recent official definition of hypnosis is following:

Hypnosis typically involves an introduction to the procedure during which the subject is told that suggestions for imaginative experiences will be presented. The hypnotic induction is an extended initial suggestion for using one's imagination, and may contain further elaborations of the introduction. A hypnotic procedure is used to encourage and evaluate responses to suggestions. When using hypnosis, one person (the subject) is guided by another (the hypnotist) to respond to suggestions for changes in subjective experience, alterations in perception, sensation, emotion, thought or behavior. Persons can also learn self-hypnosis, which is the act of administering hypnotic procedures on one's own. If the subject responds to hypnotic suggestions, it is generally inferred that hypnosis has been induced. Many believe that hypnotic responses and experiences are characteristic of a hypnotic state. While some think that it is not necessary to use the word "hypnosis" as part of the hypnotic induction, others view it as essential.

Induction

Hypnosis is preceded by induction phase, which according to state theorists leads into a "hypnotic trance" whereas "non-state" theorists view induction as "means of heightening client expectation, defining their role, focusing attention".

There exists a large number of induction techniques. The oldest and still dominant one is the eye fixation technique used by Braid and focusing the visual attention to some object - say oscillating pendulum. Ericksonian hypnotherapy relies on indirect techniques to induce trance states. Almost all methods used by Erickson - say handshake induction - rely on confusion as a manner to induce hypnotic state. Erickson sees the resistance to direct suggestions as the basic challenge and used therefore indirect suggestions including so called double bind ("Shall we consider this problem now or perhaps later?") are used. Erickson saw hypnosis as a bi-directional process: also therapist can occasionally be in trance.

Remarks:

1. What notions like "role" and "client expectation" have as quantum physical correlates is of course unclear since even the notion of "consciousness" is poorly understood physically.

2. It has been proposed that all brain states are kind of hypnotic trance states: this extremist view brings in mind the view about magnetic body as a controller of brain and in this sense a hypnotist.

3. The unconscious-to-us fast visual pathway traverses through ACC, which suggests that the activation of ACC by visual attention to pendulum or some other object is involved in eye fixation technique. One can also ask whether flux tube connections retina - pendulum - retina are formed and whether the motion of pendulum promotes the their formation, perhaps in the same manner as "Mesmeric passes" might do.

4. ACC is the part of brain which seems to be involved with the treatment of conflicting situations and Francis Crick has identified it as a candidate for a locus of free will. This supports the view that ACC is indeed essential in the induction of hypnosis.

Suggestion

Braid did not refer to suggestion in his definition of hypnotic state but saw it as focusing of the attention of subject upon a single idea. Later Braid however placed emphasis on using different verbal and non-verbal suggestions.

Bernheim shifted the emphasis from hypnosis as a physical state to the physical process of suggestion:

I define hypnotism as the induction of a peculiar psychical [i.e., mental] condition which increases the susceptibility to suggestion. Often, it is true, the [hypnotic] sleep that may be induced facilitates suggestion, but it is not the necessary preliminary. It is suggestion that rules hypnotism.

Suggestion can take place permissively or in authoritarian manner. One can distinguish between direct and indirect verbal suggestions such as insinuations, requests, metaphors, and stories. There are also nonverbal suggestions and both immediate and posthypnotic suggestions are used in hypnotherapy. Also subliminal suggestions involving visual inputs lasting so short time that there is no conscious experience: at least in this case the unconscious-to-us fast visual pathway through ACC would be naturally involved.

1. *Consciousness vs. subconsciousness*

   One of the basic issues related to hypnosis whether the suggestion is communication to the conscious or unconscious mind of the subject. Braid an Bernheim believed on conscious mind whereas Freud, Janet, and Erickson believe that sub-conscious mind is essential.

   There is also the question whether a person in deep hypnosis is conscious. It seems that this is the case: for instance, person can report about sensory experiences during hypnosis if the hypnotist requests this. The focused attention with the reduction of peripheral awareness and increased response to suggestions seem to characterize the hypnosis.

   Remark: In TGD framework subconscious and unconscious translate to "not conscious-to-us" and - according to the theory to be discussed - the highest level of subject's brain consciousness having FCC as brain correlate could fuse with that of hypnotist's magnetic body.

2. *Ideo-dynamic reflex*

   The first theory of hypnotic state was introduced by Braid, and was based on ideomotor reflex response. The notion was originally introduced by William Carpenter, a friend of Braid. Carpenter observed that under certain circumstances the mere idea of muscular movement induce a small reflexive motor response.

   Chevreul pendulum allows to demonstrate the ideo-motor reflex response in the case of highly susceptible subjects. The mere imagination of motor action producing the motion of the pendulum induces its motion and it seems that the imagination of motion generates the neural activity leading to the motion which due to the hypnotic induction is not stopped so that it can develop to a real motor action.

   Remark: One could interpret ideo-motor reflex in TGD framework as imagined motor action identified as a genuine motor action which proceeds downwards from PFC but is stopped before reaching muscles. Sensory perception has an analogous interpretation as time reversal of motor action. During hypnosis this halting mechanism would be inhibited. This process would be one particular example of inhibition, which is basic mechanism of neural activity: in fact, the role of inhibition becomes more and more important during evolution.

Susceptibility

Hypnotic suggestibility [J10] measures how easily the person can be hypnotized.

Braid distinguished between different stages of hypnotism: sub-hypnotic state, full hypnotic state, and hypnotic coma. Charcot made similar classifcation using the attributes lethargic, somnambulistic, and cataleptic. Liebeault and Bernheim introduced a more refined classification based on a combination of behavioral, physiological and subjective responses. At 20th century more refined scales were introduced. The most common scales are the Harvard Group Scale of Hypnotic Susceptibility and the Stanford Hypnotic Susceptibility Scales.

Most scales measure nowadays the degree of observed or self-evaluated responsiveness to specific suggestion tests. Normal (80 % of population), high (10 % of population) , and low (10 % of population) is the simplest characterization of susceptibility. Highly susceptible subjects have been classified to fantasizers and dissociators. Fantasizers have often had parents who have encouraged imagination. Dissociators have typically a life history involving childhood abuse or some other trauma, and they have learned to escape into numbness and forget unpleasant events. The association to day-dreaming is "going blank" rather than fantasizing wildly.

12.2.2 A brief history of hypnosis and theories of hypnosis

Hypnosis has pre-curcors in yoga and meditation practices. Meditation could be seen as self-hypnosis (if hypnosis is "two-particle phenomenon", one can wonder what this might mean!). The intense focusing of attention on single mental image can be seen as a common aspect of hypnosis and meditation practices.

Franz Mesmer [J8] was the pioneer of hypnosis. He used magnets to induce hypnotic state but later noticed that the same effects can be induced by passign the hands, at a distance from the subject's body ("Mesmeric passes"). Mesmer believed on what he called "animal magnetism" according to which Universe was filled with some kind of magnetic fluid. At the request of King Louis XVI a Board of Inquiry having as members Antoine Lavoisier, Benjamin Franklin and an expert in pain control, Joseph-Ignace Guillotin (better known in somewhat different context), started to study whether animal magnetism is real. The effects were found to be real but placebo controlled experiments convinced the board that mesmerism was most likely due to belief and imagination rather than any sort of energy flowing from the hands of Mesmer.

> *Remark*: In TGD approach to consciousness the flux quanta of magnetic bodies carrying dark matter become the key players of life and consciousness, and are also crucial for the understanding of hypnosis. Somewhat ironically, Mesmer might be making come-back. The effects would be mostly due to imagination but the hands of Mesmer might have induced magnetic flux tube connections making possible the hijacking of the brain of the subject!

James Braid [J11] revisited both the theory and practise of Mesmerism trying to reduce mesmerism to physiology and psychology. Braid emphasized the differences between sleep and hypnosis. He did not believe in any kind of magnetism or supernatural occult influence.

Besides Mesmer and Braid, Bernheim, Janet, Freud, Coue, Hull, Elman, Erickson [J7] are pioneers of hypnosis. Bernheim was a follower of Braid and emphasized suggestion as an essential element of hypnosis instead of viewing hypnosis as a trance state possessed by Braid.

Freud was highly enthusiastic about hypnosis and even wrote a book about hypnotherapy. After the advent of psychoanalysis he started to emphasize the role of free association as a road to unconscious mind. Freud however saw hypnosis as a fast alternative to time taking psychoanalytic therapy. As already described, Erickson developed his own hypno-therapy based on the use of confusion as a manner to achieve hypnotic induction. Erickson also realize that the hypnotic induction can work in both directions.

The notion of dissociation

Janet introduced the notion of dissociation of the control of behavior from ordinary consciousness [J10]. Hilgard introduced later the notion of neo-dissociation: the subject divides her mind voluntarily so that the other part responds to the hypnotist and the other part corresponds to the awareness of the subject. Hilgard made subjects take an ice water bath. They said nothing about the water being cold or feeling pain. Hilgard then asked the subjects to lift their index finger if they felt pain and 70 % of the subjects lifted their index finger. This showed that even though the subjects were listening to the suggestive hypnotist they still sensed the water's temperature.

Mind-dissociation theory of Tsai generalizes the notion of dissociation so that any function of mind can be dissociated. For instance, imagination can be dissociated leading to dreams, some sense can be dissociated leading to hypnotic anesthesia, motor function can be dissociated leading to immobility, "reason" (volition) can be dissociated so that the subject obeys the hypnotist's orders,...

Hypnotism as imagination becoming reality

A complementary view about hypnosis is as imagination, which becomes reality. Persons highly susceptible to hypnosis have been classified as either dissociators and fantasizers. Hence it seems that both views contain a germ of truth.

Remarks:

1. In TGD approach dissociation of the control of behavior from conscious mind has a concrete interpretation. The magnetic body of the hypnotist hijacks the prefrontal cortex responsible for the control of behavior. The division of the subject's mind claimed by the neo-dissociation theory conforms with this notion. Also braid regions responsible for other brain functions can be hijacked in this manner so that a picture analogous to that of Tsai emerges.

2. Also the role of imagination can be understood. Hypnotist can prevent the halting of the neural process behind motor imagination so that it transforms to genuine motor action. This hijacking and transformation of imagination to a real action applies also to sensory perception, which in TGD framework is time reversal for motor action and behavior and allows to understand sensory hallucinations induced by hypnotist.

Two key questions

In the following the history of hypnosis is discussed with emphasis on two questions.

1. Is hypnosis a genuine (altered) state of consciousness or is it a kind of role taking (partially unconscious) and learned social behavior possibly motivated by the need to appeal to the hypnotist?

2. Is hypnotic induction a message to conscious mind or subconscious/unconscious mind. Braid saw hypnotic suggestions as messages to the conscious mind whereas both Janet, Freud, and Erickson believed that hypnotic induction is communication with unconscious mind.

Remark: Self hierarchy implies that "unconscious" translates to "unconscious-to-us" in TGD framework. In TGD framework hypnotic induction would be a message to both conscious and unconscious-to-us levels of self hierarchy. The first guess would be that PFC serves as the neuro-anatomical correlate for conscious mind and ACC to that for unconscious mind. Fractality understood as abstraction hierarchy inspires the question whether PFC is same for cognition about cognition as ACC is for cognition.

State or no-state?

Braid saw hypnosis as a sequence of trance states whereas Bernheim did not believe hypnosis as state and saw suggestion as a key element of hypnosis and thus the interaction between hypnotist and subject. Erickson believed that trance states occur continually in everyday life (day-dreaming and situations in confusing situations) and that also hypnotist can fall in trance state.

Social role taking theory of Sarbin [J142] and cognitive-behavioral theory of Barber, Spanos, and Chaves [J40] took the latter view to extreme. According to social role taking theory hypnotic behaviour would be meaningful, goal-directed striving, its most general goal being to behave like a hypnotised person as this is continuously defined by the operator and understood by the client. Obviously this definition does not apply to self-hypnosis nor allows the interpretation of meditative states as self-hypnosis.

Pavlov could be seen a predecessor of cognitive-behavioral approach. Pavlov saw hypnosis as learned associations and conditioned inhibition. The argument was that the words used by hypnotist reach the whole cortex and can replace alls signals reaching cortex and can therefore induce also behavioral reflexes.

The cognitive-behavioural theory of hypnosis is in some respects similar to Sarbin's social role-taking theory. In particular, Barber argued that responses to hypnotic suggestions were mediated by a "positive cognitive set" consisting of positive expectations, attitudes, and motivation. Daniel Araoz subsequently coined the acronym "TEAM" to symbolize the subject's orientation to hypnosis in terms of "trust", "expectation", "attitude", and "motivation".

Remarks:

1. No clear neuro-physiological correlates for a unique hypnotic state have been found except some signatures in the case of highly susceptible subjects. This does not support the interpretation of hypnosis as an altered state of consciousness if hypnosis is interpreted as "single-brain" phenomenon. In TGD framework hypnosis would involve the magnetic body of hypnotist and even altered states of consciousness achieved in meditation could be seen as analogs of hypnotic states (self-hypnosis). Hence the two views about hypnosis would be consistent in TGD framework.

2. Although the approach of Pavlov looks like exaggeration it might make sense in TGD framework if reflex action is seen as standardized mental image accompanied by a pattern of neural activity. If patterns of neural activity define representations of imagined motor actions and sensory percepts and if also speech reduces to this kind of patterns, one can imagine that the mechanism inhibiting the inhibition of imagination from proceeding to real motor action or sensory percept an produce motor actions and sensory percepts. The acronym TEAM could be interpreted as listing the prerequisites for the readiness of subject to allow hypnotist to use the brain of subject.

12.2.3 Neuropsychology and hypnosis

One can find in Wikipedia article a short summary about neuropsychology of hypnosis.

> *Neurological imaging techniques provide no evidence for a neurological pattern that could be equated with a "hypnotic trance". Changes in brain activity have been found in some studies of highly responsive hypnotic subjects. These changes vary depending upon the type of suggestions being given. However, what these results indicate is unclear. They might indicate that suggestions genuinely produce changes in perception or experience that are not simply a result of imagination. However, in normal circumstances without hypnosis, the brain regions associated with motion detection are activated both when motion is seen and when motion is imagined, without any changes in the subjects' perception or experience. This may therefore indicate that highly suggestible hypnotic subjects are simply activating to a greater extent the areas of the brain used in imagination, without real perceptual changes. It is, however, premature to claim that hypnosis and meditation are mediated by similar brain systems and neural mechanisms.*

According to Wikipedia article another study has demonstrated that a color hallucination suggestion given to subjects in hypnosis activated color-processing regions of the occipital cortex. A 2004 review of research examining the EEG laboratory work in this area concludes:

> *Hypnosis is not a unitary state and therefore should show different patterns of EEG activity depending upon the task being experienced. In our evaluation of the literature, enhanced theta is observed during hypnosis when there is task performance or concentrative hypnosis, but not when the highly hypnotizable individuals are passively relaxed, somewhat sleepy and/or more diffuse in their attention.*

Hypnotic suggestion seems to enhance imagination: this conforms with the basic vision that hypnosis involves strong concentration on suggestion defining what is imagined.

The induction phase of hypnosis may also affect the activity in brain regions that control intention and process conflict. According to Anna Gosline:

Gruzelier and his colleagues studied brain activity using an fMRI while subjects completed a standard cognitive exercise, called the Stroop task. The team screened subjects before the study and chose 12 that were highly susceptible to hypnosis and 12 with low susceptibility. They all completed the task in the fMRI under normal conditions and then again under hypnosis. Throughout the study, both groups were consistent in their task results, achieving similar scores regardless of their mental state. During their first task session, before hypnosis, there were no significant differences in brain activity between the groups. But under hypnosis, Gruzelier found that the highly susceptible subjects showed significantly more brain activity in the anterior cingulate gyrus than the weakly susceptible subjects. This area of the brain has been shown to respond to errors and evaluate emotional outcomes. The highly susceptible group also showed much greater brain activity on the left side of the prefrontal cortex than the weakly susceptible group. This is an area involved with higher level cognitive processing and behaviour.

Stroop task involves two conflicting cues and one might expect that ACC is involved with the solution of this kind of task. The similar performance before hypnosis and during hypnosis suggests that the changes in activity did not improve the task performance but were somehow due to hypnotic induction.

Remark: Concerning TGD approach to hypnosis, the findings about PFC and ACC give important clues concerning the possible mechanism of hypnotic induction. The absence of specific neurological pattern reflecting "hypnotic trance" conforms with the idea that hypnosis involves something more than just brain. Instead of presence of specific EEG patterns one can expect the synchrony of EEGs of hypnotist and subject.

12.3 TGD view about hypnosis

In the following TGD inspired ideas about hypnosis are discussed. The basic guideline is the observation that PFC and ACC seems to be the brain regions activated in Stroop task under hypnosis in the case of highly susceptible subjects. A more detailed view about functions of these brain areas suggests a picture about hypnosis as a kind of hijacking of the subject's FCC and ACC by the magnetic body of the hypnotist so that the biological body and brain of the subject become to some extend part of the hypnotist. One could say that hypnosis represents one particular example of remote mental interactions in which remote control of personal biological body by magnetic body is extended to that of the foreign biological body.

Second key assumption is that imagined motor action is a halted motor action. This applies also to sensory imagination, which however involve a virtual sensory input from magnetic body to the primary sensory organs. In hypnosis hypnotist can prevent this halting action. A plausible candidate for the seat of the halting action is ACC which also is in some respects analogous to a lower level variant of PFC. This kind of analogy makes sense if brain is fractal like structure.

12.3.1 Chevreul pendulum as a manner to end up with the model of hypnosis

My personal interest on hypnosis as a possible application of TGD inspired theory of consciousness was re-stimulated by an experience testing my susceptibility to hypnotic induction. My own expectation was that I would not be "an easy case". The test was done by using improvized Chevreul pendulum. I held the pendulum at the height of my eyes. I received two kinds of suggestions. The first suggestion was a prediction that the pendulum will move. Second direct suggestion was "Don't move the pendulum". To my surprise the pendulum started to move and its amplitude grew gradually. I must admit that this looked like magic.

The first TGD inspired interpretation to come in mind was that the magnetic body of hypnotist hijacked some parts of my brain and used it to realize the suggestions given also verbally to increase their effectiveness. The discussion about the paradoxical outcome of "Don't move the pendulum" led to the key ideas of the model.

1. Imagined motor action is realized as halted motor action - the negation of motor action: somehow this halting action should fail for hypnotic suggestions. In other words, the imagined motor action starts at high level, most naturally PFC and then proceeds downwards until it is halted in normal circumstance. By the duality relating motor action and sensory perception by time reversal (predicted by zero energy ontology [L33]) similar mechanism should work at the level of sensory perception. Halting would involve inhibition of the neural signals otherwise propagating to muscles. The same failure of the halting mechanism would be behind dreams and hallucinations and automatisms as their motor counterparts.

2. Since ACC serves as a central station for top-down and bottom-up signals, ACC might be the place, where the halting signals are sent to various parts of motor cortex. Hence the catching of the attention of ACC so that it fails to perform its ordinary job would be the natural thing to do. This is achieved by generating flux tube connection binding ACC and some part of hypnotizers magnetic body to single quantum coherent system. ACC has also connections to PFC so that also PFC could be hijacked via ACC - at least in deep hypnosis.

3. ACC takes care of conflict situations and confusion as an effective method to induce hypnosis could be alternative to the eye fixation method. Confusion would induce distress inducing a contact with some magnetic body possibly providing help. This could be a basic mechanism in bicameral and schizophrenic consciousness in which "God's voice" provides commands and advices. In the case of hypnotic induction the magnetic body of hypnotist would come in rescue. The activity of ACC would be a signature of conflict situation and could help in generating the connection.

4. The formation of flux tube connections could make the pendulum effectively a part of the biological body of the subject. This is nothing new: almost anyone knows that we feel bicycle or car effectively as our body part. Also illusions in which subject person identifies an external object as part of the biological body are created routinely. The command "Don't move the pendulum" would be realized as a *motor command* "Move the pendulum" which would be usually halted but hypnotic induction would prevent this.

Some remarks about the relation to more general TGD based ideas about quantum biology and consciousness are in order.

1. The basic distinction between hijacking model and more standard models is that hypnosis is not single-brain phenomenon anymore. It would be interesting to see whether there is synchrony between the EEGs of hypnotists and subject in PFC and ACC and whether the synchronies between various brain regions could correlate with the nature of suggestions.

2. In this framework self-hypnosis would represent a situation in which some external magnetic body hijacks the brain of the person. This magnetic body could correspond to a layer of personal magnetic body or perhaps a magnetic body assignable to some collective level of consciousness as the model of bicameral and schizophrenic consciousness suggest.

3. Hypnosis can induce regression to childhood and is claimed to induce even memories about earlier lives. For instance, subjects manner to speak becomes childlike in this kind of state. Standard neuroscience does not allow beyond life memories but in TGD framework the situation remains open (for "Akashic records" view about memories see [L33]). One can argue that a strong concentration to the suggestion might allow to become conscious about memories of childhood and even of previous lives.

4. Reconnection of flux tubes and phase transitions changing the effective value of Planck constant and therefore the length of flux tubes are basic mechanisms of TGD inspired quantum biology. Catching the attention of ACC would be as a mechanism very similar to its molecular counterpart in the TGD inspired model of homeopathic healing [K37]. In the latter case the attention of receptors at cell membrane is caught by an entity mimicking the invader molecule binding otherwise to the receptor. Hence most receptors bind to entities which do not cause the damaging effects produced by the invader molecules. Mimicry would be mimicry of cyclotron frequencies achieved by tuning the magnetic field strengths associated with the mimicking entity and at the same time making possible reconnection inducing flux tube connections and conscious attention at molecular level.

12.3.2 Hypnosis as hijacking of foreign biological body

In the following I use hijacking as a metaphor for what could happen in hypnotic induction. A more positive manner to see the process would be as a voluntary sharing of brain with hypnotist's magnetic body. If one accepts TGD based view about remote mental interactions implying that personal magnetic body controls biological body by remote mental interactions, hypnosis represents a genuine example of remote mental interaction.

The model to be discussed assumes that hypnotist's magnetic body hijacks some parts of the subject's brain. The mind-dissociation model encourages to think that almost any brain region/function can be hijacked. One can however expect that there are some preferred brain regions: kind of central stations especially favorable and sensitive targets for high-jacking. In this respect important hints come from what are believed to be basic facts about functions of prefrontal cortex (PFC) [J20] and anterior cingulate cortex (ACC) [J4], and from the observation that for highly susceptible subjects these regions demonstrate heightened activity during hypnosis during the performance of so called Stroop test.

Prefrontal cortex as target of hijacking

The general ideas of the hijacking model were already described. The following provides a more detailed discussion of the model (anyone with better background in neuroscience could probably add interesting details). The best strategy is to hijack the highest brain regions responsible for volition and control of motor and sensory imagination. Prefrontal cortex (PFC) is certainly an excellent candidate in this respect but it is not of course clear whether the direct hijacking of PFC is easy.

Prefrontal cortex is the anterior part of frontal lobes lying in front of the motor and premotor areas. This brain region has been implicated in the planning complex cognitive behavior, personality expression, decision making, and moderating social behavior. One can also say that PFC carries executive function. This means cognition relating to control of cognition meaning thoughts/decisions about thoughts - imagination. Executive function relates to abilities to differentiate among conflicting thoughts, determine good and bad, better and best, same and different, future consequences of current activities, working toward a defined goal, prediction of outcomes, expectation based on actions, and social "control" (the ability to suppress urges that, if not suppressed, could lead to socially unacceptable outcomes). Clearly, PFC, the size of which also distinguishes between us and other primates, represents a very high if not the highest level of cognitive hierarchy unless one includes also the hierarchy of layers of the magnetic body.

A damage to frontal lobes can lead to loss of some of the listed functions, in particular to inability to make decisions so that also the patient has not lost his intellectual abilities and skills, he cannot do anything spontaneously but outsider must make the initiatives: this state brings in mind hypnotic state.

Anterior cingulate cortex as second target of hijacking

ACC is second brain area of primary interest. According to Wikipedia:

ACC is the frontal part of the cingulate cortex, which resembles a "collar" surrounding the frontal part of the corpus callosum. It consists of Brodmann areas 24, 32, and 33. It appears to play a role in a wide variety of autonomic functions, such as regulating blood pressure and heart rate, as well as rational cognitive functions, such as reward anticipation, decision-making, empathy, impulse control, and emotion.

The anterior cingulate cortex can be divided anatomically based on cognitive (dorsal), and emotional (ventral) components. The dorsal part of the ACC is connected with the prefrontal cortex and parietal cortex as well as the motor system and the frontal eye fields making it a central station for processing top-down and bottom-up stimuli and assigning appropriate control to other areas in the brain. By contrast, the ventral part of the ACC is connected with amygdala, nucleus accumbens, hypothalamus, and anterior insula, and is involved in assessing the salience of emotion and motivational information. The ACC seems to be especially involved when effort is needed to carry out a task such as in early learning and problem-solving.

On a cellular level, the ACC is unique in its abundance of specialized neurons called spindle cells [J23]. These cells are a relatively recent occurrence in evolutionary terms (found only in humans and other great apes, cetaceans, and elephants) and contribute to this brain region's emphasis on addressing difficult problems, as well as the pathologies related to the ACC.

A typical task that activates the ACC involves induction of some form of conflict within the subject that can potentially result in an error. Stroop task represents one such task and activates the ACC of highly susceptible subjects more strongly during hypnosis. In Stroop task the person must name the color of the ink of words that are either congruent or in-congruent (the color of the word RED is red or blue). The conflict occurs since the color or the written word is in conflict with the meaning of the word. Erickson's methods use confusion as a means of inducing hypnosis. This suggests that the activation of ACC by confusion is essential for hypnotic induction.

Error detection, anticipation of tasks, attention, motivation, and modulation of emotional responses are functions assigned with the ACC. Deep focusing of attention is indeed essential for hypnosis. The fact that frontal eye fields representing unconscious-to-us fast visual pathway initiating of eye movements such as voluntary saccades, pursuit eye movements and its connection to ACC suggests that the pendulum catches the attention of ACC in the Chevreul test. The fact that prefrontal lobes are connected to ACC suggests that hijacking of PFC could take place via ACC.

Francis Crick identifies ACC as a possible locus free will. In TGD framework this kind of identification is too strong. One might however consider the possibility that ACC is the part of brain halting the motor imagination proceeding as cortical activity downwards and prevents it from transforming to a genuine motor action. Volition might be quite generally halting or non-halting of imagined motor action. By the time reversal symmetry relating motor action and sensory perception in TGD framework, ACC would play similar role for sensory perception. Note that the selection between sensory percepts associated with bin-ocular rivalry could be understood in terms of time reversed volition. The role of ACC as central station for bottom-up and top-down stimuli would conform with this view.

Remarks:

1. One can imagine two kinds of stimuli: the motor stimuli initiated at frontal lobes originally as imagination and possibly halted by ACC and simple motor stimuli initiated by ACC respectively proceeding directly to motor organs via premotor cortex. In the similar manner one can image sensory stimuli received by ACC and not proceeding to upper levels and those proceeding to higher levels and sensory stimuli proceeding up to PFC.

2. This division could roughly correspond to "slow" and "fast" (unconscious-to-us) sensory and motor pathways. Freud's super-ego-ego-Id hierarchy might in turn relate to magnetic body-PFC-ACC division. The interpretation of ACC as a primitive analog of PFC would also conform with the role of ACC in early learning. Hijacking of ACC first by redirecting its attention - to say pendulum - so that it cannot take care of some of its basic functions, could be part of hypnotic induction.

Why the activation of ACC should promote the hypnotic induction? The activation could be a neural correlate for confusion, which puts the person to the same position in which bicameral

according to Jaynes was and schizophrenic is often. In this kind of situation some higher layer of the personal magnetic body could come in rescue. The generation of reconnections requires that ACC performs "magnetic motor activity" modulating the thickness of the flux tubes of its magnetic body (tuning the value of magnetic field to be the same as that of the hoped for helper) and perhaps also moving the flux tubes to achieve the desired reconnection. In the case of hypnosis the reconnection of between the magnetic bodies of ACC and hypnotist would take place. If ACC is responsible for "Don't" function then catching the ACC's attention by hypnotic induction or confusing it would allow the imagined motor actions and sensory perceptions to become real and hypnotic suggestions could be realized.

12.3.3 Preconscious mechanism of hypnotically altered colors

I learned recently about very interesting work on hypnosis by finnish researchers Mika Koivisto, Svetlana Kirjanen, Antti Revonsuo and Sakari Kallio. The article "A Preconscious Neural Mechanism of Hypnotically Altered Colors: A Double Case Study" is published in journal Plos ONE [J70] and is available at `http://dx.plos.org/10.1371/journal.pone.0070900`.

Here is the abstract of the article:

Hypnotic suggestions may change the perceived color of objects. Given that chromatic stimulus information is processed rapidly and automatically by the visual system, how can hypnotic suggestions affect perceived colors in a seemingly immediate fashion? We studied the mechanisms of such color alterations by measuring electroencephalography in two highly suggestible participants as they perceived briefly presented visual shapes under posthypnotic color alternation suggestions such as all the squares are blue. One participant consistently reported seeing the suggested colors. Her reports correlated with enhanced evoked upper beta-band activity (22 Hz) 70120 ms after stimulus in response to the shapes mentioned in the suggestion. This effect was not observed in a control condition where the participants merely tried to simulate the effects of the suggestion on behavior. The second participant neither reported color alterations nor showed the evoked beta activity, although her subjective experience and event-related potentials were changed by the suggestions. The results indicate a preconscious mechanism that first compares early visual input with a memory representation of the suggestion and consequently triggers the color alteration process in response to the objects specified by the suggestion. Conscious color experience is not purely the result of bottom-up processing but it can be modulated, at least in some individuals, by top-down factors such as hypnotic suggestions.

According to the announcement of finnish academy, the results challenge the existing theories of hypnosis. This work represents a model of hypnosis as one particular instance of remote mental interactions on basis of TGD inspired quantum theory of consciousness. Quantum entanglement between parts of separate brains, the notion of magnetic body, and TGD based view about sensory organs play key roles in the model. In TGD framework the primary qualia are at the level of sensory organs and sensory representations involve a feedback from magnetic body via brain to sensory organs in terms of dark photons so that the sensory percepts consist of standardized mental images - being more like an artworks emphasizing important features rather than a faithful representation of reality.

The findings of about hypnosis can be used also to test the proposed view about hypnosis. As the abstract concludes, color experience in not purely the result of bottom-up processing but can be modulated by top-down factors. In TGD framework this reflects the basic difference between standard neuroscience and TGD deriving from two assumptions.

- Sensory organs are carriers of primary qualia - the phenomenal experience.

- Brain is manufacturer of sensory and memory representations decomposing perceptive field to standardized mental images representing objects and naming them. Virtual sensory input is used to achieve this.

In the experiments the form-color correlation created by hypnotic suggestion could be in conflict with the real visual input. The other subject person sensitive to hypnosis managed to transform

the real color percept to a percept consistent with the suggestion. The other subject person also sensitive to hypnotic suggestions reported that his/her eyes and brain "saw" different colors.

In TGD Universe the interpretation would be that magnetic body and brain below it in the self hierarchy imagined the correlation consistent with the suggested one in both case. The imagined color was produced by a virtual sensory input realized as dark photons propagating down from magnetic body to cortex and to the lower levels of brain. This applies to imagination in general. For the sensory imagination the propagation halts before reaching sensory organ - now retina. For hallucinations this halting does not happen. Hypnotic suggestion can prevent this halting so that imagined color transforms to a hallucinated color. This happened for the first subject in the experiments. The second subject experienced both the real color and possibly conflicting imagined color associated with the virtual sensory input halting to some higher level in brain between visual cortex and retina. Note that this serves as evidence for the notion of self hierarchy, which is a basic prediction of TGD inspired theory of consciousness.

Also a comment about time scales involved is in order. The peak in the EEG of the person, who experienced the suggested color-shape correlation appeared after an average time of $T = .1$ seconds from the visual input. T corresponds to 10 Hz fundamental bio-rhythm and the chronon of sensory experience. In TGD framework T characterizes the scale of causal diamond (CD) defining the spotlight of consciousness assignable also to sensory percepts. That T is also the secondary p-adic length scale assigned with electron in TGD conforms with the proposal that electron Cooper pairs play a central role in sensory perception. Primary and secondary p-adic length and time scales (the latter are macroscopic) characterizing elementary particles represents new physics predicted by TGD. $R = .05$ seconds corresponds to distance $R = cT = 15$ Mm, which is more than twice the radius of Earth equal to 6.4 Mm. Hence a signal propagating with velocity of light could travel to a layer of magnetic body with this size and back during time .1 seconds.

After having received the announcement of Finnish academy and before seeing the abstract of the article, my own guess was that the high-frequency EEG refers to 40 Hz thalamo-cortical resonance studied by Antti Revonsuo - one of the authors of the recent work. I was wrong. What Revonsuo found was that 40 Hz resonance does *not* serve as a correlate of mental image as conjectured by Crick and Koch but for the emergence of a new mental image. What was studied was a situation in which the subject person experienced the emergence of 3-D geometric pattern from a chaotic set of dots and lines. 40 Hz activity accompanied only the eureka period: a possible TGD inspired interpretation is that the direct eureka experience was transformed to a memory, which did not generate 40 Hz activity. The 20 Hz activity involved with the change of the perceived color to the suggested color would also correspond to similar re-organization of the perceptive field induced by virtual sensory input masking the real one. What is interesting is that 10,20,40, 80 Hz frequencies appear as resonances in EEG and that they are octaves of 10 Hz. TGD indeed strongly suggests that preferred CD scales come as octaves. Primary p-adic length scales in turn would come as half octaves.

Chapter 13

Meditation, Mind-Body Medicine and Placebo: TGD point of view

13.1   Introduction

The chapter represents TGD inspired answers to Lian Sidorov's questions concerning meditation, mind-body medicine and placebo in quantum biology framework. To help the reader, some aspects of TGD inspired theory of consciousness and quantum biology are summarized since several new insights inspired by the notions of magnetic body and dark matter have emerged lately. This includes improved views about quantum metabolism and prebiotic life: the basic input comes from the claimed free energy phenomena interpreted in TGD framework. Water structures representing simplified analogs of basic biomolecules suggested by water splitting producing so called Brown's gas might be highly relevant also for the ordinary metabolism. The main new input concerning remote mental interactions comes from a possible answer to the question whether TGD based ontology of physics could allow the "shamanistic" view that the experiences (say encounters with strange life forms assigned with distant civilizations) induced by various psychedelics used in the spiritual practices of indigenous people could be genuine remote sensory perceptions rather than hallucinations. Affirmative answer would mean a direct and testable connection between neuropharmacology and remote sensory perception with serotonin defining the crucial neurotransmitter and pineal gland ("third eye") serving as a candidate for the brain area of special importance in this respect.

Concerning the questions about meditation, mind-body medicine and placebo, the key concept is that of magnetic body. Usually organism and environment are seen as members of an interacting pair: organism receives sensory data from environment and controls it. Now magnetic body appears as a third party, "intentional agent" using biological body as a kind of interface between magnetic body and environment. Various "motor actions" of the magnetic body are highly relevant for both consciousness and biochemistry. The pairs formed by various information molecules and corresponding receptors could define plug-ins to the Indra's net (or Internet) defined by the magnetic bodies and Josephson radiation emitted by Josephson currents assignable to receptors would propagate along flux tubes. Meditation can be seen as "bodily exercise" of the magnetic body and a method to improve the communications between magnetic body and biological body. In healing magnetic body would be the active participant and healing would be also the healing of magnetic body. The placebo effect could be seen as an outcome of intentions of magnetic body affecting biological body.

The change of gene expression in meditation could be understood in terms of magnetic body. Genetic expression would be naturally determined by the permanent flux tube connections from the magnetic body to the promoter portions of DNA. Differentiation would select the promoters to which the magnetic body has permanent connections. The change of gene expression could be due to a change of these connections. Both meditation, placebo effect, and healing could induce changes in gene expression in this manner.

The appendix of the book gives a summary about basic concepts of TGD with illustrations. There are concept maps about topics related to the contents of the chapter prepared using CMAP

realized as html files. Links to all CMAP files can be found at `http://www.tgdtheory.fi/cmaphtml.html` [L35]. Pdf representation of same files serving as a kind of glossary can be found at `http://www.tgdtheory.fi/tgdglossary.pdf` [L36]. The topics relevant to this chapter are given by the following list.

- Magnetic body [L52]

- Basic Mechanisms associated with magnetic body [L39]

- Pollack's observations [L57]

- Generalized Feynman diagrams [L48]

- The role of microtubules [L69]

- Dark proton strings and genetic code [L45]

13.2 Brief summary about TGD based vision about life and consciousness

13.2.1 Magnetic and electric bodies

The notion of "magnetic body" has become more and more central concept in TGD inspired theory of quantum biology. Also electric fields are fundamental in living matter consisting of electrets and one could speak about electric bodies too. The notion of field body is possible only in TGD framework were space-times are 4-surfaces of 8-dimensional space $M^4 \times CP_2$ and various classical fields are geometrized in terms of geometry and spinor structure induced from those of imbedding space.

One can assign to any physical system magnetic body (or more generally field body), which consists of space-time sheets representing field quanta of magnetic and electric fields geometrically: typically they have the shape of flux tube or flux sheets. Of special importance are flux tubes carrying monopole Kähler magnetic flux - as if there would be magnetic monopole serving as the source of the magnetic field. There are however know magnetic monopoles in TGD Universe. These flux tubes are in fundamental role in the description of elementary particles and very probably also the magnetic flux tubes relevant for living matter carry monopole fluxes: even magnetic field associated with permanent magnets could involve monopole flux tubes , whose characteristic property is that there is no current creating the field. In cosmology this kind of fields are present in all scales and the mystery in the standard physics framework is caused by the fact that permanent currents in this scales are not possible.

The topological dynamics of magnetic flux tubes is based on reconnection process creating and modifying the topology of the web of magnetic flux tubes. In living matter this web is assumed to be responsible for the coherent behavior of living organisms. The reconnection building a double flux tube bridge between two systems is assumed to define the space-time correlate for the generation of directed attention. Second important piece of dynamics is the change of the length of the magnetic flux tube induced by the change of h_{eff}/h. The shortening of flux tubes connecting distant biomolecules would force them near each other and make possible selective bio-catalysis. This mechanism should be crucial for DNA replication and transcription, and mRNA translation.

Also the dark matter at magnetic flux tubes is assumed to be essential element of what it is to be living. Dark matter hierarchy corresponds to a hierarchy of effective values of Planck constant given by $h_{eff}/h = n$. Cyclotron frequencies for charged bosons and Cooper pairs of charged fermions could be carriers of metabolic energy realized as cyclotron energy which is large for large values of n.

One can of course also speak about electric bodies - living matter is full of electrets and already Fröhlich realized the importance of electric fields - and cell membrane would define a fundamental system of this kind. The flux tubes connecting the interior and exterior of membrane would carry electric voltage in the stationary case and in super-conducting situation oscillating Josephson currents generating dark Josephson radiation at frequency $f_J = ZeV/h_{eff}$ are present. EEG - or rather hierarchy of dark EEGs at various frequency scales but with same energies actually

assignable to bio-photons - could correspond to this radiation and dark cyclotron radiation. They would mediate communication of sensory data to the magnetic body and control commands from the magnetic body.

13.2.2   Frequency coding and targeted attention

Dark photons are also an important piece of the bio-puzzle. Microscopically they correspond wormhole contact pairs connecting to "massless extremals" (MEs) (as a matter of fact, all elementary particle have this kind of identification). Dark photons would be generated as Josephson photons and cyclotron photons. The simplest assumption is that standard mechanisms of biochemistry generate only ordinary photons. The basic property of dark photons is that the energy for a given frequency is scaled up by factor h_{eff}/h so that ELF radiation can correspond to energies of even visible photons as would indeed do if EEG corresponds to dark photons having energies if visible and perhaps even UV photons.

1. If the photons are absorbed resonantly, photons frequencies serve as analogs of passwords so that living matter would apply the analog of radio communications for dark photons. Given part of living system in given scale would be characterized by photon frequency which by p-adic length scale hypothesis would correspond to a power of two. A collection of these frequencies coming as powers of two would effectively define a sequence of binary digits specifying the p-adic space-time sheet of the receiver. This coding mechanism could be at work not only inside organism but also between different organisms. The magnetic bodies have astrophysical dimensions and in principle there is no limit for the scales involved. Directed attention would correspond to reconnection of magnetic flux tubes implying common cyclotron frequency spectrum plus cyclotron transitions induced by the radiation transferred between the participants.

   Frequencies serving as passwords would make possible precisely targeted communications if receiver frequencies vary as a function of position. Cyclotron radiation along massless extremals parallel to magnetic flux tubes serving as kind of waveguides achieves the same. These two mechanisms could be actually one and same.

2. Zero energy ontology in turn strongly suggests communications based on reflections in time direction at the opposite boundaries of causal diamonds (CDs) having interpretation in terms of state function reductions. This allows to speculate about communications in cosmic scales taking place instantaneously with respect to subjective time. It is not clear whether the standard view about causality based on unique direction of geometric time denies this possibility.

3. Very probably frequency alone is not all that is involved. Just as in the ordinary radio communications, the signal itself could be coded by amplitude or frequency modulation of the carrier frequency. One of the possible mechanisms generating dark photons would be amplitude modulation. Frequency modulation could be realized as variation of Josephson frequency induced by that of membrane potential and cell membranes indeed carry membrane potential waves besides nerve pulses. Cyclotron frequency could be modulated by oscillations of the flux tube thickness induced the variation of magnetic field strength forced by the flux conservation.

There is evidence that a process interpreted as a propagation of bio-photons along neural fibers takes place. In TGD framework this would correspond to the propagation of dark photons along magnetic flux tubes parallel to the fibers. I have proposed that magnetic flux tubes assignable to neural pathways (and also meridians of acupuncture system) serve as analogs wave guides for dark photons. If sensory organs are really the seats of the fundamental sensory experiences and brain builds cognitive representations by analyzing the sensory input and decomposing it to objects with names as TGD suggests [K32], then the feedback from brain and even magnetic body is needed in order to build the sensory representations as kind of art works. This would explain dreams (REM) and hallucinations as being caused by virtual sensory input from the magnetic body (maybe induced by sensory input to magnetic body even from some other magnetic body as in case of remote mental interactions).

13.2.3 Meditation and magnetic body

One manner to see meditation is as a method to develop ability to precisely targeted attention by getting rid of all perturbing mental images. If one accepts that reconnections for the flux tubes of the magnetic body are crucial for the targeted attention and that the h_{eff} serves as a kind of universal quotient of spiritual intelligence, the conclusion would be that meditation means practices for developing maximally flexible magnetic body able to build rapidly contacts with higher levels of the personal magnetic body and also with other magnetic bodies. Meditator would be a master of magnetic motor actions whereas yogi would be a master of motor actions of biological body. If healing involves connection between magnetic bodies or magnetic body and biological body of healee, meditation should help also to achieve healing abilities.

In biology everything seems to obey engineering standards and the build-up of connections to other magnetic bodies need not be an exception to the rule. Various information molecules and corresponding receptors would indeed define natural candidates for the plugs connecting brain and body to the magnetic Indra's net. Therefore meditative practices should develop the ability to control the levels of various information molecules and receptors in body.

13.3 NMP, hierarchy of Planck constants, p-adic length scale hypothesis and negentropic entanglement

Around the year 2003 a number of new ideas emerged simultaneously. Learning about hyperfinite factors of type II_1 and their inclusions [K100] lead to a proposal for the mathematical description of finite measurement resolution and cognitive resolution. Also the idea about hierarchy of Planck constants allowing to identify dark matter as phases of ordinary matter, and the notion of negentropic entanglement emerged and led to a lot of speculation. Over the years connections between these notions and vision about their more detailed realization have emerged. One can say that NMP, hierarchy of Planck constants, p-adic length scale hypothesis, negentropic entanglement, and even inclusions of hyperfinite factors are very intimately related. Of course, all of this is just a highly entertaining intellectual game - very much like solving a crossword puzzle - and only time and experiment will show whether it has anything to with reality.

13.3.1 Negentropic entanglement and hierarchy of Planck constants

The hierarchy of Planck constants makes possible negentropic entanglement (see fig. `http://www.tgdtheory.fi/appfigures/cat.jpg` or fig. 21 in the appendix of this book) and genuine information represented as negentropic entanglement in which superposed state pairs have interpretation as incidences $a_i \leftrightarrow b_i$ of a rule $A \leftrightarrow B$: apart from possible phase the entanglement coefficients have same value $1/\sqrt{n}$, where $n = h_{eff}/h$ define the value of effective Planck constant and dimension for the effective covering of imbedding space. This picture generalizes also to the case of multipartite entanglement but predicts similar maximal entanglement for all divisions of the system to two parts. There are however still some questions which are not completely settled and leave some room for imagination.

1. Negentropic entanglement is possible in the discrete degrees of freedom assignable to the n-fold covering of imbedding space allowing to describe situation formally. For $h_{eff}/h = n$ one can introduce $SU(n)$ as dynamical symmetry group and require that n-particle states are singlets under $SU(n)$. $SU(n)$ brings in mind the dynamical gauge symmetry group introduced earlier for inclusions of hyper-finite factors of type II_1 [K100] to which one can assign simply laced Lie groups such as $SU(n)$ by Mac Kay correspondence [A1]. I proposed these groups as effective gauge group making possible emulation of all possible gauge group dynamics so that TGD Universe would be like Turing machine able to mimic any mathematically consistent dynamics. The inclusions would also characterize the finite measurement resolution: the states created by the included algebra would create states not distinguishable from each other in the resolution used.

   This gives rise to n-particle states constructed by contracting product of some number k of n-dimensional permutation symbols contracted with many particle states assignable to m

factors. These states would generalize k-particle states. For $k = 1$ and $m > 1$ one would have single particle state in "schizophrenic state" consisting of m particles with fractional quantum numbers n_i/n times the usual quantum numbers. Spin-statistics connection might produce problems - at least it is non-trivial - since one possible interpretation is that the states carry fractional quantum numbers - in particular fractional fermion number and charges.

These strange states with completely unique form would generalize the notion of N-atom proposed for decade ago as giving emergence of symbols and "sex" at molecular level [K19]. The status of this idea has remained very uncertain but I have not been able to throw it to paper basked. The second quantization associated with the finite coverings of imbedding space would give rise to the negentropic entanglement, symbolic dynamics, and also to "Akashic records" as almost invariants of the quantum jump sequence (thanks to their negentropic resources respected by NMP). "Molecular sex" means that all states can be seen as composites of two states with opposite fractional $SU(n)$ quantum numbers (this decomposition need not be unique!).This brings in mind the monogamy theorem for ordinary entanglement stating that maximal entanglement means this kind of decomposition to two parts.

2. While writing this I realized that the question whether negentropic entanglement is possible only in the new covering degrees of freedom or also in more familiar angular momentum, electroweak, and color degrees of freedom, remains open [K49]. The latter states are especially interesting biologically and from the point of view of photosynthesis and navigation of birds if one believes on the proposed explanations: long-lived negentropically entangled spin singlet electron-hole pairs and electron pairs are proposed as explanation of the experimental findings. If only the covering degrees of freedom are involved the entanglement stable against thermal perturbations is in these degrees of freedom.

13.3.2 NMP and evolution of intelligence

Alexander Wissner-Gross, a physicist at Harvard University and the Massachusetts Institute of Technology, and Cameron Freer, a mathematician at the University of Hawaii at Manoa, have developed a theory that they say describes many intelligent or cognitive behaviors, such as upright walking and tool use [J109, J35]. The basic idea of the theory is that intelligent system collects information about large number of histories and preserves it. Thermodynamically this means large entropy so that the evolution of intelligence would be rather paradoxically evolution of highly entropic systems. According to standard view about Shannon entropy transformation of entropy to information (or the reduction of entropy to zero) requires a process selecting one of instances of thermal ensemble with a large number of degenerate states and one can wonder what is this selection process. This sounds almost like a paradox unless one accepts the existence of this process. I have considered the core of this almost paradox in TGD framework already earlier.

According to the popular article (http://www.insidescience.org/content/physicist-proposes-new-way-987) the model does not require explicit specification of intelligent behavior and the intelligent behavior relies on "causal entropic forces" (here one can counter argue that the selection process is necessary if one wants information gain). The theory requires that the system is able to collect information and predict future histories very quickly.

The prediction of future histories is one of the basic characters of life in TGD Universe made possible by zero energy ontology (ZEO) predicting that the thermodynamical arrow of geometric time is opposite for the quantum jumps reducing the zero energy state at upper and lower boundaries of causal diamond (CD) respectively. This prediction means quite a dramatic deviation from standard thermodynamics but is consistent with the notion of syntropy introduced by Italian theoretical physicist Fantappie already for more than half a century ago as well as with the reversed time arrow of dissipation appearing often in living matter.

Negentropy Maximization Principle (NMP) resolves also the above mentioned almost paradox (at least). I have proposed analogous principle but relying on generation of negentropic entanglement and replacing entropy with number theoretic negentropy obeying modification of Shannon formula involving p-adic norm in the logarithm $log(p)$ of probability. The formula makes sense for probabilities, which are rational or in algebraic extension of rational numbers and requires that the system is in the intersection of real and p-adic worlds. The dark matter matter with integer value of Planck constant and $h_{eff} = nh$ predicts rational entanglement probabilities: their values

are simply $p_i = 1/n$ since the entanglement coefficients define a diagonal matrix proportional to unit matrix. Negentropic entanglement makes sense also for n-particle systems as found and the form of the states is essentially unique.

Negentropic entanglement corresponds therefore always to $n \times n$ density matrix proportional to unit matrix: this means maximal entanglement and maximal number theoretic entanglement negentropy for two entangled systems with number n of entangled states. n corresponds to Planck constant $h_{eff} = n \times h$ so that a connection with hierarchy of Planck constants is also obtained. Power of the p-adic prime by definition defines largest prime power divisor of n. Individually negentropically entangled systems would be very entropic since there would be n energy degenerate states with same Boltzmann weight. Negentropic entanglement changes the situation: thermodynamics of course does not apply anymore. Hence TGD produces same prediction as thermodynamical model but avoids paradox.

13.3.3 How to produce dark matter

If one wants to test the vision about dark matter, one must be able to manipulate and even produce it. I have considered several mechanisms for producing dark matter. It must be emphasized that the ideas are yet at rather heuristic level.

1. Modulation of high frequency radiation by low frequency radiation such that the ratio of the frequencies is integer, call it n, characterizing the effective Planck constant $h_{eff}/h = n$ is one proposal inspired by experimental findings of Cyril Smith related to water memory [J147]. Smith suggests that one particular ratio $n \simeq 2 \times 10^{11}$ is of special importance. Number theoretical simplicity and p-adic length scale hypothesis suggest Fermat integers - are products of distinct Fermat primes and powers of two - as good candidates for n. One could perhaps say that ordinary higher frequency photons is replaced with a bundles of n fractional photons with energy and frequency divided by n. At the level of space-time and imbedding space geometry this means the emergence of effective n-fold covering. The extreme non-linearity of Kähler action could give rise to these n-furcations.

2. The presence of strong electric fields and voltages and plasma phase seem to generate effects having explanation in terms of the hierarchy of Planck constants. In particular, di-electric breakdown seems to be involved. For instance, cell membrane characterized by the presence of extremely strong electric field. Plasmoids as lifeforms would also involve strong electric fields. Also magnetic fields seem to be essential. Splitting of water in electrolysis using strong electric fields ("peaky" electrodes) involves also strong electric fields and generates Brown's gas having anomalous properties. One could argue that the presence of strong electric fields is what leads to the generation of n-furcations at the level of space-time dynamics.

3. The latest proposal is based on some input from observations related to free energy leading to the observation that the quantum mechanical description of a system to which constant torque is applied leads to mathematical problems in the framework of standard quantum theory solved by introducing n-fold covering space of circle, hierarchy of Planck constants, and zero energy ontology [K40] [?]. The value of n is at least the number of turns made by the rotating system during the time the torque is applied. This mechanism would explain why the values of n are so large. Constant torque represents an example of an open system driven by external generalized forces and living systems are systems of this kind. Formally the system is conservative but the potential function is either many-valued or discontinuous at 2π and this forces to introduce the covering space if one wants to describe rotating and accelerating wave packets. Note also that the force can be arbitrarily small so that there is instability against generation of higher values of h_{eff}. What is of special interest is that ATP synthase (http://en.wikipedia.org/wiki/ATP_synthase) involves generator with a rotating shaft (just like an electric power plant) and therefore also a torque to compensate for dissipative losses. Is its purpose to generate large h_{eff} phase?

   Note that cavitation is one manner to generate water splitting and associated charged water clusters and plasmoids: it is is typically produced by a rotating shaft. Does this mean that turbulent water could have served as a seat for primordial life forms? Note that in homeopathy mechanical agitation is applied to the diluted sample: the proposed interpretation has

been that this drives the replication and evolution of dark life forms defined by dark nucleon sequences [K37].

13.3.4 Dark proton sequences, genetic code, and primordial life forms

The general strategy should be simple. One starts from experimental facts and explains them in terms of TGD allowing free imagination and trying to achieve internal consistency between different ideas [K40].

1. The old result is that I cannot avoid mentioning again and again is that in atto-second scale water obeys stochiometry $H_{1.5}O$ as if 1/4:th of hydrogens were dark and thus not visible in electron scattering and neutron diffraction. This fact can be found from Chaplin's home-page (`http://www1.lsbu.ac.uk/water/`) devoted to water and containing impressive list of anomalies related to the physics of water. This finding was one of the original motivations for introducing hierarchy of Planck constants.

   I introduced dark nuclei identified as sequences of dark hydrogens/protons as explanation of the strange stoichiometry and also for the anomalies: there would be two phases (at least, not the h_{eff} can have several values) present and this makes the behavior of water more complex. Dark nuclei are strings of dark protons connected by color bonds. The size scale of nucleus is scaled up by h_{eff} and would be about atomic scale: atto-second multiplied by c gives this scale.

   The really big surprise was that the model for dark proton led directly to the realisation of vertebrate genetic code [L10, K37]: the states of dark proton can be naturally arranged to groups corresponding to DNA, RNA, amino acids, and remaining states whose number is smaller than 64 which I tentatively identify in terms of tRNA. Genetic code is obtained if states in different groups are identified by requiring that states corresponding to each other have same total quark spin and same spin assignable with the flux tube (two colour bonds connecting quarks).

   In TGD framework this relates also to the understanding of water memory and homeopathy [K37] and to the evolution of immune system as well.

2. The field of free energy (presumably possessing somewhat similar academic status as the research of remote mental interactions) represents second source of experimental input. Quite lately I have been reconsidering what is believed to be known about the splitting of water - for instance using strong electric fields or cavitation. This is a rich store of anomalies. In particular although the splitting of water molecules requires energy, more energy is claimed to emerge from the process in some situations. Also cold fusion is reported to to occur in this kind of system and liberates energy as heat. Nuclear transmutations in living matter have been reported much before the cold fusion was claimed for the first time [C2, C4].

   Already more than century ago it was reported that the resulting vapor - christened as Brown's gas according to its discoverer - behaved strangely. For instance, its temperature was 130 C but it melted metal as if it had stored a lot of energy which was liberated and was heating the metal about thousand of degrees of Celsius. These results do not of course fit standard physics and have been actively forgotten and denied by the academic environment (for an authoritative skeptic explanation see Wikipedia article `http://en.wikipedia.org/wiki/Brown's_gas#Brown.27s_gas`). I know personally some people in the field of free energy and I am not able to see them as "fringe scientists" as opposed to "real scientists". It is a pity that this kind of schizophrenic splitting prevents the study of the free energy claims using the resources provided by the academic environment.

   Free energy enthusiasts have been studying this process and a lot is believed to be known about it. According to Moray B. King [H5, H1] Brown's gas can be separated from water vapor and hydrogen and is weightier than air. It is believed that charged plasma clusters resulting in the "electric expansion" of water are involved with electrons and protons separated. Torus shaped plasmoids are introduced also. In TGD framework plasmoids, which involve magnetic body carrying electron Cooper pairs at least, are identified as primordial life forms.

3. The question is how many properties assigned with chemical life are shared by plasmoids. Could linear biomolecules, storage and liberation of metabolic energy, and even genetic code have plasmoidal analogs?

    (a) Circular sequences of OH:s has been proposed by King [H5] as basic building bricks of plasmoids. To my best understanding this does not fit with the ordinary chemistry (covalent bond between OHs cannot be realized). TGD inspired proposal consistent with King's proposal is that actually OHH_{dark} sequences are in question.

       Covalent bonds are replaced with color bonds between dark nuclei, which are scaled up variants of ordinary nuclear modelled as highly entangled nucleon strings in TGD framework. Already this represents a new view about nuclear physics (it is ironic that string like appear at practically all levels in TGD Universe but that string theorists desperately try to understand physics by putting them to Planck scale).

       As a matter fact, learning about the work of Gerald Pollack et al [L38] led to a simpler model in which dark proton sequences at magnetic flux tubes replace OHH_{dark} sequences. Predictions are almost the same except for charge separation having neat explanation in the simpler model which is actually the original model for water as partially dark phase of matter.

    (b) Free energy phenomena involve the splitting of water. Water splitting is also the first step in the storage of energy to biomolecules in photosynthesis. Could OHH_{dark} or dark proton sequences define simplified counterparts of basic biomolecules, and could they carry metabolic energy in colour bonds between dark protons replacing "high energy covalent bonds"?

    (c) This metabolic energy would be liberated as metal melts in the presence of Brown's gas. This is completely analogous to the splitting of biopolymers in catabolism leading to liberation of metabolic energy. This liberation does not take place in the interaction with living matter: why the conductor property of metals leads to the burning? Why the presence of conduction electrons induced the phase transition reducing h_{eff} and scaling up p-adic prime p correspondingly so that energy is liberated. Do conduction electrons perhaps serve as a seed like in ordinary phase transitions forcing the dark Cooper pairs to decay to ordinary electrons?

    (d) This framework inspires the conjecture that chemical life has preceded by plasmoids consisting of these ultra-simplified versions of basic biomolecules. "Ontogeny recapitulates phylogeny" forces to as whether this primordial life form could be still in key role living matter meaning that the role of water would be much more than serving as a passive solvent of biomolecules. The phase of water known as ordered water and having ice as the closest analog is believed to be crucial for the stability of DNA against hydrolysis, and one can wonder whether the dark DNA defined by half dark water molecule sequences could be the basic building brick of the ordered water and accompany the ordinary DNA. This would make also highly probable the analogs of transcription and translation between ordinary and dark variants of basic biopolymers. Note that Brown's gas would be ideal fuel since it would "burn" to water: no CO_2 would be produced as in case of biofuels. Again the problem is that academic community how refuses to take free energy people seriously enough to try to demonstrate that they are wrong. Free energy enthusiasts in turn seem to concentrate too much to their dream and fail to realize that Brown's gas could carry the usable energy and the amount of this energy liberated as heat need not measure the actual success of the experiment.

13.3.5   Pollack's findings about fourth phase of water

What is described above was the view about Brown's gas before I received a link to a Youtube lecture by Gerald Pollack about fourth gel like phase of water (see `https://www.youtube.com/watch?v=i-T7tCMUDXU`) [L38]. Listening this lecture provided considerable support for this picture and led to a much more detailed and also simplified view.

The discovery of negatively charged exclusion zone formed in water bounded by gel phase was the motivation for Pollack to propose the notion of gel like fourth phase of water. Below I discuss this notion from TGD point of view.

The proposal will be that the fourth phase corresponds to negatively charged regions - exclusion zones - with size up to 100-200 microns generated when energy is fed into the water - say as radiation, in particular solar radiation. The stoichiometry of the exclusion zone is $H_{1.5}O$ and can be understood if every fourth proton is dark proton residing at the flux tubes of the magnetic body assignable to the exclusion zone and outside it. This leads to a model for prebiotic cell as exclusion zone. Dark protons are proposed to fork dark nuclei whose states can be grouped to groups corresponding to DNA, RNA, amino-acids, and tRNA and for which vertebrate genetic code is realized in a natural manner [K37, L10]. The voltage associated with the system defines the analog of membrane potential, and serves as a source of metabolic energy as in the case of ordinary metabolism. The energy is liberated in a reverse phase transition in which dark protons transform to ordinary ones. Dark proton strings serve as analogs of basic biopolymers, and one can imagine analog of bio-catalysis with enzymes replaced with their dark analogs. The recent discovery that metabolic cycles emerge spontaneously in absence of cell support this view.

The findings

One can find a biographical sketch [I13] (`http://faculty.washington.edu/ghp/cv/`) giving a list of publications containing items related to the notions of exclusion zone and fourth phase of water discussed in the talk. I list below some basic experimental findings about fourth gel like phase of water made in the laboratory led by Gerald Pollack [L38].

1. In water bounded by a gel a layer of thickness up to 100-200 microns is formed. All impurities in this layer are taken outside the layer. This motivates the term "exclusion zone". The layer consists of layers of molecular thickness and in these layers the stoichiometry is $H_{1.5}O$. The layer is negatively charged. The outside region carries compensating positive charge. This kind of blobs are formed in living matter. Also in the splitting of water producing Brown's gas negatively charged regions are reported to emerge [H5, H1].

2. The process requires energy and irradiation by visible light or thermal radiation generates the layer. Even the radiation on skin can induce the phase transition. For instance, the blood flow in narrow surface veins requires metabolic energy and irradiation forces the blood to flow.

3. The layer can serve as a battery: Pollack talks about a form of free energy deriving basically from solar radiation. The particles in the layer are taken to the outside region, and this makes possible disinfection and separation of salt from sea water. One can even understand how clouds are formed and mysteries related to the surface tension of water as being due the presence of the layer formed by $H_{1.5}O$.

4. In the splitting of water producing Brown's gas [H5, H1] having a natural identification as Pollack's fourth phase of water the needed energy can come from several alternative sources: cavitation, electric field, etc...

Dark nuclei and Pollack's findings

While listening the lecture of Pollack I realized that a model for dark water in term of dark proton sequences is enough to explain the properties of the exotic water according to experiments done in the laboratory of Pollack. There is no need to assume sequences of half-dark water molecules containing one dark proton each.

1. The dark proton sequences with dark proton having size of order atomic nucleus would reside at the flux tubes of dark magnetic field which is dipole like field in the first approximation and defines the magnetic body of the negatively charged water blob. This explains the charge separation if the flux tubes have length considerably longer than the size scale of the blob which is given by size of small cell. In the model inspired by Moray B. King's lectures charge separation is poorly understood.

2. An interesting question is whether the magnetic body is created by the electronic currents or whether it consists of flux tubes carrying monopole flux: in the latter case no currents would be needed. This is obviously purely TGD based possibility and due to the topology of CP_2.

3. This means that in the model inspired by the lectures of Moray B. King discussed above, one just replaces the sequences of partially dark water molecules with sequences of dark protons at the magnetic body of the $H1.5O$ blob. The model for the proto-variants of photosynthesis and metabolism remain as such. Also now genetic code would be realized.

   These primitive forms of photosynthesis and metabolism form could be key parts of their higher level chemical variants. Photosynthesis by irradiation would induce a phase transition generating dark magnetic flux tubes (or transforming ordinary flux tubes to dark ones) and the dark proton sequences at them. Metabolism would mean burning of the resulting blobs of dark water to ordinary water leading to the loss of charge separation. This process would be analogous to the catabolism of organic polymers liberating energy. Also organic polymers in living matter carry their metabolic energy as dark proton sequences: the layer could also prevent their hydration. That these molecules are typically negatively charged would conform with the idea that dark protons at magnetic flux tubes carry the metabolic energy.

   The liberation of energy would involve increase of the p-adic prime characterizing the flux tubes and reduction of Planck constant so that the thickness of the flux tubes remains the same but the intensity of the magnetic field is reduced. The cyclotron energy of dark protons is liberated in coherent fashion and in good approximation the frequencies of the radiation corresponds to multiplies of cyclotron frequency: this prediction is consistent with that in the original model for the findings of Blackman and others [J46].

   The phase transition generating dark magnetic flux tubes containing dark proton sequences would be the fundamental step transforming inanimate matter to living matter and the fundamental purpose of metabolism would be to make this possible.

Minimal metabolic energy consumption and the value of membrane potential

This picture raises a question relating to the possible problems with physiological temperature.

1. The Josephson radiation generated by cell membrane has photon energies coming as multiples of ZeV, where V is membrane potential about .06 V and $Z = 2$ is the charge of electron Cooper pair. This gives $E = .12$ eV.

2. There is a danger that thermal radiation masks Josephson radiation. The energy for photons at the maximum of the energy density of blackbody radiation as function of frequency is given as the maximum of function $x^3/(e^x - 1)$, $x = E/T$ given by $e^{-x} + x/3 - 1 = 0$. The maximum is given approximately by $x = 3$ and thus $E_{max} \simeq 3T$ (in units $c = 1, k_B = 1$). At physiological temperature $T = 310$ K (37 C) this gives .1 eV, which is slightly below Josephson energy: living matter seems to have minimized the value of Josephson energy - presumably to minimize metabolic costs. Note however that for the thermal energy density as function of *wavelength* the maximum is at $E \simeq 5T$ corresponding to 1.55 eV which is larger than Josephson energy. The situation is clearly critical.

3. One can ask whether also a local reduction of temperature around cell membrane in the fourth phase of water is needed.

   (a) "Electric expansion" of water giving rise to charge separation and presumably creating fourth phase of water is reported to occur [H5, H1].

   (b) Could the electric expansion/phase transition to dark phase be adiabatic involving therefore no heat transfer between the expanding water and environment? If so, it would transform some thermal energy of expanding water to work and reduce its temperature. The formula for the adiabatic expansion of ideal gas with f degrees of freedom for particle ($f = 3$ if there are no other than translational degrees of freedom) is $(T/T_0) = (V/V_0)^{-\gamma}$, $\gamma = (f+2)/f$. This gives some idea about how large reduction of temperature might be involved. If p-adic scaling for water volume by a power of

two takes place, the reduction of temperature can be quite large and it does not look realistic.

(c) The electric expansion of water need not however involve the increase of Planck constant for water volume. Only the Planck constant for flux tubes must increase and would allow the formation of dark proton sequences and the generation of cyclotron Bose-Einstein condensates or their dark analog in which fermions (electrons in particular) effectively behave as bosons (the anti-symmetrization of wave function would occur in dark degrees of freedom corresponding to multi-sheeted covering formed in the process).

Fourth phase of water and pre-biotic life in TGD Universe

If the fourth phase of water defines pre-biotic life form then the phase transition generating fourth phase of water and its reversal are expected to be fundamental elements of the ordinary metabolism, which would have developed from the pre-biotic metabolism. The following argument conforms with this expectation.

1. Cell interiors, in particular the interior of the inner mitochondrial membrane are negatively charged as the regions formed in Pollack's experiments. Furthermore, the citric acid cycle, (`http://www.en.wikipedia.org/wiki/Citric_acid_cycle`), which forms the basic element of both photosynthesis (`http://www.en.wikipedia.org/wiki/Photo-synthesis`) and cellular respiration `http://www.en.wikipedia.org/wiki/Cellular_respiration`, involves electron transport chain (`http://www.en.wikipedia.org/wiki/Electron_transport_chain`) in which electron loses gradually its energy via production of NADP and proton at given step. Protons are pumped to the other side of the membrane and generates proton gradient serving as metabolic energy storage just like battery. The interpretation for the electron transport chain in terms of Pollack's experiment would be in terms of generation of dark protons at the other side of the membrane.

2. When ATP is generated from ADP three protons per ATP flow back along the channel formed by the ATP synthase molecule (`http://www.en.wikipedia.org/wiki/ATP_synthase`) (perhaps Josephson junction) and rotate the shaft of a "motor" acting as a catalyst generating three ATP molecules per turn by phosphorylating ADP. The TGD based interpretation is that dark protons are transformed back to ordinary ones and possible negentropic entanglement is lost.

3. ATP is generated also in glycolysis (`http://www.en.wikipedia.org/wiki/Glycolysis`), which is ten-step process occurring in cytosol so that membrane like structure need not be involved. Glycolysis involves also generation of two NADH molecules and protons. An open question (to me) is whether the protons are transferred through an endoplasmic reticulum or from a region of ordered water (fourth phase of water) to its exterior so that it would contribute to potential gradient and could go to magnetic flux tubes as dark proton. This would be natural since glycolysis is realized for nearly all organisms and electron transport chain is preceded by glycolysis and uses as input the output of glycolysis (two pyruvate molecules (`http://www.en.wikipedia.org/wiki/Pyruvate`)).

4. Biopolymers - including DNA and ATP - are typically negatively charged. They could thus be surrounded by fourth phase of water and neutralizing protons would reside at the magnetic bodies. This kind of picture would conform with the idea that the fourth phase (as also magnetic body) is fractal like. In phosphorylation the metabolic energy stored to a potential difference is transferred to shorter length scales (from cell membrane scale to molecular scale).

In glycolysis (`http://www.en.wikipedia.org/wiki/Glycolysis`) the net reaction $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2(g) + 6H_2O(l) + heat$ takes place. The Gibbs free energy change is $\Delta G = -2880$ kJ per mole of $C_6H_{12}O_6$ and is negative so that the process takes place spontaneously. Single glucose molecule is theoretized to produce $N = 38$ ATP molecules in optimal situation but there are various energy losses involved and the actual value is estimated to be 29-30. From $Joule = 6.84 \times 10^{18}$ eV and $mol = 6.02 \times 10^{23}$ and for $N = 38$ one would obtain the energy yield .86 eV per single ATP. The nominal value that I have used .5 eV. This is roughly 5 to 8 times higher than $E = ZeV$, $Z = 2$,

which varies in the range .1-.16 eV so that the metabolic energy gain cannot be solely due to the electrostatic energy which would actually give only a small contribution.

In the thermodynamical approach to metabolism the additional contribution would be due to the difference of the chemical potential μ for cell exterior and interior, which is added to the membrane potential as effective potential energy. The discrepancy is however rather large and this forces the question the feasibility of the model. This forces to reconsider the model of osmosis in the light of Pollack's findings.

Pollack's findings in relation to osmosis and model for cell membrane and EEG

Osmosis (`http://en.wikipedia.org/wiki/Osmotic`) has remained to me poorly understood phenomenon. Osmosis means that solvent molecules move through a semipermeable membrane to another side of the membrane if the concentration of solute is higher at that side. Solute can be water or more general liquid, supercritical liquid, and even gas.

Osmosis is not diffusion: it can occur also towards a higher concentration of water. Water molecules are not attracted by solute molecules. A force is required and the Wikipedia explanation is that solute molecules approaching pores from outside experience repulsion and gain momentum which is transferred to the water molecules.

The findings of Pollack inspire the question whether the formation of exclusion zone could relate to osmosis and be understood in terms of the fourth phase of water using genuine quantal description.

In the thermodynamical model for ionic concentrations one adds to the membrane resting potential a contribution from the difference of chemical potentials μ_i at the two sides of the membrane. Chemical potentials for the ions parametrize the properties of the cell membrane reducing basically to the properties of the channels and pumps (free diffusion and membrane potential do not entirely determine the outcome).

If the transfer of ions - now protons - through cell membrane is quantal process and through Josephson junctions defined by transmembrane proteins, then the thermodynamical model can at best be a phenomenological parameterization of the situation. One should find the quantum counterpart of thermodynamical description, and here the identification of quantum TGD as square root of thermodynamics in Zero Energy Ontology (ZEO) suggests itself. In this approach thermodynamical distributions are replaced by probability amplitudes at single particle level such that their moduli squared give Boltzmann weights.

1. Simplest Josephson junction model for cell membrane

The first guess is that quantum description is achieved by a generalization of the Josephson junction model allowing different values of Planck constant at magnetic flux tubes carrying dark matter.

1. Josephson junctions correspond microscopically to transmembrane proteins defining channels and pumps. In rougher description entire cell membrane is described as Josephson junction.

2. The magnetic field strength at flux tube can differ at the opposite side of the membrane and even the values of h_{eff} could in principle be different. The earlier modelling attempts suggest that $h_{eff}/h = n = 2^k A$, where A is the atomic weight of ion, is a starting assumption deserving testing. This would mean that each ion resides at its own flux tubes.

   The phase transitions changing the value of h_{eff} could induce ionic flows through cell membrane, say that occurring during nerve pulse since the energy difference defining the ratio of square roots of Boltzmann weights at the two sides of the membrane would change. Also the change of the local value of the magnetic field could do the same.

Consider first the simplest model taking into account only membrane potential.

1. The simplest model for Josephson junction defined by the transmembrane protein is as a two state system (Ψ_1, Ψ_2) obeying Schrödinger equation.

$$i\hbar_1 \frac{\partial \Psi_1}{\partial t} = ZeV\Psi_1 + k_1\Psi_2 \ ,$$

$$i\hbar_2 \frac{\partial \Psi_2}{\partial t} = k_2\Psi_2 \ .$$

One can use the decomposition $\Psi_i = R_i exp(i\Phi(t))$ to express the equations in a more concrete form. The basic condition is that the total probability defined as sum of moduli squared equals to one: $R_1^2 + R_2^2 = 1$. This is guaranteed if the hermiticity condition $k_1/\hbar_1 = \overline{k_2}\hbar_2$ holds true. Equations reduce to those for an ordinary Josephson junction except that the frequency for the oscillating Josephson current is scaled down by $1/h_{eff}$.

2. One can solve for R_2 assuming $\Phi_1 = eVt/\hbar_{eff}$. This gives

$$R_2(t) = sin(\Phi_0) + \frac{k_1}{\hbar_1}sin(\frac{eVt}{\hbar_1}) \ \ .$$

R_2 oscillates around $sin(\Phi_0)$ and the concentration difference is coded by $\Phi 0$ taking the role of chemical potential as a phenomenological parameter.

3. The counterparts of Boltzmann weights would be apart from a phase factor square roots of ordinary Boltzmann weights defined by the exponent of Coulomb energy:

$$R = sin(\phi_0) = exp(\frac{ZeV(t)}{2T}) \ \ .$$

Temperature would appear as a parameter in single particle wave function and the interpretation would be that thermodynamical distribution is replaced by its square root in quantum theory. In ZEO density matrix is replaced by its hermitian square root multiplied by density matrix.

2. The counterpart of chemical potential in TGD description

This model is not as such physically realistic since the counterpart of chemical potential is lacking. The most straightforward generalization of the thermodynamical model is obtained by the addition of an ion dependent chemical potential term to the membrane potential: $ZeV \to ZeV + \mu_I$. This would however require a concrete physical interpretation.

1. The most obvious possibility is that also the chemical potential actually correspond to an interaction energy - most naturally the cyclotron energy $E_c = \hbar_{eff}ZeB_{end}/m$ of ion - in this case proton - at the magnetic flux tube. Cyclotron energy is proportional to h_{eff} and can be rather large as assumed in the model for the effects of ELF em fields on brain.

2. This model would predict the dependence of the effective chemical potential on the mass and charge of ion for a fixed value of on h_{eff} and B_{end}. The scales of ionic chemical potential and ion concentrations would also depend on value of h_{eff}.

3. The model would provide a different interpretation for the energy scale of bio-photons, which is in visible range rather than infrared as suggested by the value of membrane potential.

   The earlier proposal [K32] was that cell membrane can be in near vacuum extremal configuration in which classical Z^0 field contributes to the membrane potential and gives a large contribution for ions. The problematic aspect of the model was the necessity to assume Weinberg angle in this phase to have much smaller value than usually. Furthermore, for proton the Z^0 contribution is negligible in good approximation so that this model does not explain the high value of the metabolic energy currency.

4. The simplest model the communications to magnetic body rely on Josephson radiation whose fundamental frequency f_J is at resonance identical with the cyclotron frequency $f_c(MB)$ at particular part of the flux tube of the magnetic body:$(f_c(MB) = f_J$. $f_c(MB)$ corresponds to EEG frequency in the case of brain and biophotons are produced from dark EEG photons as ordinary photons in phase transition reducing $h_{eff} = n \times h$ to h.

   In the modified model the sum $f_c + f_{J,n}$ ($f_{J,n} = E_J/n \times h$) of h_{eff}-independent cyclotron frequency and Josephson frequency proportional to $1/h_{eff}$ equals to cyclotron frequency $f_c(MB)$ at "personal" magnetic body varying slowly along the flux tube: $f_c + f_{J,n} = f_c(MB)$.

If also the variation of f_J assignable to the action potential is included, the total variation of membrane potential gives rise to a frequency band with width roughly

$$\frac{\Delta f}{f} \simeq \frac{2f_{J,n}}{f_c + f_{J,n}} = \frac{2f_{J,1}}{nf_c + f_{J,1}} \quad .$$

If dark photons correspond to biophotons the energy is of cyclotron photon is in visible and UV range one has $nf_c = E_{bio}$ and

$$\frac{\Delta f}{f} \simeq \frac{2ZeV}{E_{bio} + ZeV} \quad .$$

The prediction is scale invariant and same for all ions and also electron unless E_{bio} depends on ion. For $eV = .05$ eV, $Z = 1$, and $E_{bio} = 2$ eV ($f \simeq 5 \times 10^{14}$ Hz) one has $\Delta f/f \sim .1$ giving 10 per cent width for EEG bands assumed in the simpler model.

If this vision is on the correct track, the fundamental description of osmosis would be in terms of a phase transition to the fourth phase of water involving generation of dark matter transferred to the magnetic flux tubes. For instance, the swelling of cell by an in-flow of water in presence of higher concentration inside cell could be interpreted as a phase transition extending exclusion zone as a process accompanied by a phase transition increasing the value of h_{eff} so that the lengths of the flux tube portions inside the cell increase and the size of the exclusion zone increases. In general case the phase transitions changing h_{eff} and B_{end} by power of two factor are possible. This description should bring magnetic body as part of bio-chemistry and allow understanding of both equilibriumion distributions, generation of nerve pulse, and basic metabolic processes leading to the generation of ATP.

Why would charge separation generate large h_{eff}?

The basic question is whether and how the separation of electron and proton charges generates large h_{eff}? A possible mechanism emerged from a model [K118] explaining anomalously large gravimagnetic effect claimed by Tajmar et al [E1, **?**] to explain the well-established anomaly related to the mass of Cooper pairs in rotating super-conduction. The mass is too large by fraction of order 10^{-4} and the proposal is that gravimagnetism changes slightly the effective Thomson magnetic field associated with the rotating super-conductor leading to wrong value of Cooper pairs mass when only ordinary Thomson field is assumed to be present. The needed gravimagnetic field is however gigantic: 28 orders larger than that predicted by GRT. Gravimagnetic field is proportional h_{eff}^2 in TGD and if one uses h_{gr} for electron-Earth system one obtains correct order of magnitude.

Nottale's finding that planetary orbits seem to correspond to Bohr orbits in gravitational potential with gigantic value of gravitational Planck constant is the basic input leading to the model of gravimagnetic anomaly.

1. By Equivalence Principle h_{gr} has the general form $h_{gr} = GMm/v_0$, where M and m are the interacting masses and v_0 is a parameter with dimensions of velocity. For three inner planets one has $v_0/c \simeq 2^{-11}$.

2. The notion of h_{gr} generalizes to that for other interactions. For instance, in electromagnetic case the formation of strong em fields implying charge separation leads to systems in which $h_{em} = Z_1 Z_2 e^2/v_0$ is large. Pollack's exclusion zone and its complement define this kind of systems and is identified as prebiotic life form.

3. Since the natural expansion parameter of perturbative expansion is the $g^2/4\pi\hbar$, one can say that transition to dark matter phase make the situation perturbative. Mother Nature is theoretician friendly.

h_{em} might be large in the exclusion zones (EZ) appearing in the water bounded by gel and their variants could play central role in living matter.

1. EZ carries very large negative charge with positive charge outside the exclusion zone.

2. TGD interpretation is in terms of $H_{1.5}O$ phase of water formed when every 4:th proton is transferred to magnetic body as dark particle with large value of h_{eff}. The proposal is that primitive life form is in question.

3. The pair formed by EZ and its complement could have large value of $h_{eff} = h_{em} = Z^2 e^2/v_0$.

4. The velocity parameter v_0 should correspond to some natural rotation velocity. What comes in mind is that complement refers to Earth and v_0 is the rotation velocity at the surface of Earth. The prediction for h_{eff} would be of order $h_{em}/h = 4\pi\alpha Z^2 \times .645 \times 10^6 \simeq 5.9 \times 10^4 Z^2$.

5. Cell membrane involves also large charge separation due to very strong electric field over the cell membrane. Also now dark phases with large h_{em} or h_{gr} could be formed.

I have proposed that metabolic machinery generates large h_{eff} phase somehow. $h_{eff} = h_{em}$ hypothesis allows to develop this hypothesis in more detail.

1. I have speculated earlier [K40] that the rotating shaft of a molecular motor associated with ATP synthase plays a key role in generating dark matter phase. What comes in mind is that charge separation takes place associating exclusion zone with the shaft and the rotational velocity v_0 of the shaft appears in the formula for h_{em}. Of course, some numerical constant not far from unity could be present. The electric field over the mitochondrial membrane generates charge separation. One can imagine several identifications for the product of charges. The charge Z associated with the complement would be naturally associated with single dark flux tube containing dark nucleon consisting of dark protons. For instance, the charge associated with the exclusion zone could be the charge of the electronic Cooper pair giving $h_{em} = 2e \times Z/v_0$.

2. The value of v_0/c is expected to be of order 10^{-14} from the angular rotation rate of ADP synthase about few hundred revolutions per second. The order of magnitude for h_{em} could be same as for h_{gr} associated with Earth-particle system.

$h_{eff}(ATPsynthase) = h_{gr}(2e, Earth)$ would make possible reconnection of electromagnetic flux tubes with gravimagnetic flux tubes [K64].

Which came first: metabolism or cell membrane?

One of the basic questions of biology is whether metabolism preceded basic biopolymers or vice versa. RNA world scenario assumes that RNA and perhaps also genetic code was first.

1. The above view suggests that both approaches are correct to some degree in TGD Universe. Both metabolism and genetic code realized in terms of dark proton sequences would have emerged simultaneously and bio-chemistry self-organized around them. Dark proton sequences defining analogs of amino-acid sequences could have defined analogs of protein catalysts and played a key role in the evolution of the metabolic pathways from the primitive pathways involving only the phase transition between ordinary water and fourth phase of water.

2. There is very interesting article [I18] reporting that complex metabolic pathways are generated spontaneously in laboratory environments mimicking hot thermal vents. Glycolysis and pentose phosphate pathway were detected. The proposal is that these pathways are catalyzed by metals rather than protein catalysts.

3. In standard biology these findings would mean that these metabolic pathways emerged before basic biopolymers and that genetic code is not needed to code for the metabolic pathways during this period. In TGD framework dark genetic code [K37, L10] would be there, and could code for the dark pathways. Dark proton strings in one-one correspondence with the amino-acid sequences could be responsible for catalysts appearing in the pathways. Only later these catalysts would have transformed to their chemical counterparts and might be accompanied by their dark templates. One cannot even exclude the possibility that the chemical realization of the DNA-aminoacid correspondence involves its dark analog in an essential manner.

13.4 TGD view about metabolism

The general strategy in TGD based attempts to understand metabolism [K40] is based on the assumption that a very large class of anomalous phenomena rely on same basic mechanism. This includes life as a gigantic collection of anomalies, water memory and homeopathy, free energy phenomena involving over-unity energy production related to the dissociation of water, lightning and ball lightning, anomalous effects associated with rotating magnetic systems, phenomena related to UFOs (light balls), and remote mental interactions. One must have a unified explanation for all these phenomena based on a real theory.

Plasmoid as primitive life form would the underlying connecting thread between these phenomena so that all the listed phenomena would involve life and prebiotic (or/and possibly postbiotic!) life. This gives very strong constraints on the model. Plasmoid should consists of the analogs of linear biomolecules, it should metabolize and communicate, in TGD Universe it should have magnetic body, and even genetic code might be realized. In particular, the simplified analog of biological metabolism would be at work. In living matter photosynthesis relies on the splitting of water whereas cell respiration relies on the reversal of this process producing carbon di-oxide and water. Something very similar should happen in free energy systems involving electrolysis, and the fact that water splitting occurs also in several free energy phenomena suggests that these processes are analogous to photosynthesis and store energy to "molecules" analogous to various linear biomolecules, in particular sugars. Even the simplified version of ADP-ATP process might be realized.

TGD suggests a very general model for the metabolism of pre-biotic systems identified as plasmoids consisting of cyclic linear structures formed by exotic water molecules. For a dark water molecule one proton would be dark and dark protons of the neighboring exotic water molecules would bind to form a linear structure identifiable as dark nucleus: this picture is a direct generalization of nuclear string model [K24, K21, L10]. These linear structures would define the analogs of linear biomolecules. This metabolism would be more fundamental than ordinary biochemical metabolism and form a yet unknown part of the latter. One cannot exclude the possibility that also other than water molecules contain dark protons: the signature would be the presence of apparently non-allowed covalent bonds due to the fact the dark proton is not visible. In the following I will discuss the basic principles involved.

The older view about the metabolic energy quanta as energies liberated as particle "drops" to a larger space-time sheet is modified (an objection against this mechanism is that its coherence for many particles is far from obvious). Metabolic energy quanta are liberated when the space-time sheet at which the particles reside expands in a phase transition increasing its p-adic prime and reducing the value of Planck constant correspondingly so that the net result is that the size of the space-time sheet remains the same. This condition implies a close relationship between p-adic and dark matter hierarchies. This process is automatically coherent since all particles suffer the change simultaneously. It applies also to a situation in which particles are in magnetic field: in this case the scale of cyclotron energies changes since the strength of the magnetic field is scaled down to guarantee the conservation of magnetic flux. This transition is not cyclotron transition but liberates essentially the same energy as coherent cyclotron transition so that magnetic fields (their "motor actions") become essential players also in metabolic activities.

13.4.1 Three possible models for liberation of metabolic energy

One can imagine three different models for the liberation of metabolic energy.

1. The simplest TGD based model is as a phase transition increasing the value of p-adic prime p assignable to the space-time sheet at which particle is topologically condensed:

   (a) Particle drops to a larger space-time sheet with larger p-adic prime p_1 with $p_1/p \simeq 2^k$. The problem is that different particles need not drop simultaneously so that coherent liberation of energy is not automatic consequence of the assumption.

   (b) The space-time sheet itself suffers a phase transition increasing its p-adic length scale. In absence of interactions (particles in box) the energies are scaled down by factor 2^{-k} and the difference is liberated as usable energy. Coherent liberation of energy is achieved

automatically. If the particle insider the space-time sheet is free in good approximation a model as particle in box applies, and if the expansion of the space-time sheet takes place adiabatically, the quantum numbers characterizing the state of the particle do not change in the transition. As a consequence, the energy $E_{\{n_i\}} = k \sum_i n_i^2 \hbar^2 / 2mL_p^2$ is reduced as $L_p \propto \sqrt{p}$ increases to L_{p_1}, where $p_1/p \simeq 2^k$ holds true. The difference of vacuum energies is liberated as usable energy in coherent manner: this is of special significance in living systems. This has led to the identification of p-adic length scales that would correspond to fundamental metabolic quantum with value about .5 eV. Entire hierarchy of metabolic quanta is predicted.

2. The space-time sheet could also carry magnetic energy and particles are expected to be in cyclotron states and perhaps form a cyclotron Bose-Einstein condensate. In this case the phase transition reduces the value of B but preservers the magnetic flux so that $B \to B/2^k$, $p_1/p \simeq 2^k$, takes place. This scales down the energies of cyclotron states by the same scaling factor 2^{-k} as in the case of free particle. The liberated energy is in good approximation just the cyclotron energy for large enough values of k. Coherence is achieved automatically. The value of the fundamental metabolic energy quantum and the value of endogenous magnetic field of about $B_{end} = .2$ Gauss deduced from the experiments of Blackman and others [J72] fix the value of h_{eff}. It would be proportional to particle mass number A.

3. The earlier model for the liberation of cyclotron energy was based on the assumption that the value of B is not changed but that the value of magnetic quantum number n changed. If n is reduced one achieves liberation of energy. Coherence of the transition might produce problems now. Both models can explain the observations of Blackman and others concerning the effects of ELF radiation on vertebrate brain since the spectrum of photons energies inducing effects correspond to cyclotron energies for the latter option and in excellent approximation to it for the previous model. The mechanism is however quite different.

This phase transition for the larger space-time sheet can take place in two steps.

1. First a phase transition increasing h_{eff} of the background space-time sheet by $n = 2^k$ occurs. This leaves ZPKE invariant but scales up the size of the space-time sheet by $2^{k/2}$. The interpretation would be as "electric expansion" of Brown's gas. No energy transfer takes place since both kinetic and magnetic energies are invariant under the scaling of $\hbar$. Note however than in the original situation the magnetic field can be very strong so that zooming up from microscopic scales can happen.

2. After this a phase transition reducing Planck constant back to h but increasing p-adic length scale by 2^k occurs. The size scale of the background space-time sheet is not affected but the zero point kinetic energy is reduced by factor 2^{-k} and liberated as usable energy. This phase transition would take place for the dark component of Brown's gas in the melting of the metal and other similar phenomena. Also the liberation of metabolic energy in living matter could correspond to this phase transition.

This model for electric expansion, implosion, and energy liberation assumes nothing about the particles involved since dark particle means ordinary particle topologically condensed on dark space-time sheet and having wave function de-localized in the n-sheeted structure. For instance, water can be dark in this sense. One could indeed consider the possibility that the vapor phase identified as charged water cluster is just water containing positive ions H_+^3 or protons and electrons and that phase transition to large $\hbar$ phase expands the space-time sheet at which water is topologically condensed at evaporates the water. Ordinary liquid to gas transition could proceed in the same manner and involve liberation of ZPKE at the second step of the process. In the general case the binding energy involved with the formation of the denser phase could compensate for the energy gain in the increase of the p-adic prime so that the melting would require energy feed.

13.4.2   Where the metabolic energy is stored?

High energy phosphate bond is one of the problematic notions of standard biology, and has served as inspiration in attempts to understand metabolism in TGD framework. The ideas have evolved

gradually and the only defense for those which have survived is that they are inspired by a rather wide spectrum of anomalies including biology, neuroscience, and free energy phenomena so that the constraint of internal consistency eliminates many options.

1. The notion of negentropic entanglement allows to consider the possibility of bound states which have wrong sign of binding energy. Entanglement would be stable because it is negentropic rather than being characterized by binding energy. This led to the idea that high energy phosphate bond as a carrier of negentropic entanglement. The milder assumption is that ATP has the ability to generate it. The problem is that one can imagine endless variety of mechanisms without further conditions.

2. A highly attractive idea is that magnetic body could serve as the fundamental storage of metabolic energy with negative energy photons serving as a manner to extract energy from the personal magnetic body or even other magnetic bodies. This would locate higher energy phosphate bond to magnetic flux tube and suggests that the energy is assignable to an analog of Cooper pair. This vision inspires also speculations about future energy technologies.

3. The generalization of the simple picture about liberation of metabolic energy as associated with the dropping of particle to a larger space-time sheet to a phase transition liberating cyclotron energy of charged particles led to the realization that also the phase transitions in which p-adic length scale increases by $2^{k/2}$ factor and h_{eff} decreases by factor 2^{-k} so that the size of space-time sheet remains the same, liberate kinetic energy or magnetic energy and this happens coherently and simultaneously for all particles involved. This mechanism makes essentially the same predictions about effects of ELF em fields at multiplet of cyclotron frequencies (in good approximation).

   In many-sheeted space-time particles topologically condense at all space-time sheets having projection to given region of space-time so that this option makes sense only near the boundaries of space-time sheet of a given system. Also p-adic phase transition increasing the size of the space-time sheet could take place and the liberated energy would correspond to the reduction of zero point kinetic energy. Particles could be transferred from a portion of magnetic flux tube portion to another one with different value of magnetic field and possibly also of Planck constant h_{eff} so that cyclotron energy would be liberated.

4. The negentropic states with wrong sign of binding energy could also correspond to cyclotron states with large h_{eff} (equally well to the states of a free particle in box, now space-time sheet). Magnetic body could carry metabolic energy and negentropic entanglement as that associated with dark pairs of charged particles. Because of their small mass electrons carry highest energy for given value of h_{eff} and magnetic field B. The deep irony is that one cannot automatically exclude even the elusive neutrinos as key players of metabolism: neutrinos have even smaller masses than electron and would carry even more energy in classical Z^0 magnetic fields possible in cell scales for large enough values of h_{eff} [K106]!

5. Also ordinary biomolecules can be said to carry metabolic energy in covalent bonds: one could therefore assign the attribute "high energy" also the them. Do we really understand these bonds or do we just accept and forget? Do we really understand what the valence electron pairs associated with covalent bonds are? Is this really nothing but standard chemistry understood for long time ago? To my best knowledge we cannot deduce the existence of chemical bonds from Schrödinger equation because the numerics gets too intensive and choose to believe on reductionistic dogma. Hence there is some room for imagination.

   (a) Concerning covalent bond, the first option is conservative and based on the free energy inspired idea that the orderer water stabilizing DNA corresponds to dark DNA sequences. If this situation prevails also for RNA and proteins known to be surrounded by order water, one can wonder whether the covalent bonds are indeed more or less standard chemistry but that it is dark DNA parallel to the ordinary DNA that carries the metabolic energy as cyclotron energy liberated as the biopolymer and its dark variant image is catabolized. The metabolic energy would be carried by the same structures

as in the case of plasmoids which would be therefore be a key element of also life as we know it!

For this option the long color flux tubes carrying quark or electron pairs would give rise to the flux tubes needed for reconnections. The transfer of metabolic energy would rely on reconnection mechanism transferring also electron Cooper pairs. Dark and thus scaled-up variant of strong interactions would become perhaps the most essential part of biophysics! Chirality selection suggests strongly that also dark variant of weak physics is in a central role in living matter.

(b) Second option suggests a radically new view about covalent bond itself. Could valence bonds corresponds to Kähler magnetic flux loops carrying this kind of dark electron pair? Could they define the loops by which biomolecules could touch each other and reconnect to form dynamical webs. Could the fundamental energy transfer process be the transfer of electron pair between molecules involving two reconnections so that piece of magnetic loop would be exchanged? Could ATP could simply give piece of flux loop containing dark electron pair to the biomolecule as it is constructed?

6. Both options would unify also biochemistry with DNA as topological quantum computer vision. DNA sequences accompanied by magnetic flux loops would make possible DNA-cell membrane flux tube connections and topological quantum computer. Also for DNA as topological quantum computer I have considered two options: one for which quarks and antiquarks are associated with the ends of flux tubes and second one in which only electron pairs are involved [K23].

These ideas are of course speculative and time will probably show that Nature has not chosen them. What I see as the beauty of the general picture is that all relevant elements of biology at molecular level would reduce to the basic "motor actions" for magnetic body and their effects on cyclotron Bose-Einstein condensates. Same can be said about basic elements of consciousness: directed attention and sensing the presence of other molecule relying on the use of cyclotron frequencies as passwords and reconnection of flux tubes.

13.5 Dark photon-bio-photon connection

TGD inspired model for bio-photons is as ordinary photons resulting as decay products of dark photons in energy-momentum conserving decay. I have discussed this model [L32] [K112] using the input from the findings of Persinger et al [J85, J86, J87].

1. In the first article [J85] entitled *Congruence of Energies for Cerebral Photon Emissions, Quantitative EEG Activities and ~ 5 nT Changes in the Proximal Geomagnetic Field Support Spin-based Hypothesis of Consciousness* correlations between cerebral photons emissions, EEG, and changes of the proximal geomagnetic field are reported. The findings provide support for the proposal of Hu and Wu [J116] that nerve pulse activity could induce spin flips of spin networks assignable to cell membrane motivated by the observation that the magnetic spin-spin interaction between protons at a distance of 10 nm (cell membrane thickness) corresponds to energies for which frequency is in EEG range.

2. In the second article [J86] entitled *Demonstration of Entanglement of Pure Photon Emissions at Two Locations That Share Specific Configurations of Magnetic Fields: Implications for Translocation of Consciousness* the group reports an excess correlation between "pure" photon emissions at two locations separated by few meters that share specific correlations of frequency modulated magnetic fields. The photon emissions were from LEDs in the experiment consider. In an earlier similar experiment, which is also discussed, they were from chemical reactions occurring in solutions contained by cell cultures.

3. In the third article [J87] entitled *Experimental Demonstration of Potential Entanglement of Brain Activity over 300 Km for Pairs of Subjects Sharing the Same Circular Rotating, Angular Accelerating Magnetic Fields: Verification by s_LORETA, QEEG Measurements* an

excess correlation of brain activity of subject persons separated by 300 km and sharing the same circular rotating, angular accelerating magnetic fields is reported.

The frequencies of the ordinary and dark photon are predicted to be in integer ratio $f_h/f_l = h_{eff}/h = n$ and I have already considered amplitude modulation as a manner to produce dark photons and mentioned Cyril Smith's experiments which can be interpreted in terms of this transformation.

1. The bio-photon emissions at two ends should be compared. The correlations between temporal patterns would be one basic signature. Temporal correlations are extremely important and should be studied further: otherwise the findings are taken as mere claims by mainstream.

2. Collection of frequencies as a password is the rather strongly TGD based prediction. Common frequencies at both ends define second signature. Phase transitions changing frequencies but preserving photon energies are of course possible so that also sub-harmonics must be considered. More specific predictions lead soon to bio-electromagnetism. I do not know whether bio-electromagnetists have continued the work of pioneers or whether anything is done nowadays.

   This picture raises an interesting question: suppose that one has identified a collection of frequencies responsible for a biological password. Could one produce these effects artificially using these frequencies to modulate a carrier wave corresponding to some bio-photon frequency?

3. Time delay is one signature and would give idea about how long distance the radiation travels and at the same time can give additional support for magnetic bodies of astrophysical size, which is certainly the most astral looking feature of TGD model for biologist.

   Delayed luminescence is also a phenomenon related to bio-photons. Delayed luminescence has been produced as a model of visual after images: this could apply to all mental after images. TGD enthusiast could see after images as a indirect support for the idea that communications to and from the layers of magnetic body take place and require definite time measuring directly the size scale of the layer. The time delay is rather long in the model of after images so that the magnetic bodies in question would be rather large involving photon travels over cosmic distances! Mainstream thinking suggests that some other mechanism is in question and the complexity of nervous system certainly allows to invent alternative mechanisms.

4. The ability to tune the cyclotron and Josephson frequencies by varying magnetic field would be basic magnetic motor skill of the meditator besides ability to move magnetic body parts to make reconnections more probable. For Josephson frequencies this skill would mean the ability to tune the value of the membrane voltage and Josephson frequency characterized by the associated value of h_{eff}. If given receptor-information molecule pair corresponds to a particular value of h_{eff} defining a connection to a particular magnetic body part as will be suggested below, an advanced meditator would have developed the ability to control the density of the receptor-information molecule pairs.

5. How to detect changes of cyclotron frequencies? In Persinger's experiments, magnetic field identified as that of Earth, was slightly reduced and therefore also the frequency. Could one learn to detect the tuning of the value of magnetic field? Can one demonstrate the ability of meditator to modify these frequencies? Can one try to identify the place where the radiation with these frequencies originates. Can one characterise body parts by slightly differing frequencies and build a kind of frequency map about body? Do deviations from standard values characterize unhealthy state?

13.6 Psychedelic induced experiences as key to the understanding of the connection between magnetic body and information molecules?

There is a book about psychedelics titled as "Inner paths to outer space: Journies to Alien Worlds through Psychedelics and Other Spiritual Technics" written by Rick Strassman, Slawek Wojtowicz, Luis Eduardo Luna and Ede Frecska [J93].

13.6.1   Some background about psychedelics

Phychoactive drugs can be classified into three basic types. Some raise the activity level, some calm down, and some change the character of consciousness profoundly. Pychdelics/hallucinogens [J93] belong to the third group. Psychedelics (such as psilobin, psicylobin, DMT, LSD) are molecules containing aromatic rings and many of them (such as psilobin, psicylobin, DMT, LSD) attach to serotonin receptors.

As the official term "hallucinogens" implies psychedelic induced experiences are regarded as hallucinations in the materialistic world view although the denial of the reality of subjective experiences themselves requires a really hard-nosed skeptic. The title of the book reveals that the question posed in the book is whether these experiences could be about real world, kind of sensory input from distant parts of the Universe. The indigenous people using ayahuasca and similar psychedelics have regarded these experiences involving meeting of representatives of other civilizations as perceptions about real worlds. Also Terence and Dennis McKenna, who are pioneers of systematic study of the effects of various psychedelics, shared this view. In the materialistic ontology of standard physics this kind of interpretation is of course excluded. That hallucinations are in question is "obvious", too obvious actually!

The classical psychedelics LSD, psilocybin, DMT, and mescaline are derivatives of two basic chemical groups: tryptamine and phenetylamine which in turn derive from the amino-acids trp and and phe. DMT is endogenous psychedelic and there is pumping of DMT blood-brain barrier so that DMT must have important function in brain. The action of classical psychedelics is on serotonin receptors and affects the serotonin intake so that the effect is stronger. The amount of serotonin in brain is not large but manifest in all functions. According to the book, the situation might be different for pineal gland which is the only nucleus of brain which does not appear as left-right pair. Descartes regarded it as the seat of soul. Pineal gland is also known as "third eye" and in lower species it indeed serves the function of eye. Taking the title of the book seriously, one can ask whether this eye is able to see but to cosmic distances possibly using large h_{eff} photons.

13.6.2   Could instantaneous communications in cosmic scales be possible in TGD Universe?

In TGD inspired ontology the notion of magnetic body with astrophysical, galactic or even supergalactic size changes the situation completely. The basic communication tool would be touch of magnetic bodies generating reconnections and making possible signalling from the biological body member of distant civilization. The perception of the biological body of alien would differ in no manner from that of my neighbor since the mechanisms would be the same as involved with the transfer of sensory data to my personal magnetic body and control commands from there to biological body (at least through genome).

The basic objection against the possibility suggested by the title of the book is that finite light velocity poses absolute upper bound for the distance of objects with it is possible to be in contact during "trip". One must be however very cautious here: the assumption that signals propagate only to singlet direction of time is essential also and derives from classical thermodynamics. In TGD framework second law continues to hold true but the arrow of geometric time for zero energy states changes in each state function reduction occurring to the either boundary of CD. Hence intantaneous communications ("remote seeing"!)using reflection in time direction become possible even over cosmological distances and define among other things the mechanism of memory in TGD Universe.

Time consuming and expensive space travel would become un-necessary: our magnetic body giving us cosmic size together with zero energy ontology making possible instantaneous "seeing" of both future and past by reflection of photons in time direction would be enough. Memory and anticipation would be basic examples about seeing in time direction. This view would also resolve Fermi paradox. We could be actually in a continual contact with the distant civilizations but without realizing it. One can ask whether similar contacts could take place in psychedelic induced experiences. Memories and future plans would be examples of "seeing" in time direction. The continual re-creation of the Universe by quantum jumps would of course mean that the actual future/past need not be same as those which are "seen". Shamans identify various plants as conscious entities teaching them - in TGD framework this would translate to magnetic bodies of representatives of distant civilizations remotely teaching the representatives of more primitive civilizations.

13.6.3 Neurotransmitter receptor complex as plug-in to cosmic internet and a new perspective on remote seeing

If one - just for fun - takes seriously the claims of shamans, one must ask whether our brain has well developed tools available for building contacts with distant civilizations and what these tools might be. The receptors of neural transmitters are obviously the natural candidates for the pathways to cosmos. One can argue that evolutionary pressures have forced living matter to develop highly standardized connections to various parts of the personal magnetic body and possibly also other magnetic bodies. Personal magnetic body has astrophysical size and EEG frequencies would correspond to communications in Earth size scale. Receptors serving as Josephson junctions emitting Josephson radiation with frequency characterised by h_{eff} are natural candidates for plug-ins.

The model for cell membrane as Josephson junction leads at the microscopic level to the view that the proteins associated with various ion pumps, channels, and receptors (of also neurotransmitters in postsynaptic junction) define Josephson junctions to which magnetic flux tubes are associated and characterized by local value of Josephson frequency, that is membrane potential and Planck constant h_{eff}. As the information molecule is attached to a receptor, a connection to some part of the some magnetic body would be generated and split as the molecule is not present. These connections are possible in the scale cell, organelle, organ, organism, population and maybe even in the scale of cosmos. Psychedelics affect serotonin receptors so that serotonin spends longer time in receptor.

The simplest picture is that the connection corresponds to a pair of flux tubes. As the connection is broken, the pair has suffered reconnection cutting it to two U-shaped closed flux tubes. When molecule is attached to the receptor, these U-shape closed flux tubes reconnect. The actual situation is of course expected to be more complex but the basic principle would be this.

In this framework psychedelics would be molecules associated with the reaction pathways facilitating the binding of neurotransmitters responsible for building connections to certain parts of the magnetic bodies characterised by passwords defined by collections of cyclotron frequencies corresponding to a hierarchy of space-time sheets. The Josephson frequency associated with the receptor is inversely proportional to h_{eff}. The natural guess is that it corresponds to the cyclotron frequency of the magnetic body part for electron, proton, or some ion associated with it. Josephson frequency should serve as kind of passwords and receptors would be in one-one correspondence with these passwords defining gateways even to the outer space if the value of Planck constant is large enough.

One might be able to test this crazy hypothesis. Pineal gland could still serve as the "third eye" but utilizing large h_{eff} photons. Fishes and birds are able to navigate to their birth places. This mechanism could involve dark electron Cooper pairs at the magnetic flux tubes of Earth's magnetic field generated by visible photons with energies above energy of red light making possible to move along magnetic flux tube: as the direction of flight ceases to be along it and spin direction of cyclotron Bose-Einstein condensate changes, cyclotron transitions induce dark photon emission at energy of visible photons in turn generating visual sensation. This would explain why radiation at MeV frequency leads to disorientation (cyclotron transitions are induced resonantly). This need not be enough. Could also "remote seeing" by pineal gland using the dark light coming along flux tubes (or maybe even active variant of this process by sending light which is reflected back in time

direction). What about remote seeing in the "usual" sense of the word: could psychedelics help also in this process?

The role of DMT is especially interesting. Body synthesizes it and pumps it through blood-brain barrier. I learned in private discussion that the experiences induced by DMT are relatively predictable (Terence Mac Kenna has described it as a sudden "dropping" to another world somewhere "below" through some kind of wall.) whereas other psychedelic substances induce rather unpredictable experiences. Could it be that DMT corresponds to a permanent connection to some fixed external magnetic body or to a higher layer of level of personal magnetic body with permanent reconnection to some part other magnetic body? DMT as also other psychedelic substances would only help to induce the signal as Josephson radiation. This would be analog to the higher probability of remote mental interaction due to pre-bonding. What happens during sleep: is this connection generated during sleep: what about concentration of DMT during sleep in various brain regions.

The transmitter-receptor complex would be naturally associated with the communications to the magnetic body and possible communications from magnetic body as sensory experiences such as psychedelic experiences and mediated by radiation in opposite time direction. Also control commands from magnetic body - assumed to be realized as signals in opposite time direction as compared to sensory signals - are important and a natural assumption is that the commands initiating gene expression enter through genome via flux sheets traversing through DNA: the time scale for gene expression is slow and also other mechanisms are very probably involved. If both genome and cell membrane can (on general grounds it seems that they must do so) send signals in both time directions, the general vision about motor action as time reversal of sensory perception implies that cell membrane receives also control commands. More generally, the complex formed by reacting biomolecules and catalyst could form a complex receiving control commands from the magnetic body. A temporary fusion of a catalyst molecule and of reacting molecules could serve as the analog of the information molecule-receptor complex. The protein Josephson junction associated with this complex would receive in a resonant manner cyclotron radiation from the magnetic body inducing a transition to a state in which the potential barrier preventing the reaction would be lower.

Irrespective of whether one takes seriously the thought game leading to this proposal, one must admit that it would provide deep for the notion of "information molecule".

13.7 Questions

The following represents answers to the 3rd JNL Panel on meditation, mind-body medicine and placebo based on the previous summary of TGD perspectives on consciousness and quantum biology. The introduction of the article should help to obtain a very short overview about the background.

13.7.1 I: Long term meditation remodelling and its effects on bio-photon emissions

Q1: Is the plasticity restricted to brain? Could meditation/visualization trigger BPE/redox-regulated changes in body wide microtubule arrays increasing coherence and synchronization?

A: I see no deep reason why plasticity would be restricted to brain alone. Brain might have however achieved highest level of plasticity because it represents a kind of "postmodern" layer in the evolution of cell cultures allowing cellular individualism. An interesting question in TGD framework is also the plasticity of magnetic body. Is meditation reshaping the magnetic body, making it more plastic so that it can build reconnections and in this manner direct attention more sharply and more stably?

Q4. Would the increased alpha power, brain connectivity and synchronization translate into greater amplitudes and bio-photon field coherence throughout the organism? And is there any mechanism through which BPEs could be reflected within the bodys various conduction matrices (neural system, the mitochondria-microtubule reticulum see Rahnama et al, 2011) acting like a resonant cavity for laser-like amplification of EEG-pumped BPEs, in order to reach the requisite thresholds for biological action?

If there is a common mechanism of action between LLLT and mind-body healing, as suggested by the parallels reviewed in the discussion above, then of particular interest is the fact that proficient qigong meditators appear capable of directing bio-photon emissions to specific areas of the body [see Intent-directed localization section in bibliography]. Given that LLLT is limited in the depth of effective tissue irradiation, the prospect of targeted delivery of specific frequencies is quite intriguing. On the other hand, the actual intensity of bio-photon fields inside the cells and the robustness of quantum coherence at physiological temperatures remain controversial issues (Tafur et al, 2010; Rahnama et al, 2011).

A: If bio-photons are what results from dark photons in phase transition, the increase in alpha power and more generally in EEG power should increase bio-photon yield : BPE pumped by EEG corresponds to BPE as leakage from EEG. That there is decrease for meditators might be related to the absence of sensory and motor mental images: if there are no mental images, there is nothing to be communicated by dark EEG photons to the personal magnetic body.

Q5. There is evidence for the conduction of bio-photons along neural fibers. Do you think its possible that the localization of BPE during such visualization exercises is due to the photons transmission from the brain to that affected area along efferent neurons, in the same way motor commands would be locally transmitted? Is it technically possible to measure such neural photon conduction in meditating human subjects? And should localization of action, such as targeted BPE, be part of patient training in mind-body interventions?

A: That LLLT is limited by tissue depth, ceases to be a problem if dark photons propagate along magnetic flux tubes. Darkness would provide also shield against de-coherence. One can imagine two manners to achieve targeting.

1. Password mechanism for which parts of body correspond to characteristic resonances so that dark photons with particular frequency determined by energy and value of h_{eff} are received only by that body part.

2. Second mechanism is propagation along magnetic flux tubes directed to that body part. If dark photons have cyclotron frequencies in the magnetic field of a flux tube, these mechanisms are more or less equivalent. Frequency corresponds to magnetic field strength and this in turn to thickness of magnetic flux tube. Microtubular matrix could be accompanied by magnetic flux tubes perhaps serving as a template for it. Biological effects at specific frequencies at the other end of the pathway would be the basic signature.

Q6. What do you think of target specificity in mind-matter interactions based on your understanding of the literature, how narrowly are we able to target a particular area of the body or a particular effect? Could the differential sensitivity to LLLT on the basis of redox status or proliferation rate account for the fact that qigong-based therapies show apoptosis of tumor cells but not normal cells? What do you think is the physical basis of such differential effects, or their localization to particular areas of the body?

A: The different sensitivity of tumor cells and normal cells would be explained by different cyclotron frequencies for their magnetic bodies. The unhealthy state would be also unhealthy state of magnetic body: maybe some parts of collective magnetic body of tumor cell complex with rather large value of h_{eff} are just missing and this translates to selfish behavior of tumor cells. The claim of inventor Royal Rife (http://en.wikipedia.org/wiki/Royal_Rife) regarded as pseudoscience by the mainstream is that tumor cells can be destroyed using irradiation with specific resonance frequencies. This method must be distinguished from radiation therapy based on ionization of DNA. Rife's claim would be roughly consistent with TGD inspired proposal. Basically the challenge would be to find the frequency serving as the password to the cancer cell's magnetic body.

Q7. In your opinion what is the most likely mechanism underlying the connection between long term meditation practice and the development of healing/ psi abilities?

A: I see meditation and visualization as practices for making magnetic body more flexible. This process modifies also biological body since genetic expression is changed as magnetic body controlling the expression of genes modifies it. Also build-up of connections to the larger layers of magnetic body with large value of h_{eff} would be in question as well as developing the ability to reconnect to other magnetic bodies. The travels of meditators/shamans/etc. to other realities could involve real sensory perceptions in TGD based ontology based on same mechanisms as remote

sensory experiences. In any case, the communications in shorter length scales, say inside body and to lower layers of personal magnetic body, would rely on this mechanism.

The modification of the gene expression in meditation could be interpreted as being due to the changes of the connections between magnetic body and biological body. Genetic expression could be determined by the permanent flux tube connections from the magnetic body to the promoter portions of DNA. Differentiation would select the promoters to which the magnetic body has permanent connections. The role of transmitter-receptor complex could be taken by the complex formed by the promoter and RNA polymerase making possible to receive the cyclotron radiation from the magnetic body. The model for motor action and sensory perception assumes that they are time reversals of each other so that the cyclotron radiation to genome and Josephson radiation from the cell membrane would travel in opposite time directions. In the most general case both radiations can travel in either time directions so that also cell membrane could receive control commands (possibly interpreted as virtual sensory input giving rise to what is usually regarded as hallucinations).

The change of the gene expression would be due to a change of these connections. Both meditation, placebo effect, and healing could induce changes in gene expression in this manner. One can wonder whether this change of connections to the magnetic body can be heritable so that it would provide a new mechanism of epigenetics (examples of which are histone modification and DNA methylation). If dark photons are involved with the communications to and from the magnetic body then also BPEs as dark photon leakages would reflect the change of genetic expression.

13.7.2   II: Healing input parameters, dosimetry, research technology

Q8. What other approaches and technologies could be used to quantify healing intent? Is there a place for operator EEG, heart rate variability, skin conductance and operator bio-photon measurements on the input side of mind-body research protocols? Should we find a correlation between healing effects and BPE intensity/frequencies, would this provide a more useful, quantitative assessment of healer input in mind-body methodologies than the years of meditation practice?

A: If information molecule-receptor complexes serve as bridges to magnetic body parts, the technology quantifying healing intent would involve also correlates at neuro-pharmacological level. Neuroscience and study of remote mental interactions would fuse together. Elaborate maps about the information molecule connections to magnetic body would be constructed.

Q9. Since we know the action spectra required for specific LLLT effects, would it be useful to compare these LLLT spectra to the BPE wavelengths measured outside the heads of qigong healers attempting to produce the same effects through visualization? Could we feedback-train patients to reproduce such circumcerebral frequencies through meditation?

A: The comparison of peaks of LLLT and bio-photon spectra would be very interesting. This idea can be expanded if one accepts interpretation of EEG as dark photons The naive prediction would be that the ratios of peak frequencies for EEG for given value of h_{eff} and for bio-photons are same. In principle (I do not know about practice) this could be tested by looking at action spectra for LLT and bio-photons!

Q10. What do you think is the mechanism through which sender-receiver bonding facilitates DMILS effects? Specifically, could we test whether healing-specific EEG frequencies and the intensity of BPE at the sender are greater when the sender has a shared history with the receiver (due to cognitive/emotional memory activation and increased neural recruitment)? Could then pre-bonding with a targeted tissue, such as detailed visualization of a tumor, be used to enhance the effect of a patients healing meditation on his own body?

A: Pre-trial bonding would translate to permanent flux tube connections between magnetic bodies due to the reconnections. This would facilitate DMILs effects: the two magnetic bodies would receive some input from each others biological bodies by dark photons, say EEG. The correlations between EEG spectra and also spectra at other frequencies could serve as a signature for this.

Q11: Could endogenous, EEG generated bio-photons be trapped and utilized as such a source of energy? And could specific forms of meditation trigger new, low-dissipation physiological configurations and metabolic pathways which would allow the capture and high-efficiency utilization of surrounding environmental photons, such as light absorbed through the eyes? How could we test for such epigenetic and molecular configuration changes?

A: The trapping of dark photons to flux tubes would look more natural than trapping of bio-photons in TGD framework. The utilization of environmental photons in Bigu does not look to me an attractive option: dark photons from magnetic body would look more natural if TGD ontology is accepted. I have considered a model for Bigu assuming that magnetic bodies serve as fundamental storages of metabolic energy. What this really means is far from obvious and several options can be imagined. The metabolic energy assigned with the covalent bonds of biopolymers could be actually cyclotron energy assignable with large h_{eff} magnetic flux tubes. Metabolism could be basically transfer or generation of negentropic entanglement assignable most plausibly to electron Cooper pairs. Bigu might reduce to sending of negative energy dark photons to some magnetic body with same cyclotron frequency (but does this generate negentropic entanglement by generating negentropic entanglement, say between electrons of Cooper pair?). This would involve formation of reconnection to this magnetic body (same field strength, same cyclotron frequency). Negative energy photons make sense only if the arrow of geometric time (thermodynamical time) can vary, and this quite generally would make possible also instantaneous communications as reflections of signals in time direction making possible remote mental interactions with arbitrarily distant targets. Zero energy ontology guarantees this.

13.7.3 III: Is placebo a form of healing intent? Placebo genotype vs phenotype

Q12: How do you physiologically interpret the recent finding that patients with a met/met COMT variant are more prone to placebo effects?

A: That persons with met/met COMT would be more prone to placebo effects than normal variant, looks at first rather weird. From Wikipedia (`http://en.wikipedia.org/wiki/Catechol-O-methyl_transferase`) one learns about the claim that people with this variant tend to feel themselves happier than those with normal variant.

If one believes that neural transmitter-receptor complex establishes a plug-in from neuron to relevant part of the magnetic body, then this does not look so weird. Methylation of DNA and proteins is a universal manner to modify the functioning of reaction pathways and appears also in epigenetics. Met/met COMT instead of Met/Val COMT could favor the generation of this kind of bridges to some parts of magnetic body with higher value of h_{eff}: if larger negentropy is responsible for feeling happiness, then the finding could be understood. The parts of the magnetic body are in one-to-one correspondence with those of brain areas and might have similar specialization to feel happy or unhappy as limbic brain is claimed to have (right limbic brain seems to be specialized in suffering!). These bridges or "plug-ins" would most naturally correspond to post-synaptic receptors for some neural transmitters - perhaps one could localize them to limbic brain.

Placebo would be self-healing based on building this kind of contacts. Healing could be seen as healing of the communications between biological and magnetic body (or bodies, say magnetic bodies of collectives).

Q13. Given the evidence that meditation produces different effects on plasma catecholamines according to BDNF or COMT polymorphisms, do you think there is there a common genetic/CNS/therapeutic pathway between placebo and healing qi ability? Could subjects placebo and healing effectiveness be correlated with an ability to entrain massive CNS domains through both activation of broad cognitive basins (multi-sensory visualization) and emotional modules? Would certain genetic variants be more conductive to this type of CNS activation?

A: I tend to think that many pathways are involved. The pathway in question need not be the same for placebo and healing qi ability. For phychedelics and perhaps also for remote perception the pathways affecting serotonin accumulation to postsynaptic receptors seem to be important and pineal gland might be the seat of action. The general mechanism could be similar to that conjectured for the action of psychedelics/hallucinogens. The interpretation would be that connections to some parts of magnetic body or even other magnetic bodies become more stable. If information molecules and receptor proteins are crucial for building connections to the magnetic body, gene dependence is implied: biochemist could probably easily tell whether methylation is a universal mechanism for modifying these molecules.

Q14. Could certain types of meditation training replicate this effect even in subjects who do not carry the COMT met/met variant i.e. could we train patients to compensate for placebo effects by long term physiological remodelling?

A: It is hard to believe that meditation would not work at all for those without met/met variant. It would only make things easier.

Q15. Would it be useful to compare the remote bio-PK ability of the two populations studied for placebo in the COMT experiment, to see if that same genetic variant may translate in a different in vitro effect size?

A: Both PK ability and placebo would involve "motor actions" of magnetic body. I however believe that the structure of hierarchy of magnetic bodies is as rich as the spectrum of neurotransmitters and other information molecules. Therefore I prefer to not answer the question!

13.7.4   IV: Biophotons in long range effects: DMILS from life precursors to biosphere; morphogenetic fields, GCP,TGD

Q16. There is some evidence for remote viewing by healer and healee. Could this be due to bio-photon emissions induced through external qi?

A: The TGD expectation differs from the usual view. Dark photons is what is relevant for remote mental interactions and sending and receiving of dark photons involves leakage as bio-photons, which are ordinary photons. Various correlations between bio-photon emissions at sending and receiving ends could serve as signature for the presence of remote mental interactions, say remote viewing and healing, say correlations of temporal patterns, correlations between energies of bio-photons, and the frequencies of dark photons manifesting as EEG frequencies. Optimistically one could even expect that the ratios of peak EEG frequencies are same as those of peak bio-photon frequencies. Healing involves visualization and this might imply that also remote viewing is induced as a side product. If pineal gland functions like a "third eye" able to remote view by using dark photons instead of ordinary ones as for lower animals, its role in all remote mental actions could be important. Could this be tested by looking at what happens in pineal gland or some other brain region during remote mental interactions? Could the ability of birds and fishes to migrate to the birth places be one spectacular example of remote mental interaction? This is discussed in more detail in Appendix.

Q18. Can one imagine any technology differentiating between memory/imagination and remote perception using bio-photon profiles.

A: In TGD framework it is surprisingly difficult to distinguish between these two since also memories and vision about future can be also seen as examples of remote viewing. If fishes and birds are able to find their birth places in the manner discussed in Appendix, one would have a rather dramatic example about remote sensory perception. Hypnosis could be seen as second dramatic example of remote mental interaction.

Q19. Is the increased photon emission at living recipients.due to a change in physiology? Or of energy/signature of entanglement. Stress related clinical research of meditation or research with focus on quantum non-locality?

A: TGD expectation would be that the emission would be basically due to leakage during communications to some parts of magnetic bodies involved. If one is ready to believe in dark photons and magnetic body, neuropharmacology of conscious experience and quantum non-locality inspired approach could be combined together. Questions to be asked would such as "What what bio-photon energy and what ELF frequency (that is h_{eff}) does a particular information molecule/neurotransmitter correspond to?" The hierarchy of Planck constants and the hierarchical anatomy of magnetic body would correlate with analogous hierarchy of information molecules and their receptors with neurotransmitters at top: this would mean also hierarchy at the level of cells with neurons at the top.

Chapter 1

Appendix

Originally this appendix was meant to be a purely technical summary of basic facts but in its recent form it tries to briefly summarize those basic visions about TGD which I dare to regarded stabilized. I have added illustrations making it easier to build mental images about what is involved and represented briefly the key arguments. This chapter is hoped to help the reader to get fast grasp about the concepts of TGD.

The basic properties of imbedding space and related spaces are discussed and the relationship of CP_2 to standard model is summarized. The notions of induction of metric and spinor connection, and of spinor structure are discussed. Many-sheeted space-time and related notions such as topological field quantization and the relationship many-sheeted space-time to that of GRT space-time are discussed as well as the recent view about induced spinor fields and the emergence of fermionic strings. Various topics related to p-adic numbers are summarized with a brief definition of p-adic manifold and the idea about generalization of the number concept by gluing real and p-adic number fields to a larger book like structure. Hierarchy of Planck constants can be now understood in terms of the non-determinism of Kähler action and the recent vision about connections to other key ideas is summarized.

A-1 Imbedding space $M^4 \times CP_2$ and related notions

Space-times are regarded as 4-surfaces in $H = M^4 \times CP_2$ the Cartesian product of empty Minkowski space - the space-time of special relativity - and compact 4-D space CP_2 with size scale of order 10^4 Planck lengths. One can say that imbedding space is obtained by replacing each point m of empty Minkowski space with 4-D tiny CP_2. The space-time of general relativity is replaced by a 4-D surface in H which has very complex topology. The notion of many-sheeted space-time gives an idea about what is involved.

Fig. 1. Imbedding space $H = M^4 \times CP_2$ as Cartesian product of Minkowski space M^4 and complex projective space CP_2. http://www.tgdtheory.fi/appfigures/Hoo.jpg

Denote by M_+^4 and M_-^4 the future and past directed lightcones of M^4. Denote their intersection, which is not unique, by CD. In zero energy ontology (ZEO) causal diamond (CD) is defined as cartesian product $CD \times CP_2$. Often I use CD to refer just to $CD \times CP_2$ since CP_2 factor is relevant from the point of view of ZEO.

Fig. 2. Future and past light-cones M_+^4 and M_-^4. Causal diamonds (CD) are defined as their intersections. http://www.tgdtheory.fi/appfigures/futurepast.jpg

Fig. 3. Causal diamond (CD) is highly analogous to Penrose diagram but simpler. http://www.tgdtheory.fi/appfigures/penrose.jpg

A rather recent discovery was that CP_2 is the only compact 4-manifold with Euclidian signature of metric allowing twistor space with Kähler structure. M^4 is in turn is the only 4-D space with Minkowskian signature of metric allowing twistor space with Kähler structure so that $H = M^4 \times CP_2$ is twistorially unique.

One can loosely say that quantum states in a given sector of "world of classical worlds" (WCW) are superpositions of space-time surfaces inside CDs and that positive and negative energy parts of zero energy states are localized and past and future boundaries of CDs. CDs form a hierarchy. One can have CDs within CDs and CDs can also overlap. The size of CD is characterized by the proper time distance between its two tips. One can perform both translations and also Lorentz boosts of CD leaving either boundary invariant. Therefore one can assign to CDs a moduli space and speak about wave function in this moduli space.

In number theoretic approach it is natural to restrict the allowed Lorentz boosts to some discrete subgroup of Lorentz group and also the distances between the tips of CDs to multiples of CP_2 radius defined by the length of its geodesic. Therefore the moduli space of CDs discretizes. The quantization of cosmic recession velocities for which there are indications, could relate to this quantization.

A-2 Basic facts about CP_2

CP_2 as a four-manifold is very special. The following arguments demonstrates that it codes for the symmetries of standard models via its isometries and holonomies.

A-2.1 CP_2 as a manifold

CP_2, the complex projective space of two complex dimensions, is obtained by identifying the points of complex 3-space C^3 under the projective equivalence

$$(z^1, z^2, z^3) \equiv \lambda(z^1, z^2, z^3) \ . \tag{A-2.1}$$

Here λ is any non-zero complex number. Note that CP_2 can be also regarded as the coset space $SU(3)/U(2)$. The pair z^i/z^j for fixed j and $z^i \neq 0$ defines a complex coordinate chart for CP_2. As j runs from 1 to 3 one obtains an atlas of three coordinate charts covering CP_2, the charts being holomorphically related to each other (e.g. CP_2 is a complex manifold). The points $z^3 \neq 0$ form a subset of CP_2 homeomorphic to R^4 and the points with $z^3 = 0$ a set homeomorphic to S^2. Therefore CP_2 is obtained by "adding the 2-sphere at infinity to R^4".

Besides the standard complex coordinates $\xi^i = z^i/z^3$, $i = 1, 2$ the coordinates of Eguchi and Freund [A29] will be used and their relation to the complex coordinates is given by

$$\begin{aligned} \xi^1 &= z + it \ , \\ \xi^2 &= x + iy \ . \end{aligned} \tag{A-2.2}$$

These are related to the "spherical coordinates" via the equations

$$\begin{aligned} \xi^1 &= r \exp(i\frac{(\Psi + \Phi)}{2}) \cos(\frac{\Theta}{2}) \ , \\ \xi^2 &= r \exp(i\frac{(\Psi - \Phi)}{2}) \sin(\frac{\Theta}{2}) \ . \end{aligned} \tag{A-2.3}$$

The ranges of the variables r, Θ, Φ, Ψ are $[0, \infty], [0, \pi], [0, 4\pi], [0, 2\pi]$ respectively.

Considered as a real four-manifold CP_2 is compact and simply connected, with Euler number Euler number 3, Pontryagin number 3 and second $b = 1$.

Fig. 4. CP_2 as manifold. `http://www.tgdtheory.fi/appfigures/cp2.jpg`

A-2.2 Metric and Kähler structure of CP_2

In order to obtain a natural metric for CP_2, observe that CP_2 can be thought of as a set of the orbits of the isometries $z^i \to exp(i\alpha)z^i$ on the sphere S^5: $\sum z^i \bar{z}^i = R^2$. The metric of CP_2 is obtained by projecting the metric of S^5 orthogonally to the orbits of the isometries. Therefore the distance between the points of CP_2 is that between the representative orbits on S^5.

The line element has the following form in the complex coordinates

$$ds^2 = g_{a\bar{b}} d\xi^a d\bar{\xi}^b \ , \tag{A-2.4}$$

where the Hermitian, in fact Kähler metric $g_{a\bar{b}}$ is defined by

$$g_{a\bar{b}} = R^2 \partial_a \partial_{\bar{b}} K \ , \tag{A-2.5}$$

where the function K, Kähler function, is defined as

$$
\begin{aligned}
K &= log(F) \ , \\
F &= 1 + r^2 \ .
\end{aligned}
\tag{A-2.6}
$$

The Kähler function for S^2 has the same form. It gives the S^2 metric $dz d\bar{z}/(1+r^2)^2$ related to its standard form in spherical coordinates by the coordinate transformation $(r, \phi) = (tan(\theta/2), \phi)$.

The representation of the CP_2 metric is deducible from S^5 metric is obtained by putting the angle coordinate of a geodesic sphere constant in it and is given

$$\frac{ds^2}{R^2} = \frac{(dr^2 + r^2\sigma_3^2)}{F^2} + \frac{r^2(\sigma_1^2 + \sigma_2^2)}{F} \ , \tag{A-2.7}$$

where the quantities σ_i are defined as

$$
\begin{aligned}
r^2\sigma_1 &= Im(\xi^1 d\xi^2 - \xi^2 d\xi^1) \ , \\
r^2\sigma_2 &= -Re(\xi^1 d\xi^2 - \xi^2 d\xi^1) \ , \\
r^2\sigma_3 &= -Im(\xi^1 d\bar{\xi}^1 + \xi^2 d\bar{\xi}^2) \ .
\end{aligned}
\tag{A-2.8}
$$

R denotes the radius of the geodesic circle of CP_2. The vierbein forms, which satisfy the defining relation

$$s_{kl} = R^2 \sum_A e_k^A e_l^A \ , \tag{A-2.9}$$

are given by

$$
\begin{aligned}
e^0 &= \frac{dr}{F} \ , & e^1 &= \frac{r\sigma_1}{\sqrt{F}} \ , \\
e^2 &= \frac{r\sigma_2}{\sqrt{F}} \ , & e^3 &= \frac{r\sigma_3}{F} \ .
\end{aligned}
\tag{A-2.10}
$$

The explicit representations of vierbein vectors are given by

$$
\begin{aligned}
e^0 &= \frac{dr}{F} \ , & e^1 &= \frac{r(sin\Theta cos\Psi d\Phi + sin\Psi d\Theta)}{2\sqrt{F}} \ , \\
e^2 &= \frac{r(sin\Theta sin\Psi d\Phi - cos\Psi d\Theta)}{2\sqrt{F}} \ , & e^3 &= \frac{r(d\Psi + cos\Theta d\Phi)}{2F} \ .
\end{aligned}
\tag{A-2.11}
$$

The explicit representation of the line element is given by the expression

$$ds^2/R^2 \quad = \quad \frac{dr^2}{F^2} + \frac{r^2}{4F^2}(d\Psi + cos\Theta d\Phi)^2 + \frac{r^2}{4F}(d\Theta^2 + sin^2\Theta d\Phi^2) \ . \tag{A-2.12}$$

The vierbein connection satisfying the defining relation

$$de^A \quad = \quad -V^A_B \wedge e^B \ , \tag{A-2.13}$$

is given by

$$
\begin{array}{llll}
V_{01} & = & -\frac{e^1}{r_2} \ , & V_{23} & = & \frac{e^1}{r_2} \ , \\
V_{02} & = & -\frac{e^2}{r} \ , & V_{31} & = & \frac{e^2}{r} \ , \\
V_{03} & = & (r - \frac{1}{r})e^3 \ , & V_{12} & = & (2r + \frac{1}{r})e^3 \ .
\end{array}
\tag{A-2.14}
$$

The representation of the covariantly constant curvature tensor is given by

$$
\begin{array}{llll}
R_{01} & = & e^0 \wedge e^1 - e^2 \wedge e^3 \ , & R_{23} & = & e^0 \wedge e^1 - e^2 \wedge e^3 \ , \\
R_{02} & = & e^0 \wedge e^2 - e^3 \wedge e^1 \ , & R_{31} & = & -e^0 \wedge e^2 + e^3 \wedge e^1 \ , \\
R_{03} & = & 4e^0 \wedge e^3 + 2e^1 \wedge e^2 \ , & R_{12} & = & 2e^0 \wedge e^3 + 4e^1 \wedge e^2 \ .
\end{array}
\tag{A-2.15}
$$

Metric defines a real, covariantly constant, and therefore closed 2-form J

$$J \quad = \quad -ig_{a\bar{b}}d\xi^a d\bar{\xi}^b \ , \tag{A-2.16}$$

the so called Kähler form. Kähler form J defines in CP_2 a symplectic structure because it satisfies the condition

$$J^k_{\ r}J^{rl} \quad = \quad -s^{kl} \ . \tag{A-2.17}$$

The form J is integer valued and by its covariant constancy satisfies free Maxwell equations. Hence it can be regarded as a curvature form of a $U(1)$ gauge potential B carrying a magnetic charge of unit $1/2g$ (g denotes the gauge coupling). Locally one has therefore

$$J \quad = \quad dB \ , \tag{A-2.18}$$

where B is the so called Kähler potential, which is not defined globally since J describes homological magnetic monopole.

It should be noticed that the magnetic flux of J through a 2-surface in CP_2 is proportional to its homology equivalence class, which is integer valued. The explicit representations of J and B are given by

$$
\begin{array}{lll}
B & = & 2re^3 \ , \\
J & = & 2(e^0 \wedge e^3 + e^1 \wedge e^2) = \frac{r}{F^2}dr \wedge (d\Psi + cos\Theta d\Phi) + \frac{r^2}{2F}sin\Theta d\Theta d\Phi \ .
\end{array}
\tag{A-2.19}
$$

The vierbein curvature form and Kähler form are covariantly constant and have in the complex coordinates only components of type (1,1).

Useful coordinates for CP_2 are the so called canonical coordinates in which Kähler potential and Kähler form have very simple expressions

$$
\begin{aligned}
B &= \sum_{k=1,2} P_k dQ_k \ , \\
J &= \sum_{k=1,2} dP_k \wedge dQ_k \ .
\end{aligned}
\tag{A-2.20}
$$

The relationship of the canonical coordinates to the "spherical" coordinates is given by the equations

$$
\begin{aligned}
P_1 &= -\frac{1}{1+r^2} \ , \\
P_2 &= \frac{r^2 cos\Theta}{2(1+r^2)} \ , \\
Q_1 &= \Psi \ , \\
Q_2 &= \Phi \ .
\end{aligned}
\tag{A-2.21}
$$

A-2.3 Spinors in CP_2

CP_2 doesn't allow spinor structure in the conventional sense [A22] . However, the coupling of the spinors to a half odd multiple of the Kähler potential leads to a respectable spinor structure. Because the delicacies associated with the spinor structure of CP_2 play a fundamental role in TGD, the arguments of Hawking are repeated here.

To see how the space can fail to have an ordinary spinor structure consider the parallel transport of the vierbein in a simply connected space M. The parallel propagation around a closed curve with a base point x leads to a rotated vierbein at x: $e^A = R^A_B e^B$ and one can associate to each closed path an element of $SO(4)$.

Consider now a one-parameter family of closed curves $\gamma(v) : v \in (0,1)$ with the same base point x and $\gamma(0)$ and $\gamma(1)$ trivial paths. Clearly these paths define a sphere S^2 in M and the element $R^A_B(v)$ defines a closed path in $SO(4)$. When the sphere S^2 is contractible to a point e.g., homologically trivial, the path in $SO(4)$ is also contractible to a point and therefore represents a trivial element of the homotopy group $\Pi_1(SO(4)) = Z_2$.

For a homologically nontrivial 2-surface S^2 the associated path in $SO(4)$ can be homotopically nontrivial and therefore corresponds to a nonclosed path in the covering group Spin(4) (leading from the matrix 1 to -1 in the matrix representation). Assume this is the case.

Assume now that the space allows spinor structure. Then one can parallel propagate also spinors and by the above construction associate a closed path of Spin(4) to the surface S^2. Now, however this path corresponds to a lift of the corresponding $SO(4)$ path and cannot be closed. Thus one ends up with a contradiction.

From the preceding argument it is clear that one could compensate the non-allowed -1- factor associated with the parallel transport of the spinor around the sphere S^2 by coupling it to a gauge potential in such a way that in the parallel transport the gauge potential introduces a compensating -1-factor. For a $U(1)$ gauge potential this factor is given by the exponential $exp(i2\Phi)$, where Φ is the magnetic flux through the surface. This factor has the value -1 provided the $U(1)$ potential carries half odd multiple of Dirac charge $1/2g$. In case of CP_2 the required gauge potential is half odd multiple of the Kähler potential B defined previously. In the case of $M^4 \times CP_2$ one can in addition couple the spinor components with different chiralities independently to an odd multiple of $B/2$.

A-2.4 Geodesic sub-manifolds of CP_2

Geodesic sub-manifolds are defined as sub-manifolds having common geodesic lines with the imbedding space. As a consequence the second fundamental form of the geodesic manifold vanishes, which means that the tangent vectors h^k_α (understood as vectors of H) are covariantly constant quantities with respect to the covariant derivative taking into account that the tangent vectors are vectors both with respect to H and X^4.

In [A16] a general characterization of the geodesic sub-manifolds for an arbitrary symmetric space G/H is given. Geodesic sub-manifolds are in 1-1-correspondence with the so called Lie triple systems of the Lie-algebra g of the group G. The Lie triple system t is defined as a subspace of g characterized by the closedness property with respect to double commutation

$$[X, [Y, Z]] \in t \text{ for } X, Y, Z \in t \ . \tag{A-2.22}$$

$SU(3)$ allows, besides geodesic lines, two nonequivalent (not isometry related) geodesic spheres. This is understood by observing that $SU(3)$ allows two nonequivalent $SU(2)$ algebras corresponding to subgroups $SO(3)$ (orthogonal 3×3 matrices) and the usual isospin group $SU(2)$. By taking any subset of two generators from these algebras, one obtains a Lie triple system and by exponentiating this system, one obtains a 2-dimensional geodesic sub-manifold of CP_2.

Standard representatives for the geodesic spheres of CP_2 are given by the equations

$$S_I^2 \ : \ \xi^1 = \bar{\xi}^2 \text{ or equivalently } (\Theta = \pi/2, \Psi = 0) \ ,$$

$$S_{II}^2 \ : \ \xi^1 = \xi^2 \text{ or equivalently } (\Theta = \pi/2, \Phi = 0) \ .$$

The non-equivalence of these sub-manifolds is clear from the fact that isometries act as holomorphic transformations in CP_2. The vanishing of the second fundamental form is also easy to verify. The first geodesic manifold is homologically trivial: in fact, the induced Kähler form vanishes identically for S_I^2. S_{II}^2 is homologically nontrivial and the flux of the Kähler form gives its homology equivalence class.

A-3 CP_2 geometry and standard model symmetries

A-3.1   Identification of the electro-weak couplings

The delicacies of the spinor structure of CP_2 make it a unique candidate for space S. First, the coupling of the spinors to the $U(1)$ gauge potential defined by the Kähler structure provides the missing $U(1)$ factor in the gauge group. Secondly, it is possible to couple different H-chiralities independently to a half odd multiple of the Kähler potential. Thus the hopes of obtaining a correct spectrum for the electromagnetic charge are considerable. In the following it will be demonstrated that the couplings of the induced spinor connection are indeed those of the GWS model [B9] and in particular that the right handed neutrinos decouple completely from the electro-weak interactions.

To begin with, recall that the space H allows to define three different chiralities for spinors. Spinors with fixed H-chirality $e = \pm 1$, CP_2-chirality l, r and M^4-chirality L, R are defined by the condition

$$\begin{aligned} \Gamma\Psi &= e\Psi \ , \\ e &= \pm 1 \ , \end{aligned} \tag{A-3.1}$$

where Γ denotes the matrix $\Gamma_9 = \gamma_5 \times \gamma_5$, $1 \times \gamma_5$ and $\gamma_5 \times 1$ respectively. Clearly, for a fixed H-chirality CP_2- and M^4-chiralities are correlated.

The spinors with H-chirality $e = \pm 1$ can be identified as quark and lepton like spinors respectively. The separate conservation of baryon and lepton numbers can be understood as a consequence of generalized chiral invariance if this identification is accepted. For the spinors with a definite H-chirality one can identify the vielbein group of CP_2 as the electro-weak group: $SO(4) = SU(2)_L \times SU(2)_R$.

The covariant derivatives are defined by the spinorial connection

$$A \ = \ V + \frac{B}{2}(n_+ 1_+ + n_- 1_-) \ . \tag{A-3.2}$$

Here V and B denote the projections of the vielbein and Kähler gauge potentials respectively and $1_{+(-)}$ projects to the spinor H-chirality $+(-)$. The integers $n_\pm$ are odd from the requirement of a respectable spinor structure.

The explicit representation of the vielbein connection V and of B are given by the equations

$$
\begin{aligned}
V_{01} &= -\frac{e^1}{r_2} , & V_{23} &= \frac{e^1}{r_2} , \\
V_{02} &= -\frac{e^2}{r} , & V_{31} &= \frac{e^2}{r} , \\
V_{03} &= (r - \tfrac{1}{r})e^3 , & V_{12} &= (2r + \tfrac{1}{r})e^3 ,
\end{aligned}
\tag{A-3.3}
$$

and

$$
B = 2re^3 ,
\tag{A-3.4}
$$

respectively. The explicit representation of the vielbein is not needed here.

Let us first show that the charged part of the spinor connection couples purely left handedly. Identifying Σ_3^0 and Σ_2^1 as the diagonal (neutral) Lie-algebra generators of $SO(4)$, one finds that the charged part of the spinor connection is given by

$$
A_{ch} = 2V_{23}I_L^1 + 2V_{13}I_L^2 ,
\tag{A-3.5}
$$

where one have defined

$$
\begin{aligned}
I_L^1 &= \frac{(\Sigma_{01} - \Sigma_{23})}{2} , \\
I_L^2 &= \frac{(\Sigma_{02} - \Sigma_{13})}{2} .
\end{aligned}
\tag{A-3.6}
$$

A_{ch} is clearly left handed so that one can perform the identification

$$
W^\pm = \frac{2(e^1 \pm ie^2)}{r} ,
\tag{A-3.7}
$$

where $W^\pm$ denotes the charged intermediate vector boson.

Consider next the identification of the neutral gauge bosons γ and Z^0 as appropriate linear combinations of the two functionally independent quantities

$$
\begin{aligned}
X &= re^3 , \\
Y &= \frac{e^3}{r} ,
\end{aligned}
\tag{A-3.8}
$$

appearing in the neutral part of the spinor connection. We show first that the mere requirement that photon couples vectorially implies the basic coupling structure of the GWS model leaving only the value of Weinberg angle undetermined.

To begin with let us define

$$
\begin{aligned}
\bar{\gamma} &= aX + bY , \\
\bar{Z}^0 &= cX + dY ,
\end{aligned}
\tag{A-3.9}
$$

where the normalization condition

$$
ad - bc = 1 ,
$$

is satisfied. The physical fields γ and Z^0 are related to $\bar{\gamma}$ and $\bar{Z}^0$ by simple normalization factors.

Expressing the neutral part of the spinor connection in term of these fields one obtains

$$A_{nc} = [(c+d)2\Sigma_{03} + (2d-c)2\Sigma_{12} + d(n_+1_+ + n_-1_-)]\bar{\gamma}$$
$$+ [(a-b)2\Sigma_{03} + (a-2b)2\Sigma_{12} - b(n_+1_+ + n_-1_-)]\bar{Z}^0 \ .$$

$$\text{(A-3.10)}$$

Identifying Σ_{12} and $\Sigma_{03} = 1 \times \gamma_5 \Sigma_{12}$ as vectorial and axial Lie-algebra generators, respectively, the requirement that γ couples vectorially leads to the condition

$$c = -d \ . \tag{A-3.11}$$

Using this result plus previous equations, one obtains for the neutral part of the connection the expression

$$A_{nc} = \gamma Q_{em} + Z^0(I_L^3 - sin^2\theta_W Q_{em}) \ . \tag{A-3.12}$$

Here the electromagnetic charge Q_{em} and the weak isospin are defined by

$$Q_{em} = \Sigma^{12} + \frac{(n_+1_+ + n_-1_-)}{6} \ ,$$
$$I_L^3 = \frac{(\Sigma^{12} - \Sigma^{03})}{2} \ . \tag{A-3.13}$$

The fields γ and Z^0 are defined via the relations

$$\gamma = 6d\bar{\gamma} = \frac{6}{(a+b)}(aX + bY) \ ,$$
$$Z^0 = 4(a+b)\bar{Z}^0 = 4(X - Y) \ . \tag{A-3.14}$$

The value of the Weinberg angle is given by

$$sin^2\theta_W = \frac{3b}{2(a+b)} \ , \tag{A-3.15}$$

and is not fixed completely. Observe that right handed neutrinos decouple completely from the electro-weak interactions.

The determination of the value of Weinberg angle is a dynamical problem. The angle is completely fixed once the YM action is fixed by requiring that action contains no cross term of type γZ^0. Pure symmetry non-broken electro-weak YM action leads to a definite value for the Weinberg angle. One can however add a symmetry breaking term proportional to Kähler action and this changes the value of the Weinberg angle.

To evaluate the value of the Weinberg angle one can express the neutral part F_{nc} of the induced gauge field as

$$F_{nc} = 2R_{03}\Sigma^{03} + 2R_{12}\Sigma^{12} + J(n_+1_+ + n_-1_-) \ , \tag{A-3.16}$$

where one has

$$R_{03} = 2(2e^0 \wedge e^3 + e^1 \wedge e^2) \ ,$$
$$R_{12} = 2(e^0 \wedge e^3 + 2e^1 \wedge e^2) \ ,$$
$$J = 2(e^0 \wedge e^3 + e^1 \wedge e^2) \ , \tag{A-3.17}$$

in terms of the fields γ and Z^0 (photon and Z- boson)

$$F_{nc} = \gamma Q_{em} + Z^0(I_L^3 - sin^2\theta_W Q_{em}) \ . \tag{A-3.18}$$

Evaluating the expressions above one obtains for γ and Z^0 the expressions

$$\begin{aligned} \gamma &= 3J - sin^2\theta_W R_{03} \ , \\ Z^0 &= 2R_{03} \ . \end{aligned} \tag{A-3.19}$$

For the Kähler field one obtains

$$J = \frac{1}{3}(\gamma + sin^2\theta_W Z^0) \ . \tag{A-3.20}$$

Expressing the neutral part of the symmetry broken YM action

$$\begin{aligned} L_{ew} &= L_{sym} + fJ^{\alpha\beta}J_{\alpha\beta} \ , \\ L_{sym} &= \frac{1}{4g^2}Tr(F^{\alpha\beta}F_{\alpha\beta}) \ , \end{aligned} \tag{A-3.21}$$

where the trace is taken in spinor representation, in terms of γ and Z^0 one obtains for the coefficient X of the γZ^0 cross term (this coefficient must vanish) the expression

$$\begin{aligned} X &= -\frac{K}{2g^2} + \frac{fp}{18} \ , \\ K &= Tr\left[Q_{em}(I_L^3 - sin^2\theta_W Q_{em})\right] \ , \end{aligned} \tag{A-3.22}$$

In the general case the value of the coefficient K is given by

$$K = \sum_i \left[-\frac{(18 + 2n_i^2)sin^2\theta_W}{9}\right] \ , \tag{A-3.23}$$

where the sum is over the spinor chiralities, which appear as elementary fermions and n_i is the integer describing the coupling of the spinor field to the Kähler potential. The cross term vanishes provided the value of the Weinberg angle is given by

$$sin^2\theta_W = \frac{9\sum_i 1}{(fg^2 + 2\sum_i(18 + n_i^2))} \ . \tag{A-3.24}$$

In the scenario where both leptons and quarks are elementary fermions the value of the Weinberg angle is given by

$$sin^2\theta_W = \frac{9}{(\frac{fg^2}{2} + 28)} \ . \tag{A-3.25}$$

The bare value of the Weinberg angle is 9/28 in this scenario, which is quite close to the typical value 9/24 of GUTs [B15] .

A-3.2 Discrete symmetries

The treatment of discrete symmetries C, P, and T is based on the following requirements:

1. Symmetries must be realized as purely geometric transformations.

2. Transformation properties of the field variables should be essentially the same as in the conventional quantum field theories [B5] .

The action of the reflection P on spinors of is given by

$$\Psi \quad \rightarrow \quad P\Psi = \gamma^0 \otimes \gamma^0 \Psi \ . \tag{A-3.26}$$

in the representation of the gamma matrices for which γ^0 is diagonal. It should be noticed that W and Z^0 bosons break parity symmetry as they should since their charge matrices do not commute with the matrix of P.

The guess that a complex conjugation in CP_2 is associated with T transformation of the physicist turns out to be correct. One can verify by a direct calculation that pure Dirac action is invariant under T realized according to

$$
\begin{aligned}
m^k &\rightarrow T(M^k) \ , \\
\xi^k &\rightarrow \bar{\xi}^k \ , \\
\Psi &\rightarrow \gamma^1\gamma^3 \otimes 1\Psi \ .
\end{aligned}
\tag{A-3.27}
$$

The operation bearing closest resemblance to the ordinary charge conjugation corresponds geometrically to complex conjugation in CP_2:

$$
\begin{aligned}
\xi^k &\rightarrow \bar{\xi}^k \ , \\
\Psi &\rightarrow \Psi^\dagger \gamma^2\gamma^0 \otimes 1 \ .
\end{aligned}
\tag{A-3.28}
$$

As one might have expected symmetries CP and T are exact symmetries of the pure Dirac action.

A-4 The relationship of TGD to QFT and string models

TGD could be seen as a generalization of quantum field theory (string models) obtained by replacing pointlike particles (strings) as fundamental objects with 3-surfaces.

Fig. 5. TGD replaces point-like particles with 3-surfaces. http://www.tgdtheory.fi/appfigures/particletgd.jpg

The fact that light-like 3-surfaces are effectively metrically 2-dimensional and thus possess generalization of 2-dimensional conformal symmetries with light-like radial coordinate defining the analog of second complex coordinate suggests that this generalization could work and extend the super-conformal symmetries to their 4-D analogs.

The boundary $\delta M_+^4 = S^2 \times R_+$- of 4-D light-cone M_+^4 is also metrically 2-dimensional and allows extended conformal invariance. Also the group of isometries of light-cone boundary and of light-like 3-surfaces is infinite-dimensional since the conformal scalings of S^2 can be compensated by S^2-local scaling of the light-like radial coordinate of R_+. These simple facts mean that 4-dimensional Minkowski space and 4-dimensional space-time surfaces are in completely unique position as far as symmetries are considered.

String like objects obtained as deformations of cosmic strings $X^2 \times Y^2$, where X^2 is minimal surface in M^4 and Y^2 a holomorphic surface of CP_2 are fundamental extremals of Kähler action having string world sheet as M^4 projections. Cosmic strings dominate the primordial cosmology of TGD Universe and inflationary period corresponds to the transition to radiation dominated cosmology for which space-time sheets with 4-D M^4 projection dominate.

Also genuine string like objects emerge from TGD. The conditions that the em charge of modes of induces spinor fields is well-defined requires in the generic case the localization of the modes

at 2-D surfaces -string world sheets and possibly also partonic 2-surfaces. This in Minkowskian space-time regions.

Fig. 6. Well-definedness of em charge forces the localization of induced spinor modes to 2-D surfaces in generic situtation in Minkowskian regions of space-time surface. `http://www.tgdtheory.fi/appfigures/fermistring.jpg`

TGD based view about elementary particles has two aspects.

1. The space-time correlates of elementary particles are identified as pairs of wormhole contacts with Euclidian signature of metric and having 4-D CP_2 projection. Their throats behave effectively as Kähler magnetic monopoles so that wormhole throats must be connected by Kähler magnetic flux tubes with monopole flux so that closed flux tubes are obtained.

2. Fermion number is carried by the modes of the induced spinor field. In Minkowskian space-time regions the modes are localized at string world sheets connecting the wormhole contacts.

Fig. 7. TGD view about elementary particles. a) Particle corresponds 4-D generalization of world line or b) with its light-like 3-D boundary (holography). c) Particle world lines have Euclidian signature of the induced metric. d) They can be identified as wormhole contacts. e) The throats of wormhole contacs carry effective Kähler magnetic charges so that wormhole contacts must appear as pairs in order to obtain closed flux tubes. f) Wormhole contacts are accompnied by fermionic strings connecting the throats at same sheet: the strings do not extend inside the wormhole contacts. `http://www.tgdtheory.fi/appfigures/elparticletgd.jpg`

Particle interactions involve both stringy and QFT aspects.

1. The boundaries of string world sheets correspond to fundamental fermions. This gives rise to massless propagator lines in generalized Feynman diagrammatics. One can speak of "long" string connecting wormhole contacts and having hadronic string as physical counterpart. Long strings should be distinguished from wormhole contacts which due to their superconformal invariance behave like "short" strings with length scale given by CP_2 size, which is 10^4 times longer than Planck scale characterizing strings in string models.

2. Wormhole contact defines basic stringy interaction vertex for fermion-fermion scattering. The propagator is essentially the inverse of the superconformal scaling generator L_0. Wormhole contacts containing fermion and antifermion at its opposite throats beheave like virtual bosons so that one has BFF type vertices typically.

3. In topological sense one has 3-vertices serving as generalizations of 3-vertices of Feynman diagrams. In these vertices 4-D "lines" of generalized Feynman diagrams meet along their 3-D ends. One obtains also the analogs of stringy diagrams but stringy vertices do not have the usual interpretation in terms of particle decays but in terms of propagation of particle along two different routes.

Fig. 8. a) TGD analogs of Feynman and string diagrammatics at the level of space-time topology. b) The 4-D analogs of both string diagrams and QFT diagrams appear but the interpretation of the analogs stringy diagrams is different. `http://www.tgdtheory.fi/appfigures/tgdgraphs.jpg`

A-5   Induction procedure and many-sheeted space-time

Since the classical gauge fields are closely related in TGD framework, it is not possible to have space-time sheets carrying only single kind of gauge field. For instance, em fields are accompanied by Z^0 fields for extremals of Kähler action.

Classical em fields are always accompanied by Z^0 field and some components of color gauge field. For extremals having homologically non-trivial sphere as a CP_2 projection em and Z^0 fields are the only non-vanishing electroweak gauge fields. For homologically trivial sphere only W fields are non-vanishing. Color rotations does not affect the situation.

For vacuum extremals all electro-weak gauge fields are in general non-vanishing although the net gauge field has U(1) holonomy by 2-dimensionality of the CP_2 projection. Color gauge field

has $U(1)$ holonomy for all space-time surfaces and quantum classical correspondence suggest a weak form of color confinement meaning that physical states correspond to color neutral members of color multiplets.

Induction procedure for gauge fields

Induction procedure for gauge potentials and spinor structure is a standard procedure of bundle theory. If one has imbedding of some manifold to the base space of a bundle, the bundle structure can be induced so that it has as base space the imbedded manifold. In the recent case the imbedding of space-time surface to imbedding space defines the induction procedure. The induce gauge potentials and gauge fields are projections of the spinor connection of the imbedding space to the space-time surface. Induction procedure makes sense also for the spinor fields of imbedding space and one obtains geometrization of both electroweak gauge potentials and of spinors.

Fig. 9. Induction of spinor connection and metric as projection to the space-time surface. `http://www.tgdtheory.fi/appfigures/induct.jpg`

Induced gauge fields for space-times for which CP$_2$ projection is a geodesic sphere

If one requires that space-time surface is an extremal of Kähler action and has a 2-dimensional CP$_2$ projection, only vacuum extremals and space-time surfaces for which CP$_2$ projection is a geodesic sphere, are allowed. Homologically non-trivial geodesic sphere correspond to vanishing W fields and homologically non-trivial sphere to non-vanishing W fields but vanishing γ and Z^0. This can be verified by explicit examples.

$r = \infty$ surface gives rise to a homologically non-trivial geodesic sphere for which e_0 and e_3 vanish imply the vanishing of W field. For space-time sheets for which CP$_2$ projection is $r = \infty$ homologically non-trivial geodesic sphere of CP_2 one has

$$\gamma = (\frac{3}{4} - \frac{sin^2(\theta_W)}{2})Z^0 \simeq \frac{5Z^0}{8} \quad .$$

The induced W fields vanish in this case and they vanish also for all geodesic sphere obtained by $SU(3)$ rotation.

$Im(\xi^1) = Im(\xi^2) = 0$ corresponds to homologically trivial geodesic sphere. A more general representative is obtained by using for the phase angles of standard complex CP_2 coordinates constant values. In this case e^1 and e^3 vanish so that the induced em, Z^0, and Kähler fields vanish but induced W fields are non-vanishing. This holds also for surfaces obtained by color rotation. Hence one can say that for non-vacuum extremals with 2-D CP$_2$ projection color rotations and weak symmetries commute.

A-5.1 Many-sheeted space-time

TGD space-time is many-sheeted: in other words, there are in general several space-sheets which have projection to the same M^4 region. Second manner to say this is that CP_2 coordinates are many-valued functions of M^4 coordinates. The original physical interpretation of many-sheeted space-time time was not correct: it was assumed that single sheet corresponds to GRT space-time and this obviously leads to difficulties since the induced gauge fields are expressible in terms of only four imbedding space coordinates.

Fig. 10. Illustration of many-sheeted space-time of TGD. `http://www.tgdtheory.fi/appfigures/manysheeted.jpg`

Superposition of effects instead of superposition of fields

The first objection against TGD is that superposition is not possible for induced gauge fields and induced metric. The resolution of the problem is that it is effects which need to superpose, not the fields.

Test particle topologically condenses simultaneously to all space-time sheets having a projection to same region of M^4 (that is touches them). The superposition of effects of fields at various space-time sheets replaces the superposition of fields.This is crucial for the understanding also how GRT space-time relates to TGD space-time, which is also in the appendix of this book).

Wormhole contacts

Wormhole contacts are key element of many-sheeted space-time. One does not expect them to be stable unless there is non-trivial Kähler magnetic flux flowing through then so that the throats look like Kähler magnetic monopoles.

Fig. 11. Wormhole contact. `http://www.tgdtheory.fi/appfigures/wormholecontact.jpg`

Since the flow lines of Kähler magnetic field must be closed this requires the presence of another wormhole contact so that one obtains closed monopole flux tube decomposing to two Minkowskian pieces at the two space-time sheets involved and two wormhole contacts with Euclidian signature of the induced metric. These objects are identified as space-time correlates of elementary particles and are clearly analogous to string like objects.

The relationship between the many-sheeted space-time of TGD and of GRT space-time

The space-time of general relativity is single-sheeted and there is no need to regard it as surface in H although the assumption about representability as vacuum extremal gives very powerful constraints in cosmology and astrophysics and might make sense in simple situations.

The space-time of GRT can be regarded as a long length scale approximation obtained by lumping together the sheets of the many-sheeted space-time to a region of M^4 and providing it with an effective metric obtained as sum of M^4 metric and deviations of the induced metrics of various space-time sheets from M^4 metric. Also induced gauge potentials sum up in the similar manner so that also the gauge fields of gauge theories would not be fundamental fields.

Fig. 12. The superposition of fields is replaced with the superposition of their effects in many-sheeted space-time. `http://www.tgdtheory.fi/appfigures/fieldsuperpose.jpg`

Space-time surfaces of TGD are considerably simpler objects that the space-times of general relativity and relate to GRT space-time like elementary particles to systems of condensed matter physics. Same can be said about fields since all fields are expressible in terms of imbedding space coordinates and their gradients, and general coordinate invariance means that the number of bosonic field degrees is reduced locally to 4. TGD space-time can be said to be a microscopic description whereas GRT space-time a macroscopic description. In TGD complexity of space-time topology replaces the complexity due to large number of fields in quantum field theory.

Topological field quantization and the notion of magnetic body

Topological field quantization also TGD from Maxwell's theory. TGD predicts topological light rays ("massless extremals (MEs)) as space-time sheets carrying waves or arbitrary shape propagating with maximal signal velocity in single direction only and analogous to laser beams and carrying light-like gauge currents in the generi case. There are also magnetic flux quanta and electric flux quanta. The deformations of cosmic strings with 2-D string orbit as M^4 projection gives rise to magnetic flux tubes carrying monopole flux made possible by CP_2 topology allowing homological Kähler magnetic monopoles.

Fig. 13. Topological quantization for magnetic fields replaces magnetic fields with bundles of them defining flux tubes as topological field quanta. `http://www.tgdtheory.fi/appfigures/field.jpg`

The imbeddability condition for say magnetic field means that the region containing constant magnetic field splits into flux quanta, say tubes and sheets carrying constant magnetic field. Unless one assumes a separate boundary term in Kähler action, boundaries in the usual sense are forbidden except as ends of space-time surfaces at the boundaries of causal diamonds. One obtains typically pairs of sheets glued together along their boundaries giving rise to flux tubes with closed cross section possibly carrying monopole flux.

These kind of flux tubes might make possible magnetic fields in cosmic scales already during primordial period of cosmology since no currents are needed to generate these magnetic fields: cosmic string would be indeed this kind of objects and would dominated during the primordial period. Even superconductors and maybe even ferromagnets could involve this kind of monopole flux tubes.

A-5.2 Imbedding space spinors and induced spinors

One can geometrize also fermionic degrees of freedom by inducing the spinor structure of $M^4 \times CP_2$.

CP_2 does not allow spinor structure in the ordinary sense but one can couple the opposite H-chiralities of H-spinors to an $n = 1$ ($n = 3$) integer multiple of Kähler gauge potential to obtain a respectable modified spinor structure. The em charges of resulting spinors are fractional (integer valued) and the interpretation as quarks (leptons) makes sense since the couplings to the induced spinor connection having interpretation in terms electro-weak gauge potential are identical to those assumed in standard model.

The notion of quark color differs from that of standard model.

1. Spinors do not couple to color gauge potential although the identification of color gauge potential as projection of $SU(3)$ Killing vector fields is possible. This coupling must emerge only at the effective gauge theory limit of TGD.

2. Spinor harmonics of imbedding space correspond to triality $t = 1$ ($t = 0$) partial waves. The detailed correspondence between color and electroweak quantum numbers is however not correct as such and the interpretation of spinor harmonics of imbedding space is as representations for ground states of super-conformal representations. The wormhole pairs associated with physical quarks and leptons must carry also neutrino pair to neutralize weak quantum numbers above the length scale of flux tube (weak scale or Compton length). The total color quantum numbers or these states must be those of standard model. For instance, the color quantum numbers of fundamental left-hand neutrino and lepton can compensate each other for the physical lepton. For fundamental quark-lepton pair they could sum up to those of physical quark.

The well-definedness of em charge is crucial condition.

1. Although the imbedding space spinor connection carries W gauge potentials one can say that the imbedding space spinor modes have well-defined em charge. One expects that this is true for induced spinor fields inside wormhole contacts with 4-D CP_2 projection and Euclidian signature of the induced metric.

2. The situation is not the same for the modes of induced spinor fields inside Minkowskian region and one must require that the CP_2 projection of the regions carrying induced spinor field is such that the induced W fields and above weak scale also the induced Z^0 fields vanish in order to avoid large parity breaking effects. This condition forces the CP_2 projection to be 2-dimensional. For a generic Minkowskian space-time region this is achieved only if the spinor modes are localized at 2-D surfaces of space-time surface - string world sheets and possibly also partonic 2-surfaces.

3. Also the Kähler-Dirac gamma matrices appearing in the modified Dirac equation must vanish in the directions normal to the 2-D surface in order that Kähler-Dirac equation can be satisfied. This does not seem plausible for space-time regions with 4-D CP_2 projection.

4. One can thus say that strings emerge from TGD in Minkowskian space-time regions. In particular, elementary particles are accompanied by a pair of fermionic strings at the opposite space-time sheets and connecting wormhole contacts. Quite generally, fundamental fermions would propagate at the boundaries of string world sheets as massless particles and wormhole contacts would define the stringy vertices of generalized Feynman diagrams. One obtains geometrized diagrammatics, which brings looks like a combination of stringy and Feynman diagrammatics.

5. This is what happens in the the generic situation. Cosmic strings could serve as examples about surfaces with 2-D CP_2 projection and carrying only em fields and allowing delocalization of spinor modes to the entire space-time surfaces.

A-5.3 Space-time surfaces with vanishing em, Z^0, or Kähler fields

In the following the induced gauge fields are studied for general space-time surface without assuming the extremal property. In fact, extremal property reduces the study to the study of vacuum extremals and surfaces having geodesic sphere as a CP_2 projection and in this sense the following arguments are somewhat obsolete in their generality.

Space-times with vanishing em, Z^0, or Kähler fields

The following considerations apply to a more general situation in which the homologically trivial geodesic sphere and extremal property are not assumed. It must be emphasized that this case is possible in TGD framework only for a vanishing Kähler field.

Using spherical coordinates (r, Θ, Ψ, Φ) for CP_2, the expression of Kähler form reads as

$$
\begin{aligned}
J &= \frac{r}{F^2} dr \wedge (d\Psi + cos(\Theta)d\Phi) + \frac{r^2}{2F} sin(\Theta)d\Theta \wedge d\Phi \ , \\
F &= 1 + r^2 \ .
\end{aligned}
\tag{A-5.1}
$$

The general expression of electromagnetic field reads as

$$
\begin{aligned}
F_{em} &= (3 + 2p)\frac{r}{F^2} dr \wedge (d\Psi + cos(\Theta)d\Phi) + (3 + p)\frac{r^2}{2F} sin(\Theta)d\Theta \wedge d\Phi \ , \\
p &= sin^2(\Theta_W) \ ,
\end{aligned}
\tag{A-5.2}
$$

where Θ_W denotes Weinberg angle.

1. The vanishing of the electromagnetic fields is guaranteed, when the conditions

$$
\begin{aligned}
\Psi &= k\Phi \ , \\
(3 + 2p)\frac{1}{r^2 F}(d(r^2)/d\Theta)(k + cos(\Theta)) &+ (3 + p)sin(\Theta) = 0 \ ,
\end{aligned}
\tag{A-5.3}
$$

hold true. The conditions imply that CP_2 projection of the electromagnetically neutral space-time is 2-dimensional. Solving the differential equation one obtains

$$
\begin{aligned}
r &= \sqrt{\frac{X}{1 - X}} \ , \\
X &= D \left[|\frac{(k + u)}{C}| \right]^\epsilon \ , \\
u &\equiv cos(\Theta) \ , \quad C = k + cos(\Theta_0) \ , \quad D = \frac{r_0^2}{1 + r_0^2} \ , \quad \epsilon = \frac{3 + p}{3 + 2p} \ ,
\end{aligned}
\tag{A-5.4}
$$

where C and D are integration constants. $0 \le X \le 1$ is required by the reality of r. $r = 0$ would correspond to $X = 0$ giving $u = -k$ achieved only for $|k| \le 1$ and $r = \infty$ to $X = 1$ giving $|u + k| = [(1 + r_0^2)/r_0^2]^{(3+2p)/(3+p)}$ achieved only for

$$
sign(u + k) \times [\frac{1 + r_0^2}{r_0^2}]^{\frac{3+2p}{3+p}} \le k + 1 \ ,
$$

where $sign(x)$ denotes the sign of x.

The expressions for Kähler form and Z^0 field are given by

$$J = -\frac{p}{3+2p}X du \wedge d\Phi \ ,$$
$$Z^0 = -\frac{6}{p}J \ . \tag{A-5.5}$$

The components of the electromagnetic field generated by varying vacuum parameters are proportional to the components of the Kähler field: in particular, the magnetic field is parallel to the Kähler magnetic field. The generation of a long range Z^0 vacuum field is a purely TGD based feature not encountered in the standard gauge theories.

2. The vanishing of Z^0 fields is achieved by the replacement of the parameter ϵ with $\epsilon = 1/2$ as becomes clear by considering the condition stating that Z^0 field vanishes identically. Also the relationship $F_{em} = 3J = -\frac{3}{4}\frac{r^2}{F}du \wedge d\Phi$ is useful.

3. The vanishing Kähler field corresponds to $\epsilon = 1, p = 0$ in the formula for em neutral space-times. In this case classical em and Z^0 fields are proportional to each other:

$$Z^0 = 2e^0 \wedge e^3 = \frac{r}{F^2}(k+u)\frac{\partial r}{\partial u}du \wedge d\Phi = (k+u)du \wedge d\Phi \ ,$$
$$r = \sqrt{\frac{X}{1-X}} \ , \quad X = D|k+u| \ ,$$
$$\gamma = -\frac{p}{2}Z^0 \ . \tag{A-5.6}$$

For a vanishing value of Weinberg angle ($p = 0$) em field vanishes and only Z^0 field remains as a long range gauge field. Vacuum extremals for which long range Z^0 field vanishes but em field is non-vanishing are not possible.

The effective form of CP_2 metric for surfaces with 2-dimensional CP_2 projection

The effective form of the CP_2 metric for a space-time having vanishing em,Z^0, or Kähler field is of practical value in the case of vacuum extremals and is given by

$$ds^2_{eff} = (s_{rr}(\frac{dr}{d\Theta})^2 + s_{\Theta\Theta})d\Theta^2 + (s_{\Phi\Phi} + 2ks_{\Phi\Psi})d\Phi^2 = \frac{R^2}{4}[s^{eff}_{\Theta\Theta}d\Theta^2 + s^{eff}_{\Phi\Phi}d\Phi^2] \ ,$$
$$s^{eff}_{\Theta\Theta} = X \times \left[\frac{\epsilon^2(1-u^2)}{(k+u)^2} \times \frac{1}{1-X} + 1 - X\right] \ ,$$
$$s^{eff}_{\Phi\Phi} = X \times \left[(1-X)(k+u)^2 + 1 - u^2\right] \ , \tag{A-5.7}$$

and is useful in the construction of vacuum imbedding of, say Schwartchild metric.

Topological quantum numbers

Space-times for which either em, Z^0, or Kähler field vanishes decompose into regions characterized by six vacuum parameters: two of these quantum numbers (ω_1 and ω_2) are frequency type parameters, two (k_1 and k_2) are wave vector like quantum numbers, two of the quantum numbers (n_1 and n_2) are integers. The parameters ω_i and n_i will be referred as electric and magnetic quantum numbers. The existence of these quantum numbers is not a feature of these solutions alone but represents a much more general phenomenon differentiating in a clear cut manner between TGD and Maxwell's electrodynamics.

The simplest manner to avoid surface Kähler charges and discontinuities or infinities in the derivatives of CP_2 coordinates on the common boundary of two neighboring regions with different vacuum quantum numbers is topological field quantization, 3-space decomposes into disjoint topological field quanta, 3-surfaces having outer boundaries with possibly macroscopic size.

Under rather general conditions the coordinates Ψ and Φ can be written in the form

$$
\begin{aligned}
\Psi &= \omega_2 m^0 + k_2 m^3 + n_2 \phi + \text{Fourier expansion} \;, \\
\Phi &= \omega_1 m^0 + k_1 m^3 + n_1 \phi + \text{Fourier expansion} \;.
\end{aligned}
\tag{A-5.8}
$$

m^0, m^3 and ϕ denote the coordinate variables of the cylindrical M^4 coordinates) so that one has $k = \omega_2/\omega_1 = n_2/n_1 = k_2/k_1$. The regions of the space-time surface with given values of the vacuum parameters ω_i, k_i and n_i and m and C are bounded by the surfaces at which space-time surface becomes ill-defined, say by $r > 0$ or $r < \infty$ surfaces.

The space-time surface decomposes into regions characterized by different values of the vacuum parameters r_0 and Θ_0. At $r = \infty$ surfaces n_2, ω_2 and m can change since all values of Ψ correspond to the same point of CP_2: at $r = 0$ surfaces also n_1 and ω_1 can change since all values of Φ correspond to same point of CP_2, too. If $r = 0$ or $r = \infty$ is not in the allowed range space-time surface develops a boundary.

This implies what might be called topological quantization since in general it is not possible to find a smooth global imbedding for, say a constant magnetic field. Although global imbedding exists it decomposes into regions with different values of the vacuum parameters and the coordinate u in general possesses discontinuous derivative at $r = 0$ and $r = \infty$ surfaces. A possible manner to avoid edges of space-time is to allow field quantization so that 3-space (and field) decomposes into disjoint quanta, which can be regarded as structurally stable units a 3-space (and of the gauge field). This doesn't exclude partial join along boundaries for neighboring field quanta provided some additional conditions guaranteeing the absence of edges are satisfied.

For instance, the vanishing of the electromagnetic fields implies that the condition

$$
\Omega \equiv \frac{\omega_2}{n_2} - \frac{\omega_1}{n_1} = 0 \;,
\tag{A-5.9}
$$

is satisfied. In particular, the ratio ω_2/ω_1 is rational number for the electromagnetically neutral regions of space-time surface. The change of the parameter n_1 and n_2 (ω_1 and ω_2) in general generates magnetic field and therefore these integers will be referred to as magnetic (electric) quantum numbers.

A-6   p-Adic numbers and TGD

A-6.1   p-Adic number fields

p-Adic numbers (p is prime: 2,3,5,...) can be regarded as a completion of the rational numbers using a norm, which is different from the ordinary norm of real numbers [A7] . p-Adic numbers are representable as power expansion of the prime number p of form

$$
x = \sum_{k \geq k_0} x(k) p^k, \; x(k) = 0, ..., p-1 \;.
\tag{A-6.1}
$$

The norm of a p-adic number is given by

$$
|x| = p^{-k_0(x)} \;.
\tag{A-6.2}
$$

Here $k_0(x)$ is the lowest power in the expansion of the p-adic number. The norm differs drastically from the norm of the ordinary real numbers since it depends on the lowest pinary digit of the p-adic number only. Arbitrarily high powers in the expansion are possible since the norm of the p-adic number is finite also for numbers, which are infinite with respect to the ordinary norm. A convenient representation for p-adic numbers is in the form

$$
x = p^{k_0} \varepsilon(x) \;,
\tag{A-6.3}
$$

where $\varepsilon(x) = k + ...$ with $0 < k < p$, is p-adic number with unit norm and analogous to the phase factor $exp(i\phi)$ of a complex number.

The distance function $d(x, y) = |x - y|_p$ defined by the p-adic norm possesses a very general property called ultra-metricity:

$$d(x, z) \quad \leq \quad max\{d(x, y), d(y, z)\} \quad . \tag{A-6.4}$$

The properties of the distance function make it possible to decompose R_p into a union of disjoint sets using the criterion that x and y belong to same class if the distance between x and y satisfies the condition

$$d(x, y) \quad \leq \quad D \quad . \tag{A-6.5}$$

This division of the metric space into classes has following properties:

1. Distances between the members of two different classes X and Y do not depend on the choice of points x and y inside classes. One can therefore speak about distance function between classes.

2. Distances of points x and y inside single class are smaller than distances between different classes.

3. Classes form a hierarchical tree.

Notice that the concept of the ultra-metricity emerged in physics from the models for spin glasses and is believed to have also applications in biology [B12] . The emergence of p-adic topology as the topology of the effective space-time would make ultra-metricity property basic feature of physics.

A-6.2   Canonical correspondence between p-adic and real numbers

The basic challenge encountered by p-adic physicist is how to map the predictions of the p-adic physics to real numbers. p-Adic probabilities provide a basic example in this respect. Identification via common rationals and canonical identification and its variants have turned out to play a key role in this respect.

Basic form of canonical identification

There exists a natural continuous map $I : R_p \to R_+$ from p-adic numbers to non-negative real numbers given by the "pinary" expansion of the real number for $x \in R$ and $y \in R_p$ this correspondence reads

$$\begin{aligned} y &= \sum_{k>N} y_k p^k \to x = \sum_{k<N} y_k p^{-k} \quad , \\ y_k &\in \{0, 1, .., p-1\} \quad . \end{aligned} \tag{A-6.6}$$

This map is continuous as one easily finds out. There is however a little difficulty associated with the definition of the inverse map since the pinary expansion like also decimal expansion is not unique $(1 = 0.999...)$ for the real numbers x, which allow pinary expansion with finite number of pinary digits

$$\begin{aligned} x &= \sum_{k=N_0}^{N} x_k p^{-k} \quad , \\ x &= \sum_{k=N_0}^{N-1} x_k p^{-k} + (x_N - 1)p^{-N} + (p-1)p^{-N-1} \sum_{k=0,..} p^{-k} \quad . \end{aligned}$$
$$\tag{A-6.7}$$

The p-adic images associated with these expansions are different

$$
\begin{aligned}
y_1 &= \sum_{k=N_0}^{N} x_k p^k \ , \\
y_2 &= \sum_{k=N_0}^{N-1} x_k p^k + (x_N - 1)p^N + (p-1)p^{N+1} \sum_{k=0,..} p^k \\
&= y_1 + (x_N - 1)p^N - p^{N+1} \ ,
\end{aligned}
\tag{A-6.8}
$$

so that the inverse map is either two-valued for p-adic numbers having expansion with finite pinary digits or single valued and discontinuous and non-surjective if one makes pinary expansion unique by choosing the one with finite pinary digits. The finite pinary digit expansion is a natural choice since in the numerical work one always must use a pinary cutoff on the real axis.

The topology induced by canonical identification

The topology induced by the canonical identification in the set of positive real numbers differs from the ordinary topology. The difference is easily understood by interpreting the p-adic norm as a norm in the set of the real numbers. The norm is constant in each interval $[p^k, p^{k+1})$ (see Fig. **??**) and is equal to the usual real norm at the points $x = p^k$: the usual linear norm is replaced with a piecewise constant norm. This means that p-adic topology is coarser than the usual real topology and the higher the value of p is, the coarser the resulting topology is above a given length scale. This hierarchical ordering of the p-adic topologies will be a central feature as far as the proposed applications of the p-adic numbers are considered.

Ordinary continuity implies p-adic continuity since the norm induced from the p-adic topology is rougher than the ordinary norm. p-Adic continuity implies ordinary continuity from right as is clear already from the properties of the p-adic norm (the graph of the norm is indeed continuous from right). This feature is one clear signature of the p-adic topology.

Fig. 14. The real norm induced by canonical identification from 2-adic norm. `http://www.tgdtheory.fi/appfigures/norm.png`

The linear structure of the p-adic numbers induces a corresponding structure in the set of the non-negative real numbers and p-adic linearity in general differs from the ordinary concept of linearity. For example, p-adic sum is equal to real sum only provided the summands have no common pinary digits. Furthermore, the condition $x +_p y < max\{x, y\}$ holds in general for the p-adic sum of the real numbers. p-Adic multiplication is equivalent with the ordinary multiplication only provided that either of the members of the product is power of p. Moreover one has $x \times_p y < x \times y$ in general. The p-Adic negative -1_p associated with p-adic unit 1 is given by $(-1)_p = \sum_k (p-1)p^k$ and defines p-adic negative for each real number x. An interesting possibility is that p-adic linearity might replace the ordinary linearity in some strongly nonlinear systems so these systems would look simple in the p-adic topology.

These results suggest that canonical identification is involved with some deeper mathematical structure. The following inequalities hold true:

$$
\begin{aligned}
(x+y)_R &\leq x_R + y_R \ , \\
|x|_p |y|_R \leq (xy)_R &\leq x_R y_R \ ,
\end{aligned}
\tag{A-6.9}
$$

where $|x|_p$ denotes p-adic norm. These inequalities can be generalized to the case of $(R_p)^n$ (a linear vector space over the p-adic numbers).

$$
\begin{aligned}
(x+y)_R &\leq x_R + y_R \ , \\
|\lambda|_p |y|_R \leq (\lambda y)_R &\leq \lambda_R y_R \ ,
\end{aligned}
\tag{A-6.10}
$$

where the norm of the vector $x \in T_p^n$ is defined in some manner. The case of Euclidian space suggests the definition

$$(x_R)^2 \quad = \quad (\sum_n x_n^2)_R \quad . \tag{A-6.11}$$

These inequalities resemble those satisfied by the vector norm. The only difference is the failure of linearity in the sense that the norm of a scaled vector is not obtained by scaling the norm of the original vector. Ordinary situation prevails only if the scaling corresponds to a power of p.

These observations suggests that the concept of a normed space or Banach space might have a generalization and physically the generalization might apply to the description of some non-linear systems. The nonlinearity would be concentrated in the nonlinear behavior of the norm under scaling.

Modified form of the canonical identification

The original form of the canonical identification is continuous but does not respect symmetries even approximately. This led to a search of variants which would do better in this respect. The modification of the canonical identification applying to rationals only and given by

$$I_Q(q = p^k \times \frac{r}{s}) = p^k \times \frac{I(r)}{I(s)} \tag{A-6.12}$$

is uniquely defined for rationals, maps rationals to rationals, has also a symmetry under exchange of target and domain. This map reduces to a direct identification of rationals for $0 \le r < p$ and $0 \le s < p$. It has turned out that it is this map which most naturally appears in the applications. The map is obviously continuous locally since p-adically small modifications of r and s mean small modifications of the real counterparts.

Canonical identification is in a key role in the successful predictions of the elementary particle masses. The predictions for the light elementary particle masses are within extreme accuracy same for I and I_Q but I_Q is theoretically preferred since the real probabilities obtained from p-adic ones by I_Q sum up to one in p-adic thermodynamics.

Generalization of number concept and notion of imbedding space

TGD forces an extension of number concept: roughly a fusion of reals and various p-adic number fields along common rationals is in question. This induces a similar fusion of real and p-adic imbedding spaces. Since finite p-adic numbers correspond always to non-negative reals n-dimensional space R^n must be covered by 2^n copies of the p-adic variant R_p^n of R^n each of which projects to a copy of R_+^n (four quadrants in the case of plane). The common points of p-adic and real imbedding spaces are rational points and most p-adic points are at real infinity.

Real numbers and various algebraic extensions of p-adic number fields are thus glued together along common rationals and also numbers in algebraic extension of rationals whose number belong to the algebraic extension of p-adic numbers. This gives rise to a book like structure with rationals and various algebraic extensions of rationals taking the role of the back of the book. Note that Neper number is exceptional in the sense that it is algebraic number in p-adic number field Q_p satisfying $e^p \ mod \ p = 1$.

Fig. 15. Various number fields combine to form a book like structure. `http://www.tgdtheory.fi/appfigures/book.jpg`

For a given p-adic space-time sheet most points are literally infinite as real points and the projection to the real imbedding space consists of a discrete set of rational points: the interpretation in terms of the unavoidable discreteness of the physical representations of cognition is natural. Purely local p-adic physics implies real p-adic fractality and thus long range correlations for the real space-time surfaces having enough common points with this projection.

p-Adic fractality means that M^4 projections for the rational points of space-time surface X^4 are related by a direct identification whereas CP_2 coordinates of X^4 at these points are related by I, I_Q or some of its variants implying long range correlates for CP_2 coordinates. Since only a discrete set of points are related in this manner, both real and p-adic field equations can be satisfied and there are no problems with symmetries. p-Adic effective topology is expected to be

a good approximation only within some length scale range which means infrared and UV cutoffs. Also multi-p-fractality is possible.

A-6.3 The notion of p-adic manifold

The notion of p-adic manifold is needed in order to fuse real physics and various p-adic physics to a larger structure which suggests that real and p-adic number fields should be glued together along common rationals bringing in mind adeles. The notion is problematic because p-adic topology is totally disconnected implying that p-adic balls are either disjoint or nested so that ordinary definition of manifold using p-adic chart maps fails. A cure is suggested to be based on chart maps from p-adics to reals rather than to p-adics (see the appendix of the book)

The chart maps are interpreted as cognitive maps, "thought bubbles" with reverse map interpreted as a transformation of intention to action and would be realized in terms of canonical identification or some of its variants.

Fig. 16. The basic idea between p-adic manifold. `http://www.tgdtheory.fi/appfigures/padmanifold.jpg`

There are some problems.

1. Canonical identification does not respect symmetries since it does not commute with second pinary cutoff so that only a discrete set of rational points is mapped to their real counterparts by chart map arithmetic operations which requires pinary cutoff below which chart map takes rationals to rationals so that commutativity with arithmetics and symmetries is achieved in finite resolution: above the cutoff canonical identification is used

2. Canonical identification is continuous but does not map smooth p-adic surfaces to smooth real surfaces requiring second pinary cutoff so that only a discrete set of rational points is mapped to their real counterparts by chart map requiring completion of the image to smooth preferred extremal of Kähler action so that chart map is not unique in accordance with finite measurement resolution

3. Canonical identification vreaks general coordinate invariance of chart map: (cognition-induced symmetry breaking) minimized if p-adic manifold structure is induced from that for p-adic imbedding space with chart maps to real imbedding space and assuming preferred coordinates made possible by isometries of imbedding space: one however obtains several inequivalent p-adic manifold structures depending on the choice of coordinates: these cognitive representations are not equivalent.

A-7 Hierarchy of Planck constants and dark matter hierarchy

Hierarchy of Planck constants was motivated by the "impossible" quantal effects of ELF em fields on vertebrate cyclotron energies $E = hf = \hbar \times eB/m$ are above thermal energy is possible only if $\hbar$ has value much larger than its standard value. Also Nottale's finding that planetary orbits migh be understood as Bohr orbits for a gigantic gravitational Planck constant.

Hierachy of Planck constant would mean that the values of Planck constant come as integer multiples of ordinary Planck constant: $h_{eff} = n \times h$. The particles at magnetic flux tubes characterized by h_{eff} would correspond to dark matter which would be invisible in the sense that only particle with same value of h_{eff} appear in the same vertex of Feynman diagram.

Hierarchy of Planck constants would be due to the non-determism of the Kähler action predicting huge vacuum degeneracy allowing all space-time surfaces which are sub-manifolds of any $M^4 \times Y^2$, where Y^2 is Lagrangian sub-manifold of CP_2. For agiven Y^2 one obtains new manifolds Y^2 by applying symplectic transformations of CP_2.

Non-determinism would mean that the 3-surface at the ends of causal diamond (CD) can be connected by several space-time surfaces carrying same conserved Kähler charges and having same values of Kähler action. Conformal symmetries defined by Kac-Moody algebra associated with the imbedding space isometries could act as gauge transformations and respect the light-likeness property of partonic orbits at which the signature of the induced metric changes from Minkowskian

to Euclidian (Minkowskianb space-time region transforms to wormhole contact say). The number of conformal equivalence classes of these surfaces could be finite number n and define discrete physical degree of freedom and one would have $h_{eff} = n \times h$. This degeneracy would mean "second quantization" for the sheets of n-furcation: not only one but several sheets can be realized.

This relates also to quantum criticality postulated to be the basic characteristics of the dynamics of quantum TGD. Quantum criticalities would correspond to an infinite fractal hierarchy of broken conformal symmetries defined by sub-algebras of conformal algebra with conformal weights coming as integer multiples of n. This leads also to connections with quantum criticality and hierarchy of broken conformal symmetries, p-adicity, and negentropic entanglement which by consistency with standard quantum measurement theory would be described in terms of density matrix proportional $n \times n$ identity matrix and being due to unitary entanglement coefficients (typical for quantum computing systems).

Formally the situation could be described by regarding space-time surfaces as surfaces in singular n-fold singular coverings of imbedding space. A stronger assumption would be that they are expressible as as products of n_1 -fold covering of M^4 and n_2-fold covering of CP_2 meaning analogy with multi-sheeted Riemann surfaces and that M^4 coordinates are n_1-valued functions and CP_2 coordinates n_2 -valued functions of space-time coordinates for $n = n_1 \times n_2$. These singular coverings of imbedding space form a book like structure with singularities of the coverings localizable at the boundaries of causal diamonds defining the back of the the book like structure.

Fig. 17. Hierarchy of Planck constants. `http://www.tgdtheory.fi/appfigures/planckhierarchy.jpg`

A-8 Some notions relevant to TGD inspired consciousness and quantum biology

Below some notions relevant to TGD inspired theory of consciousness and quantum biology.

A-8.1 The notion of magnetic body

Topological field quantization inspires the notion of field body about which magnetic body is especially important example and plays key role in TGD inspired quantum biology and consciousness theory. This is a crucial departure fromt the Maxwellian view. Magnetic body brings in third level to the description of living system as a system interacting strongly with environment. Magnetic body would serve as an intentional agent using biological body as a motor instrument and sensory receptor. EEG would communicated the information from biological body to magnetic body and Libet's findings from time delays of consciousness support this view.

The following pictures illustrate the notion of magnetic body and its dynamics relevant for quantum biology in TGD Universe.

Fig. 18. Magnetic body associated with dipole field. `http://www.tgdtheory.fi/appfigures/fluxquant.jpg`

Fig. 19. Illustration of the reconnection by magnetic flux loops. `http://www.tgdtheory.fi/appfigures/reconnect1.jpg`

Fig. 20. Illustration of the reconnection by flux tubes connecting pairs of molecules. `http://www.tgdtheory.fi/appfigures/reconect2.jpg`

Fig. 21. Flux tube dynamics. a) Reconnection making possible magnetic body to "recognize" the presence of another magnetic body, b) braiding, knotting and linking of flux tubes making possible topological quantum computation, c) contraction of flux tube in phase transition reducing the value of h_{eff} allowing two molecules to find each other in dense molecular soup. `http://www.tgdtheory.fi/appfigures/fluxtubedynamics.jpg`

A-8.2   Number theoretic entropy and negentropic entanglement

TGD inspired theory of consciousness relies heavily p-Adic norm allows an to define the notion of Shannon entropy for rational probabilities (and even those in algebraic extension of rationals) by replacing the argument of logarithm of probability with its p-adic norm. The resulting entropy can be negative and the interpretation is that number theoretic entanglement entropy defined by this formula for the p-adic prime minimizing its value serves as a measure for conscious information. This negentropy characterizes two-particle system and has nothing to do with the formal negative negentropy assignable to thermodynamic entropy characterizing single particle. Negentropy Maximization Principle (NMP) implies that number theoretic negentropy increases during evolution by quantum jumps. The condition that NMP is consistent with the standard quantum measurement theory requires that negentropic entanglement has a density matrix proportional to unit matrix so that in 2-particle case the entanglement matrix is unitary.

Fig. 22. Schrödinger cat is neither dead or alive. For negentropic entanglement this state would be stable. `http://www.tgdtheory.fi/appfigures/cat.jpg`

A-8.3   Life as something residing in the intersection of reality and p-adicities

In TGD inspired theory of consciousness p-adic space-time sheets correspond to space-time correlates for thoughts and intentions. The intersections of real and p-adic preferred extremals consist of points whose coordinates are rational or belong to some extension of rational numbers in preferred imbedding space coordinates. They would correspond to the intersection of reality and various p-adicities representing the "mind stuff" of Descartes. There is temptation to assign life to the intersection of realities and p-adicities. The discretization of the chart map assigning to real space-time surface its p-adic counterpart would reflect finite cognitive resolution.

At the level of "world of classical worlds" (WCW) the intersection of reality and various p-adicities would correspond to space-time surfaces (or possibly partonic 2-surfaces) representable in terms of rational functions with polynomial coefficients with are rational or belong to algebraic extension of rationals.

The quantum jump replacing real space-time sheet with p-adic one (vice versa) would correspond to a buildup of cognitive representation (realization of intentional action).

Fig. 23. The quantum jump replacing real space-time surface with corresponding p-adic manifold can be interpreted as formation of though, cognitive representation. Its reversal would correspond to a transformation of intention to action. `http://www.tgdtheory.fi/appfigures/padictoreal.jpg`

A-8.4   Sharing of mental images

The 3-surfaces serving as correlates for sub-selves can topologically condense to disjoint large space-time sheets representing selves. These 3-surfaces can also have flux tube connections and this makes possible entanglement of sub-selves, which unentangled in the resolution defined by the size of sub-selves. The interpretation for this negentropic entanglement would be in terms of sharing of mental images. This would mean that contents of consciousness are not completely private as assumed in neuroscience.

Fig. 24. Sharing of mental images by entanglement of subselves made possible by flux tube connections between topologically condensed space-time sheets associated with mental images. `http://www.tgdtheory.fi/appfigures/sharing.jpg`

A-8.5   Time mirror mechanism

Zero energy ontology (ZEO) is crucial part of both TGD and TGD inspired consciousness and leads to the understanding of the relationship between geometric time and experience time and how the arrow of psychological time emerges. One of the basic predictions is the possibiity of negative

energy signals propagating backwards in geometric time and having the property that entropy basically associated with subjective time grows in reversed direction of geometric time. Negative energy signals inspire time mirror mechanism (see fig. `http://www.tgdtheory.fi/appfigures/timemirror.jpg` or fig. 24 in the appendix of this book) providing mechanisms of both memory recall, realization of intentional action initiating action already in geometric past, and remote metabolism. What happens that negative energy signal travels to past and is reflected as positive energy signal and returns to the sender. This process works also in the reverse time direction.

Fig. 25. Zero energy ontology allows time mirror mechanism as a mechanism of memory recall. Essentially "seeing" in time direction is in question. `http://www.tgdtheory.fi/appfigures/timemirror.jpg`

REFERENCES

Mathematics

[A1] MacKay correspondence. `http://en.wikipedia.org/wiki/ADE_classification`.

[A2] Super Virasoro algebra. `http://en.wikipedia.org/wiki/Super_Virasoro_algebra`.

[A3] T-duality. `http://en.wikipedia.org/wiki/T-duality`.

[A4] Yangian symmetry. `http://en.wikipedia.org/wiki/Yangian`.

[A5] John C. Baez. The Octonions. *Bull. Amer. Math. Soc.. `http://math.ucr.edu/home/baez/Octonions/octonions.html`*, 39(2002), 2001.

[A6] H. J. Borchers. On Revolutionizing QFT with Tomita's Modular Theory. *J. Math. Phys.. `http://www.lqp.uni-goettingen.de/papers/99/04/99042900.html`*, pages 3604–3673, 2000.

[A7] Z. I. Borevich and I. R. Shafarevich. *Number Theory*. Academic Press, 1966.

[A8] L. Brekke and P. G. O. Freund. p-Adic Numbers in Physics. *Phys. Rep.*, 233(1), 1993.

[A9] A. Connes and D. Kreimer. *Hofp algebras, renormalization, and non-commutative geometry*, volume 1999. Kluwer, 1998.

[A10] J. Dixmier. *Von Neumann Algebras*. North-Holland, Amsterdam, 1981.

[A11] Eisenhart. *Riemannian Geometry*. Princeton University Press, 1964.

[A12] D. S. Freed. The Geometry of Loop Groups, 1985.

[A13] G. W. Gibbons and C. N. Pope. CP_2 as gravitational instanton. *Comm. Math. Phys.*, 55, 1977.

[A14] R. Haag and D. Kastler. An Algebraic Approach to Quantum Field Theory. *Journal of Mathematical Physics*, 5:848–861, 1964.

[A15] S. W. Hawking and C. N. Pope. Generalized Spin Structures in Quantum Gravity. *Phys. Lett.*, (1), 1978.

[A16] S. Helgason. *Differential Geometry and Symmetric Spaces.* Academic Press, New York, 1962.

[A17] R. A. Minklos I. M. Gelfand and Z. Ya. Shapiro. *Representations of the rotation and Lorentz groups and their applications.* Pergamon Press, 1963.

[A18] F. R. Jones. *Braid groups, Hecke algebras and type II_1 factors.* 1983.

[A19] V. Jones. In and around the origin of quantum groups. `http://arxiv.org/abs/math/0309199`, 2003.

[A20] C. Kassel. *Quantum Groups.* Springer Verlag, 1995.

[A21] J. Milnor. *Topology form Differential Point of View.* The University Press of Virginia, Virginia, 1965.

[A22] C. N. Pope. Eigenfunctions and $Spin^c$ Structures on CP_2, 1980.

[A23] R. J. Rivers. *Path Integral Methods in Quantum Field Theory.* Cambridge University Press, Cambridge, 1987.

[A24] S. Sawin. Links, Quantum Groups, and TQFT's. `http://arxiv.org/abs/q-alg/9506002`, 1995.

[A25] B. Schroer. Lectures on Algebraic Quantum Field Theory and Operator Algebras. `http://xxx.lanl.gov/abs/math-ph/0102018`, 2001.

[A26] L. Schwartz. Generalisation de la Notion de Fonction, de Derivation, de Transformation de Fourier et Applications Mathematiques et Physiques. *Publications de l'Institut de Mathematique de l'Universite de Strasbourg, Vols 9-10, Paris: Hermann,* 1945.

[A27] B. Shipman. The geometry of momentum mappings on generalized flag manifolds, connections with a dynamical system, quantum mechanics and the dance of honeybee. `http://math.cornell.edu/~oliver/Shipman.gif`, 1998.

[A28] M. Spivak. *Differential Geometry I,II,III,IV.* Publish or Perish, Boston, 1970.

[A29] B. Gilkey T. Eguchi and J. Hanson. *Phys. Rep.,* 66:1980, 1980.

[A30] M. Takesaki. *Tomita's Theory of Modular Hilbert Algebras and Its Applications,* volume 128. Springer, Berlin, 1970.

[A31] R. Thom. *Commentarii Math. Helvet.,* 28, 1954.

[A32] Wallace. *Differential Topology.* W. A. Benjamin, New York, 1968.

[A33] E. Witten. Quantum field theory and the Jones polynomial. *Comm. Math. Phys.,* 121:351–399, 1989.

[A34] C. N. Yang and M. L. Ge. *Braid Group, Knot Theory, and Statistical Mechanics.* World Scientific, 1989.

Theoretical Physics

[B1] Airy functions. `http://en.wikipedia.org/wiki/Airy_function`.

[B2] ElitzurVaidman bomb-testing problem. `http://en.wikipedia.org/wiki/ElitzurVaidman_bomb-testing_problem`.

[B3] Montonen Olive Duality. `http://en.wikipedia.org/wiki/Montonen-Olive_duality`.

[B4] No-cloning theorem. `http://en.wikipedia.org/wiki/No_cloning_theorem`.

[B5] J. Björken and S. Drell. *Relativistic Quantum Fields*. Mc Graw-Hill, New York, 1965.

[B6] N. Arkani-Hamed et al. A duality for the S-matrix. `http://arxiv.org/abs/0907.5418`, 2009.

[B7] Nima Arkani-Hamed et al. The All-Loop Integrand For Scattering Amplitudes in Planar N=4 SYM. `http://arxiv.org/find/hep-th/1/au:+Bourjaily_J/0/1/0/all/0/1`, 2010.

[B8] P. Svrcek F. Cachazo and E. Witten. MHV Vertices and Tree Amplitudes In Gauge Theory. `http://arxiv.org/abs/hep-th/0403047`, 2004.

[B9] K. Huang. *Quarks,Leptons & Gauge Fields*. World Scientific, 1982.

[B10] C. Itzykson and J.-B. Zuber. *Quantum Field Theory*. Mc Graw-Hill, New York, 1980.

[B11] H. Larsen M. Freedman and Z. Wang. A modular functor which is universal for quantum computation. *Comm. Math. Phys.. http://arxiv.org/abs/quant-ph/0001108*, 1(2):605–622, 2002.

[B12] G. Parisi. *Field Theory, Disorder and Simulations*. World Scientific, 1992.

[B13] B. Feng R. Britto, F. Cachazo and E. Witten. Direct Proof of Tree-Level Recursion Relation in Yang- Mills Theory. *Phys. Rev.. http://arxiv.org/abs/hep-th/0501052*, 94:181602, 2005.

[B14] J. H. Schwartz. *Super strings. The first 15 years of Superstring Theory*. World Scientific, 1985.

[B15] A. Zee. *The Unity of Forces in the Universe*. World Science Press, Singapore, 1982.

Particle and Nuclear Physics

[C1] D. T. H. Davies et al. Precise Charm to Strange Mass Ratio and Light Quark Masses from Full Lattice QCD. *Phys. Rev.. http://prl.aps.org/abstract/PRL/v104/i13/e132003*, 104, 2010.

[C2] C. L. Kervran. *Biological transmutations, and their applications in chemistry, physics, biology, ecology, medicine, nutrition, agriculture, geology*. Swan House Publishing Co., 1972.

[C3] E. Samuel. Ghost in the Atom. *New Scientist*, (2366):30, October 2002.

[C4] P. Tompkins and C. Bird. *The secret life of plants*. Harper & Row, New York, 1973.

Condensed Matter Physics

[D1] Burning salt water. `http://www.youtube.com/watch?v=aGgOATfoBgo`.

[D2] Fractional quantum Hall Effect. `http://en.wikipedia.org/wiki/Fractional_quantum_Hall_effect`.

[D3] Larmor precession. `http://en.wikipedia.org/wiki/Larmor_precession`.

[D4] Liquid crystals on line. `http://www.lcionline.net/`.

[D5] Spontaneous burning. `http://www.ncbi.nlm.nih.gov/sites/entrez?cmd=Retrieve&db=PubMed&list_uids=6149513&dopt=AbstractPlus`.

[D6] Spontaneous human combustion. `http://www.alternativescience.com/spontaneous-human-combustion-burning-issue.htm`.

[D7] Ferromagnetism. `http://www.tcd.ie/Physics/Magnetism/Lectures/5006/5006-5.pdf`, 2007.

[D8] J. K. Borchardt. The chemical formula H2O - a misnomer. *The Alchemist*, August 2003.

[D9] M. Chaplin. Water Structure and Behavior. `http://www.lsbu.ac.uk/water/index.html`, 2005.

[D10] R. A. Cowley. Neutron-scattering experiments and quantum entanglement. *Physica B*, 350:243–245, 2004.

[D11] D. J. Evans et al. Experimental Demonstration of Violations of the Second Law of Thermodynamics for Small Systems and Short Time Scales. *Phys. Rev.*, 89, 2002.

[D12] R. Moreh et al. Search for anomalous scattering of keV neutrons from H2O-D2O mixtures. *Phys. Rev.*, 94, 2005.

[D13] X. Figueroa G. Pollack and Z. Qing. Molecules, water and radiant energy: new clues for the origin of life. *International journal of molecular sciences*, 10(4):1419–29, 2009.

[D14] Mae-Wan Ho. Can Water burn. `http://www.i-sis.org.uk/canWaterBurn.php`, 2009.

[D15] Mae-Wan Ho. Living with Oxygen. `http://www.i-sis.org.uk/livingWithOxygen.php`, 2009.

[D16] Mae-Wan Ho. Making Fuel from Water. *Institute of Science in Society report.*, 2009.

[D17] Mae-Wan Ho. The body does burn water. `http://www.i-sis.org.uk/theBodyDoesBurnWater.php`, 2009.

[D18] Mae-Wan Ho. Water electric. *Institute of Science in Society report*, 2009.

[D19] D. M. Pepper. Nonlinear Optical Phase Conjugation. *Optical Engineering*, 21(2), March 1982.

[D20] Jian-ming Zheng and Pollack. Long-range forces extending from polymer-gel surfaces. `http://arxiv.org/abs/cond-mat/0305093`, 2003.

Cosmology and Astro-Physics

[E1] M. Tajmar et al. Experimental Detection of Gravimagnetic London Moment. `http://arxiv.org/abs/gr-gc0603033`, 2006.

[E2] S. E. Shnoll et al. Realization of discrete fluctuations in macroscopic processes. *Physics-Uspekhi.* `http://home.t01.itscom.net/allais/blackprior/shnoll/shnoll-1.pdf`, 41(10):1025–1035, 1998.

[E3] S. E. Shnoll et al. Experiments with rotating collimators cutting out pencil of α-particle at radiactive decay of ^{239}Pu evidence sharp anisotropy of space. *Progress in Physics.* `http://www.ptep-online.com/index_files/2005/PP-01-11.PDF`, pages 81–83, 2005.

[E4] S. E. Shnoll et al. Fine structure of histograms of alpha-activity measurements depends on direction of alpha particles flow and the Earth rotation: experiments with collimators. `http://www.cifa-icef.org/shnoll.pdf`, 2008.

[E5] S. Oliver. The interstellar medium: Magnetic Fields. `http://astronomy.sussex.ac.uk/~sjo/teach/ism2002/lect_notes/`, 2002.

[E6] V. A. Panchelyuga and S. E. Shnoll. On the Dependence of a Local-Time Effect on Moving Sources of Fluctuations. *Progress in Physics.* `http://www.ptep-online.com/index_files/2007/PP-10-12.PDF`, pages 55–56, 2007.

[E7] V. A. Panchelyuga and S. E. Shnoll. On the Dependence of a Local-Time Effect on Spatial Direction. *Progress in Physics.* `http://www.ptep-online.com/index_files/2007/PP-10-11.PDF`, pages 51–54, 2007.

[E8] D. Da Roacha and L. Nottale. Gravitational Structure Formation in Scale Relativity. `http://arxiv.org/abs/astro-ph/0310036`, 2003.

[E9] S. E. Shnoll and V. A. Panchelyuga. The Palindrome effect. *Progress in Physics.* `http://www.ptep-online.com/index_files/2008/PP-13-20.PDF`, 2:151–153, 2008.

[E10] V. Trimble. The department of celestial mechanics: part II. *Beam Line*, 1996.

Physics of Earth

[F1] Ionosphere. `http://en.wikipedia.org/wiki/Ionosphere`.

[F2] Kennelly-Heaviside layer. `http://en.wikipedia.org/wiki/Kennelly-Heaviside_layer`.

[F3] Plate tectonics. `http://en.wikipedia.org/wiki/Plate_tectonics`.

[F4] G. Zgrablic et al. Instrumental recording of electrophonic sounds from Leonid fireballs. *Journal of Geophysical Research. http:// fizika. org/ ilwcro/ results/*, 2001.

[F5] L. A. Frank et al. Plasma velocity distributions in the near-Earth plasma sheet: A first look with the Geotail spacecraft. *J. Geophys. Res.*, 101:10627–10637, 1996.

[F6] J. Hecht. The Giant Crystal at the Heart of the Earth. *New Scientist*, page 17, January 1994.

[F7] A. Saleh. Capturing the Earth's songs. *ABC Science Online. http:// www. abc. net. au/ science/ news/ stories/ s237849. htm*, 2001.

Fringe Physics

[H1] M. B. King. Free-energy devices. `http://www.free-energy-info.co.uk/MorayKing.pdf`.

[H2] Teslas Wireless Energy... For the 21st Century!!! One Step Beyond Direct TV!!! `http://www.teslatech.info/ttmagazine/v1n4/valone.htm`, 2003.

[H3] A. Akai. Longitudinal waves. Cold electricity. *New Energy Technologies. http:// www. slashdocs. com/ inixhk/ longitudinal-waves-cold-electricity. html*.

[H4] S. Ejaz and S. Anwar. Voltage distribution along reactor winding under very fast transients. Masters's thesis in Chalmers. `http://home.comcast.net/~onichelson/VOLTGN.pdfhttp:// publications.lib.chalmers.se/records/fulltext/171671/171671.pdf`.

[H5] M. B. King. Water Electrolyzers and the Zero-Point Energy. *Physics Procedia. http:// www. sciencedirect. com/ science/ journal/ 18753892*, 20:335–445, 2011.

[H6] P. Lindeman. *The free energy secrets of cold electricity. http:// www. teslasociety. ch/ info/ NTV_ 2011/ free. pdf*. Clear Tech, Inc.

[H7] O. Nichelson. A Special Case of Voltage Gain. `http://home.comcast.net/~onichelson/VOLTGN.pdf`.

[H8] O. Nichelson. Nikola Tesla's later energy generation designs. `http://home.earthlink.net/~drestinblack/generator.htm`. 1991.

[H9] E. Podkletnov and G. Modanese. Investigation of high voltage discharges in low pressure gases through large ceramic super-conducting electrodes. `http://xxx.lanl.gov/abs/physics/0209051`, 2002.

[H10] V. V. Roschin and S. M. Godin. *Generator with Energy Conversion and Anti-Gravity Effects*. Jupiter Verlag, 2001.

Biology

[I1] Biophotons. `http://en.wikipedia.org/wiki/Biophotons`.

[I2] Brief introduction into WaveGenetics. Its scope and opporturnities. `http://www.wavegenetics.jino-net.ru`.

[I3] Chirality (chemistry). `http://en.wikipedia.org/wiki/Chirality_(chemistry)`.

[I4] Diffuse interstellar bands. `http://en.wikipedia.org/wiki/Diffuse_interstellar_band`.

[I5] DNA replication. `http://en.wikipedia.org/wiki/DNA_replication`.

[I6] Everywhere in a Flash: The Quantum Physics of Photosynthesis. `http://www.wired.com/wiredscience/2010/02/quantum-photosynthesis/`.

[I7] Fertilization. `http://en.wikipedia.org/wiki/Fertilization`.

[I8] High energy phosphate. `http://en.wikipedia.org/wiki/High-energy_phosphate`.

[I9] Interstellar Dust as Agent and Subject of Galactic Evolution. `http://www.ricercaitaliana.it/prin/dettaglio_completo_prin_en-2005022470.htm`.

[I10] M. Emoto. `http://www.i-sis.org.uk/water4.php`.

[I11] Meiosis. `http://en.wikipedia.org/wiki/Meiosis`.

[I12] Mitosis. `http://en.wikipedia.org/wiki/Mitosis`.

[I13] Pollack Laboratory- Biographical Sketch. `http://faculty.washington.edu/ghp/cv/`.

[I14] Polymerase chain reaction. `http://en.wikipedia.org/wiki/PCR`.

[I15] Protein aggregation. `http://en.wikipedia.org/wiki/Protein_aggregation`.

[I16] 'Psychic cells': Scientists discover cells can communicate through physical barriers. `http://newsroom.ucla.edu/portal/ucla/ucla-drew-scientists-undercover-243053.aspx`.

[I17] Quantum Mechanics Boosts Photosynthesis. `http://physicsworld.com/cws/article/news/41632`.

[I18] Spark of life: Metabolism appears in lab without cells. `http://www.newscientist.com/article/dn25471-spark-of-life-metabolism-appears-in-lab-without-cells.html?cmpid=RSS|NSNS|2012-GLOBAL|online-news#.U14rRMZK7B3`.

[I19] The First National Conference on the Bigu Manifestation, Health Effects and Scientific Research of Yan Xin Qigong. `http://www.scribd.com/doc/40294944/Bigu-Conference-Report-PennState-June-2000`.

[I20] Untangling the Quantum Entanglement Behind Photosynthesis: Berkeley scientists shine new light on green plant secrets. `http://newscenter.lbl.gov/feature-stories/2010/05/10/untangling-quantum-entanglement/`.

[I21] Water has memory. `http://www.youtube.com/watch?v=ILSyt_Hhbjg`.

[I22] Dr. Phil Callahan on Power of Paramagnetism. *Nexus.* *`http://www.nexusmagazine.com`*, February 2003.

[I23] Acupuncture's Molecular Effects Pinned Down: New Insights Spur Effort to Boost Treatment's Impact Significantly. Science News. `http://www.sciencedaily.com/releases/2010/05/100530144021.htm`, 2010.

[I24] Unusual Quantum Effect Discovered in Earliest Stages of Photosynthesis. *Science News.* *`http://www.sciencedaily.com/releases/2012/05/120524092932.htm`*, 2012.

[I25] The Fourth Phase of Water: Dr. Gerald Pollack at TEDxGuelphU. `https://www.youtube.com/watch?v=i-T7tCMUDXU`, 2014.

[I26] F. Musemeci A. Triglia and A. Scordino. Biophysical aspects of the ultraweak Photon emission from the living systems during growth. `http://www.datadiwan.de/iib/ib1002e1.htm`, 2001.

[I27] B. P. Bajpai. Coherent nature of the radiation emitted in delayed luminescence of leaves. *J Theor Biol*, 1999.

[I28] M. S. Benford. Probable Axion Detection via Consistent Radiographic Findings after Exposure to a Shpilman Axion Generator. *Journal of Theoretics*, 4, 1999.

[I29] L. Brizhik. Nonlinear mechanism for weak photon emission from biosystems. *Indian J Exp Biol*, 46(5):353–357, 2008.

[I30] H. Burr. *The fields of life.* New York: Ballantine, 1972.

[I31] P. Callahan. *Insect behavior.* Acres U.S.A., February 1971.

[I32] P. S. Callahan. Moth and Candle: the Candle Flame as a Sexual Mimic of the Coded Infrared Wavelengths from a Moth Sex Scent. *Applied Optics*, 16(12), 1977.

[I33] S. Comorosan. On a possible biological spectroscopy. *Bull. of Math. Biol.*, page 419, 1975.

[I34] A. A. Lev et al. Rapid switching of ion current in narrow pores: implications for biological ion channels. *Proceedings of the Royal Society of London. Series B: Biological Sciences*, pages 187–192, June 1993.

[I35] B. T. Dotta et al. Biophoton emissions from cell cultures: biochemical evidence for the plasma membrane as the primary source. *Gen Physiol Biophys*, 30(3):301–309, 2011.

[I36] B. Tsytovich et al. From Plasma crystals and helical structures towards inorganic living matter. *New Journal of Physics.* `http://www.iop.org/EJ/abstract/1367-2630/9/8/263`, August 2007.

[I37] F. A. Popp et al. Emission of Visible and Ultraviolet Radiation by Active Biological Systems. *Collective Phenomena*, 3, 1981.

[I38] F. A. Popp et al. Evidence of non-classical (squeezed) light in biological systems. *Phys Lett A*, 293(4):98–102, 2002.

[I39] F.A. Popp et al. Physical aspects of biophotons. *Experientia*, 44(7):576–585, 1988.

[I40] G.N. Ling et al. Experimental confirmation, from model studies, of a key prediction of the polarized multilayer theory of cell water. *Physiological Chemistry and Physics*, 10(1):87–88, 1978.

[I41] J. Benveniste et al. Human basophil degranulation triggered by very dilute antiserum against IgE. *Nature*, 333:816–818, 1988.

[I42] J. Benveniste et al. Transatlantic transfer of digitized antigen signal by telephone link. *Journal of Allergy and Clinical Immunology.* `http://www.digibio-.com/`, 99:175, 1989.

[I43] J. C. Lin et al. The Micro-wave Auditive phenomenon. *Proceedings of the IEEE*, 68, 1980.

[I44] L. Montagnier et al. Electromagnetic Signals Are Produced by Aqueous Nanostructures Derived from Bacterial DNA Sequences. *Interdiscip. Sci. Comput. Life Sci..* `http://www.springerlink.com/content/0557v31188m3766x/`, 2009.

[I45] L. Montagnier et al. DNA waves and water. `http://arxiv.org/abs/1012.5166`, 2010.

[I46] M. Rahnama et al. Emission of mitochondrial biophotons and their effect on electrical activity of membrane via microtubules. *Journal of Integrative Neurosciences.* `http://arxiv.org/pdf/1012.3371.pdf`, 1:65–88, 2009.

[I47] M. Rattemeyer et al. *J. Int. Soc. Life Inf. Sci.*, 18:413–417, 1981.

[I48] M. S. Benford et al. QuantaGraphy: Images from the quantum hologram. 2001.

[I49] N. Goldman et al. Adenosine A1 receptors mediate local anti-nociceptive effects of acupuncture. *Nature Neuroscience.* `http://www.nature.com/neuro/journal/v13/n7/full/nn.2562.html`, 13:883–888, 2010.

[I50] P. Gariaev et al. *The DNA-wave biocomputer*, volume 10. CHAOS, 2001.

[I51] P. P. Gariaev et al. Holographic Associative Memory of Biological Systems. *Proceedings SPIE - The International Society for Optical Engineering. Optical Memory and Neural Networks*, pages 280–291, 1991.

[I52] P. P. Gariaev et al. The spectroscopy of bio-photons in non-local genetic regulation. *Journal of Non-Locality and Remote Mental Interactions.* `http://www.emergentmind.org/gariaevI3.htm`, (3), 2002.

[I53] Popp et al. Biophoton emission. New evidence for coherence and DNA as source. *Biophys*, 6(1):33–52, 1984.

[I54] Y. Kataoka et al. Activity-Dependent Neural Tissue Oxidation Emits Intrinsic Ultraweak Photons. *Biochemical and Biophysical Research Communications*, 285(4):10071011, 2001.

[I55] K. H. Li F.-A. Popp and Q. Gu (eds.). *Recent Advances in Bio-photon Research and its Applications.* World Scientific, Singapore, 1992.

[I56] H. Fröhlich. The extraordinary dielectric properties of biological materials and the action of enzymes. *Nature*, 72(1968):641–649, 1975.

[I57] H. Lee G. R. Fleming and Y.-C. Cheng. Coherence Dynamics in Photosynthesis: Protein Protection of Excitonic Coherence. *Science.* `http://www.nature.com/ejhg/journal/v10/n11/index.html`, 316(5830):1462–1465, 2007.

[I58] P. P. Gariaev and M. U. Maslow. Fractal Presentation of Natural Language Texts and Genetic Code, 2nd International Conference on Quantitative Linguistics. *QUALICO '94*, pages 193–194, 1994.

[I59] M. Shaduri. & G.Tshitshinadze. On the problem of application of Bioenergography in medicine. *Georgian Engineering News*, 2, 1999.

[I60] E. Pearlman H. R. Chinnery and P. G. McMenamin. Cutting Edge: Membrane Nanotubes In Vivo: A Feature of MHC Class II+ Cells in the Mouse Cornea. *J. Immunol.*, 180:5779–5783, 2008.

[I61] M. W. Ho. *The Rainbow and the Worm.* World Scientific, Singapore, 1993.

[I62] M. W. Ho. Genes don't Generate Body Patterns. `http://www.i-sis.org.uk/Genes_dont_Generate_Body_Patterns.php`, 2011.

[I63] M. W. Ho. Mystery of Missing Heritability Solved. `http://www.i-sis.org.uk/Mystery_of_Missing_Heritability_Solved.php`, 2011.

[I64] M. W. Ho. No Genes for Intelligence in the Human Genome. `http://www.i-sis.org.uk/No_Genes_for_Intelligence_in_the_Human_Genome.php`, 2011.

[I65] M. W. Ho. Proteins secret water music in nanospace. `http://www.i-sis.org.uk/Proteins_secret_water_music_in_nanospace.php`, 2011.

[I66] M. W. Ho. Quantum Coherent Water Homeopathy. `http://www.i-sis.org.uk/Quantum_Coherent_Water_Homeopathy.php`, 2011.

[I67] M. W. Ho and P. T. Saunders. *Liquid Crystalline Mesophase in living organisms.* World Scientific, Singapore, 1994.

[I68] C. E. Ingalls. Sensation of Hearing in Electromagnetic Fields. `http://www.angelfire.com/or/mctrl/ingalls.htm`, 2002.

[I69] T. I. Karu. *The Science of Low-Power Laser Therapy*. Gordon and Breach, Sci. Publ.. `http://www.laserhealthsystems.com/Dr.%20Tiina%20Karu%20Presentation.htm`, London, 1998.

[I70] M. Levin. The wisdom of the body: future techniques and approaches to morphogenetic fields in regenerative medicine, developmental biology and cancer. *Regen. Med. http://www.futuremedicine.com/doi/pdf/10.2217/rme.11.69*, 6(6):667–673, 2011.

[I71] M. Levin. Morphogenetic fields in embryogenesis, regeneration, and cancer: Non-local control of complex patterning. *Biosystems. http://www.ncbi.nlm.nih.gov/pubmed/22542702*, 109(3):243–261, 2012.

[I72] G. Ling. Three sets of independent disproofs against the membrane-pump theory. `http://www.gilbertling.org/lp6a.htm`, 1978.

[I73] G. Ling. Oxidative phosphorylation and mitochondrial physiology: a critical review of chemiosmotic theory and reinterpretation by the association-induction hypothesis. *Physiol. Chem. & Physics*, 13, 1981.

[I74] G. N. Ling. *A physical theory of the living state: the association-induction hypothesis; with considerations of the mechanics involved in ionic specificity*. Blaisdell Pub. Co., New York, 1962.

[I75] G. N. Ling. Maintenance of low sodium and high potassium levels in resting muscle cells. *Journal of Physiology (Cambridge)*, pages 105–123, July 1978.

[I76] G. N. Ling. *A revolution in the physiology of the living cell*. Malabar, FL: Krieger Pub. Co., 1992.

[I77] E. Lozneanu and M. Sanduloviciu. Minimal-cell system created in laboratory by self-organization. *Chaos, Solitons & Fractals*, 18(2):335, September 2003.

[I78] E. Lozneanu and M. Sanduloviciu. Minimal-cell system created in laboratory by self-organization. *Chaos, Solitons & Fractals*, 18(2):335, September 2003.

[I79] V. Matveev. Main principles of Lings physical theory of the living cell. `http://vladimirmatveev.ru/mainprinciples.html`, 2012.

[I80] S. N. Mayburov and Ilya Volodyaev. Photons Production and Communications in Biological Systems. *Progress In Electromagnetics Research Symposium Abstracts*, 2009.

[I81] L. McTaggart. *The Field*. HarperCollinsPublishers Ltd. `http:/www.torsioelement.com`, 2001.

[I82] Z. Merali. Water gave life on Earth a guiding hand. *New Scientist*, 2540:25, February 2006.

[I83] Z. Merali. Water gave live on Earth a guiding hand. *New Scientist*, (2540), February 2006.

[I84] G. G. Tertishni P. P. Gariaev and A.V. Tovmash. Experimental investigation in vitro of holographic mapping and holographic transposition of DNA in conjuction with the information pool encircling DNA. *New Medical Tehcnologies*, 9:42–53, 2007.

[I85] D. V. Parkhomtchouk and M. Yamamoto. Super-Delayed Luminescence from Biological Tissues. *J. Int. Soc. Life Inf. Sci.*, 2000.

[I86] G. Pollack. *Cells, Gels and the Engines of Life*. Ebner and Sons, 2000.

[I87] F.-A. Popp. *Photon-storage in biological systems*, pages 123–149. Urban & Schwarzenberg, Muenchen-Baltimore, 1989.

[I88] F. A. Popp. Properties of biophotons and their theoretical implications. *Indian J Exp Biol*, 41(5):391–402, 2003.

[I89] F. A. Popp. Cancer growth and its inhibition in terms of coherence. *Electromagn Biol Med*, 28(1):53–60, 2009.

[I90] F.-A. Popp and J.-J. Chang. Photon Sucking and the Basis of Biological Organization. `http://www.datadiwan.de/iib/ib0201e3.htm`, 2001.

[I91] W. K. Purves and G. H. Orians. *Life: The Science of Biology*. Sinauer, Massachusetts, 1987.

[I92] D. Robson. Researchers Seek to Demystify the Metabolic Magic of Sled Dogs. `http://www.nytimes.com/2008/05/06/science/06dogs.html?_r=1&ex=1210737600&en=313979157c777587&ei=5070&emc=eta-1`, 2008.

[I93] D. Lubrich S. J. Green and A. J Turberfield. DNA Hairpins: Fuel for Autonomous DNA Devices. *Biophysical Journal*, October 2006.

[I94] F. Sachs and F. Qin. Gated, ion-selective channels observed with patch pipettes in the absence of membranes: novel properties of a gigaseal. *Biophysical Journal*, pages 1101–1107, September 1993.

[I95] B. Sakmann and B. Neher. *Single-channel recording*. Plenum, London, 1983.

[I96] R. Sheldrake. *A New Science of Life: The Hypothesis of Formative Causation*. Inner Traditions Intl Ltd., 1995.

[I97] R. Sheldrake. *The Presence of Past: Morphic Resonance and the Habits of Nature*. Icon Books Ltd, 2011.

[I98] J. Slavinski. Biophotons from stressed and dying organisms: toxicological aspects. *Indian J Exp Biol*, 41(5):483–493, 2003.

[I99] C. Smith. *Learning From Water, A Possible Quantum Computing Medium*. CHAOS, 2001.

[I100] B. L. Strehler and W. Arnold. Light production by green plants. *J. Gen. Physiol.*, 34:809–820, 1951.

[I101] M. Levin T. Somrat. An automated training paradigm reveals long-term memory in planarians and its persistence through head regeneration. *The Journal of Experimental Biology. $http://mechanism.ucsd.edu/teaching/f13/cs200/Levin\_longterm\_learning\_planaria\_2013.pdf$*, 216:3799–3810, 2013.

[I102] G. Vassilatos. Nocturnal Disturbances and the Infrasonic "HUM". `http://www.borderlands.com/journal/nux.htm`, 2001.

[I103] U. P. Vijh. Extended Red Emission. `http://ardbeg.astro.utoledo.edu/~karen/baglunch/vijh_abl_spr04.pdf`, 2004.

[I104] M. Wan-Ho. Crystal Clear Messages from Water. `http://en.wikipedia.org/wiki/Protein_aggregation`.

[I105] D. J. Woodbury. Pure lipid vesicles can induce channel-like conductances in planar bilayers., July 1989.

Neuroscience and Consciousness

[J1] A Secret Sense in The Human Nose? `http://www.hhmi.org/senses/`.

[J2] Action potential. http://en.wikipedia.org/wiki/Action_potential.

[J3] Active information in Physics. http://www2.warwick.ac.uk/fac/sci/psych/people/academic/jpickering/johnpickering/ivalo/.

[J4] Anterior cingulate cortex. http://en.wikipedia.org/wiki/Anterior_cingulate_cortex.

[J5] Color vision. http://en.wikipedia.org/wiki/Color_vision.

[J6] Discovery-of-quantum-vibrations-in-microtubules-inside-brain-neurons-corroborates-controversial-20-year-old-theory-of-consciousness? http://www.kurzweilai.net/discovery-of-quantum-vibrations-in-microtubules-inside-brain-neurons-corroborates-contro

[J7] Ericksonian Hypnosis. http://en.wikipedia.org/wiki/Ericksonian_Hypnosis.

[J8] Franz Mesmer. http://en.wikipedia.org/wiki/Franz_Mesmer.

[J9] God and the Brain - The Persinger 'God Helmet', The Brain, and visions of God. http://vimeo.com/22669312.

[J10] Hypnosis. http://en.wikipedia.org/wiki/Hypnosis.

[J11] James Braid. http://en.wikipedia.org/wiki/James_Braid_(surgeon).

[J12] Microtubules. http://en.wikipedia.org/wiki/Microtubules.

[J13] Neo-cortex. http://en.wikipedia.org/wiki/Neocortex.

[J14] Neurophenomenology. http://en.wikipedia.org/wiki/Neurophenomenology.

[J15] Out-of-body experiences. http://en.wikipedia.org/wiki/Out_Of_Body_Experiences.

[J16] Out-of-Body Experiences (OBEs) and Brain Localisation. A Perspective. http://www.pni.org/esp/medicine/obe/obeangular.htm.

[J17] Pflanzenwachstum durch Elektrofeld. http://www.s-line.de/homepages/keppler/elektrofeld.htm.

[J18] Photoreceptor cell. http://en.wikipedia.org/wiki/Photoreceptor_cell.

[J19] Physicists challenge notion of electric nerve impulses; say sound more likely. http://www.scienceblog.com/cms/physicists-challenge-notion-of-electric-nerve-impulses-say-sound-more-likely-12738.html.

[J20] Prefrontal cortex. http://en.wikipedia.org/wiki/Prefrontal_cortex.

[J21] Qigong and Energy Medicine Database. http://www.qigonginstitute.org/html/database.php.

[J22] Retinal Transduction: Hyperpolarization of Primary Photoreceptors by Ligh. http://www.acbrown.com/neuro/Lectures/NrVisn/NrVisnRtnlHprp.htm.

[J23] Spindle cell. http://en.wikipedia.org/wiki/Spindle_cell.

[J24] Synaptic plasticity. http://en.wikipedia.org/wiki/Synaptic_plasticity.

[J25] PK Effect on Pre-Recorded Targets. *The Journal for the American Society for Psychical Research.* http://www.fourmilab.ch/rpkp/retro.html, 70, 1976.

[J26] The observational theories: A primer. *European Journal of Parapsychology*, 1978.

[J27] Addition effect for PK on pre-recorded targets. http://www.fourmilab.ch/rpkp/addition.html. *Journal of Parapsychology*, 49, 1985.

[J28] Acousto-conformational transitions in cytoskeletal microtubules: implications for intracellular information processing. *Nanobiology*, 1:457–468, 1992.

[J29] Correlations of Random Binary Sequences with Pre-Stated Operator Intention: A Review of a 12-Year Program. `http://www.princeton.edu/~pear/pdfs/1997-correlations-random-binary-sequences-12-year-review.pdf`, 1997.

[J30] Sheldrake on Presentiment & Psychokinesis. `http://www.thebirdman.org/Index/Fight/Fight-SheldrakeOnPresentiment&Psychokinesis.html`, 1999.

[J31] Biofield Research: A Roundtable Discussion of Scientific and Methodological Issues. *The journal of alternative and complementary medicine*, 18(12):1081–1086, 2012.

[J32] Cytoskeletal Signaling: Is Memory Encoded in Microtubule Lattices by CaMKII Phosphorylation? *PLoS Computational Biology*, 8(3), 2012.

[J33] Eyes work without connection to brain: ectopic eyes function without natural connection to brain. `http://www.sciencedaily.com/releases/2013/02/130227183311.htm`, 2013.

[J34] M. Hämäläinen A. Ahonen and J. Knuutila. Magneettisten aivosignaalien mittaus ja prosessointi–100-kanavainen mittalaite tavoitteena. *Arkhimedes*, 42(3), 1990.

[J35] Wissner-Gross A. D and C. E. Freer. Causal entropic forces. *Phys. Rev. Lett. http://prl.aps.org/abstract/PRL/v110/i16/e168702*, 110(168702), 2013.

[J36] K. S. Saroka B. T. Dotta and M. A. Persinger. Increased photon emission from the head while imagining light in the dark is correlated with changes in electroencephalographic power: support for Bkkon's biophoton hypothesis. *Neurosci Lett*, 513(2):151–154, 2012.

[J37] M. A. Persinger B. T. Dotta. Doubling of local photon emissions when two simultaneous, spatially-separated, chemiluminescent reactions share the same magnetic field configurations. *Journal of Biophysical Chemistry. http://core.kmi.open.ac.uk/display/5850998*, 3(1), 2012.

[J38] B. J. Baars. *A cognitive theory of consciousness*. New York: Cambridge University Press, 1988.

[J39] A. Bandyopadhyay. Experimental Studies on a Single Microtubule (Google Workshop on Quantum Biology), 2011.

[J40] Spanos Barber and Chaves. *Hypnotism: Imagination & Human Potentialities*. Pergamon Press, 1974.

[J41] R. O. Becker. *Cross Currents*. Penguin Putnam Inc., New York, 1990.

[J42] R. O. Becker and G. Selden. *The Body Electric: Electromagnetism and the Foundation of Life*. William Morrow & Company, Inc., New York, 1990.

[J43] D. J. Bierman and D. I. Radin. Anomalous Anticipatory Response on Randomized Future Conditions. *Perceptual and Motor Skills*, 84:689–690, 1997.

[J44] D. J Bierman and D. I. Radin. Anomalous unconscious emotional responses: Evidence for a reversal of the arrow of time. `http://www-psy.uva.nl/resedu/pn/PUBS/BIERMAN/1998/tucson/tucson3.html`, 1998.

[J45] M. Bischof. Biophotons-The light in our cells. *Journal of Optometric Phototherapy*, pages 1–5, 2005.

[J46] C. F. Blackman. *Effect of Electrical and Magnetic Fields on the Nervous System*, pages 331–355. Plenum, New York, 1994.

[J47] S. Blackmore. *Beyond the Body*. Granada, London, 1983.

[J48] S. J. Blackmore. Near death experiences: in or out of the body? *Skeptical Inquirerhttp: //www. uwe. ac. uk/ fas/ staff/ sb/ si91nde. html* , 1991:34–45, 1991.

[J49] S. J. Blackmore and T. S. Troscianko. The physiology of the tunnel. *Journal of Near-Death Studies*, 8:15–28, 1989.

[J50] I. Bokkon. Phosphene phenomenon: a new concept. *Biosystems*, 92(2):168–174, 2008.

[J51] I. Bokkon. Visual perception and imagery: a new molecular hypothesis. *Biosystems*, 96(2):178–184, 2009.

[J52] A. L. Botkin. The Induction of After-Dearth Communications Utilizing Eye-Movement Desensitization and Reprocessing: A New Discovery. *Journal of Near-Death Studies*, (3):181, 2000.

[J53] J. Brown. Martial arts students influence the past. *New Scientist*, July 1994.

[J54] P. Carruthers. Higher order theories of consciousness. In *The Blackwell companion to consciousness*, pages 277–286. Oxford: Blackwell, 2007.

[J55] D. Chalmers. *The conscious mind: in search of a fundamental theory.* Oxford University Press, New York, 1996.

[J56] K. Chen and G. He. Preliminary Studies of the Effect of Qigong Therapy on Cancer. 2001.

[J57] K. W. Chen. An Analytic Review of Studies on Measuring Effecs of External Qi in China. *Alternative Therapies*, 10(4):38–50, 2004.

[J58] U. Di Corpo. The conflict between entropy and syntropy: the vital needs model. 2007.

[J59] J. D. Cowan. Spontaneous symmetry breaking in large-scale nervous activity. *International Journal of Quantum Chemistry*, 22:1059–1082, 1982.

[J60] F. Crick and C. Koch. Towards a neurobiological theory of consciousness. *Seminars in neurosciences*, 2:273–304, 1990.

[J61] R. Cytowich. *Psyche*, 2(10), 1995.

[J62] A. Damasio. *The Feeling of What Happens.* Sane Töregard Agency, 1999.

[J63] D. C. Dennett. *Consciousness explained.* Boston: Little, Brown, 1991.

[J64] F. Dretske. *Naturalizing the mind.* Cambridge, MA: MIT Press, 1995.

[J65] B. J. Dunne and R. G. Jahn. Consciousness and Anomalous Physical Phenomena. `http: //www.princeton.edu/~pear/finalcap.pdf`, 1995.

[J66] S. J. P. Spottiswoode E. C. May and C. L. James. Shannon entropy as an intrinsic target property: towards a reductionistic model of anomalous cognition. `http://www.jsasoc.com/ docs/entropy.pdf`, 1994.

[J67] J. Ackerman E. P. Van Wijk and R. Van Wijk. Effect of meditation on ultraweak photon emission from hands and forehead. *Research in complementary and natural classical medicine*, 12(2):107–112, 2005.

[J68] G. M. Edelman and G. Tononi. *A Universe of consciousness.* New York: Basic Books, 2000.

[J69] A. K. Engel et al. Temporal Binding, Binocular Rivalry, and Consciousness. `http://www. phil.vt.edu/ASSC/engel/engel.html`, 2000.

[J70] A. Revonsuo et al. A Preconscious Neural Mechanism of Hypnotically Altered Colors: A Double Case Study. *Plos ONE. http:// dx. plos. org/ 10. 1371/ journal. pone. 0070900* , 8(8), 2013.

[J71] B. Libet et al. Subjective referral of the timing for a conscious sensory experience. *Brain*, 102, 1979.

[J72] C. F. Blackman et al. Induction of calcium-ion efflux from brain tissue by radio-frequency radiation: effects of modulation frequency and field strength. *Radio Sci.*, 14, 1979.

[J73] C. H. Wang et al. Spontaneous and visible light-induced ultraweak photon emission from rat eyes. *Brain Res*, 1639:1–9, 2011.

[J74] E.-M. Mandelkow et al. On the Surface Lattice of Microtubules : Helix Starts, Protofilament Number, Seam, and Handedness. *http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2114131/pdf/jc10231067.pdf*, 1985.

[J75] G. Cheron et al. Inactivation of Calcium-Binding Pr ein Genes Induces 160 Hz Oscillations in the Cerebellar Cortex of Alert Mice. *The Journal of Neuroscience. http://www.jneurosci.org/cgi/content/full/24/2/434*, 2004:434–441, January 2004.

[J76] H. Nakamura et al. Biophoton and Temperature Changes of Human Hand during Qigong. *J Intl Soc Life Info Science*, 2000.

[J77] Hunter et al. Cerebral dynamics and discrete energy changes in the personal environment during intuitive-like states and perceptions. *Journal of Consciousness Exploration & Research. http://jcer.com/index.php/jcj/article/view/116*, 1(9):1179–1197, 2010.

[J78] I. Bokkon et al. Estimation of the number of biophotons involved in the visual perception of a single-object image: biophoton intensity can be considerably higher inside cells than outside. *J Photochem Photobiol B*, 2010.

[J79] I. Bokkon et al. Visible light induced ocular delayed bioluminescence as a possible origin of negative afterimage. *J Photochem Photobiol B*, 103(2):192–119, 2011.

[J80] J. P. Hunter et al. The effect of tactile and visual sensory inputs on phantom limb awareness. *Brain*, 126(3), March 2003.

[J81] J. R. Reimers et al. PenroseHameroff orchestrated objective-reduction proposal for human consciousness is not biologically feasible. *Phys Rev E*, 80:021912021916, 2009.

[J82] J. R. Reimers et al. Weak, strong, and coherent regimes of Fröhlich condensation and their applications to terahertz medicine and quantum consciousness. *Proc Natl Acad Sci*, 106:4219–4224, 2009.

[J83] M. Kikkawa et al. Direct visualization of the microtubule lattice seam both in vitro and in vivo. *JCB. http://jcb.rupress.org/content/127/6/1965.abstract*, 127(6), 1994.

[J84] M. Kobayashi et al. In vivo imaging of spontaneousultraweak photon emission from a rats brain correlated with cerebral energy metabolism and oxidative stress. *Neurosci Res*, 34:103–113, 1999.

[J85] M. Persinger et al. Congruence of Energies for Cerebral Photon Emissions, Quantitative EEG Activities and 5 nT Changes in the Proximal Geomagnetic Field Support Spin-based Hypothesis of Consciousness. *Journal of Consciousness Expolaration & Research. http://jcer.com/index.php/jcj/article/view/277*, 2013.

[J86] M. Persinger et al. Demonstration of Entanglement of Pure Photon Emissions at Two Locations That Share Specific Configurations of Magnetic Fields: Implications for Translocation of Consciousness. *Journal of Consciousness Expolaration & Research. http://jcer.com/index.php/jcj/article/view/278*, 2013.

[J87] M. Persinger et al. Experimental Demonstration of Potential Entanglement of Brain Activity Over 300 Km for Pairs of Subjects Sharing the Same Circular Rotating, Angular Accelerating Magnetic Fields: Verification by s_LORETA, QEEG Measurements. *Journal of Consciousness Expolaration & Research. http://jcer.com/index.php/jcj/article/view/279*, 2013.

[J88] M. Rahnama et al. Emission of Biophotons and Neural Activity of the Brain. $http://www.scribd.com/doc/45664376/Bio-Photons$, 2011.

[J89] M. Yamamoto et al. EEG Change in Anomalous Perception Task Related to Somatic Sensation. *Journal of International Society of Life Information Science*, March 1997.

[J90] N. Usui et al. Very high frequency oscillations (over 1000 Hz) in human epilepsy. *Clin Neurophysiol*, 121:1825–1831, 2010.

[J91] O. Blanke et al. Stimulating illusory own-body perceptions. *Brain*, 127(2):243–258, 2002.

[J92] R. Van Wijk et al. Ultra-weak Photon Emission and EEG Alpha Rhythm. *NeuroQuantology*, 16:452–463, 2008.

[J93] Rock Strassman et al. *Inner paths to Outer Space*. $http://www.amazon.com/Inner-Paths-Outer-Space-Psychedelics/dp/159477224X$. Park Street Press, Rochester Vermont, 2008.

[J94] S. Hameroff et al. Conduction pathways in microtubules, biological quantum computation, and consciousness. *Biosystems. $http://www.quantumconsciousness.org/biosystemselsevier.htm$*, 64(1-3):149–168, 2002.

[J95] S. Haraguchi et al. Biophoton Change by Mental Concentration. *J Intl Soc Life Info Science*, 2001.

[J96] S. Lin S et al. Comparison of bioenergy and physiological markers in qigong and acupuncture research. *National meeting of the Society for Acupuncture Research*, 2004.

[J97] S. Sahu et al. Atomic water channel controlling remarkable properties of a single brain microtubule: correlating single protein to its supramolecular assembly. *Biosens Bioelectron*, pages 141–148, 2013.

[J98] S. Sahu et al. Multi-level memory-switching properties of a single brain microtubule . *Appl Phys Lett. $http://dx.doi.org/10.1063/1.4793995$*, 102(123701), 2013.

[J99] S. W. Lazar et al. Meditation experience is associated with increased cortical thickness. *Neuroreport*, 16(17):1893–1897, 2005.

[J100] T. H. Bullock et al. Temporal fluctuations in coherence of brain waves. http://cogprints.soton.ac.uk/documents/disk0/00/00/01/11/cog00000111-00/Temp_fluc_coherence.htm, 1995.

[J101] U. Lindenberger et al. Brains swinging in concert: cortical phase synchronization while playing guitar. *BMC Neuroscience. $http://www.ukdistribute.com/links/1236944478453-BMCNeuroscience_Brains_swinging_in_concert.pdf$*, 2009:22, 2009.

[J102] W. Chen et al. Temperature and Biophoton Changes of the Middle Finger during Qigong and Light Imagery Tasks. *J Intl Soc Life Info Science*, 2002.

[J103] L. Fantappie. *Teoria Unitaria del Mondo Fisico e Biologico*. Di Renzo Editore, Roma, 1942.

[J104] H. Fröehlich. Bose condensation of strongly excited longitudinal electric modes. *Phys Lett A*, 26:402–403, 1968.

[J105] A. Bandyopadhyay G. Ghosh, S. Sahu. Evidence of massive global synchronization and the consciousness: Comment on "Consciousness in the universe: A review of the 'Orch OR' theory" by Hameroff and Penrose. *Biosens Bioelectron*, 2013.

[J106] G. S. Gericke. Reactive oxygen species and related haem pathway components as possible epigenetic modifiers in neurobehavioural pathology. *Med Hypotheses*, 66(1):92–99, 2006.

[J107] M. Germine. Scientific Validation of Planetary Consciousness. *Journal of Non-Locality and Remote Mental Interactions. $http://www.emergentmind.org/germineI3.htm$*, 1(3), 2002.

[J108] Mark Germine. Experimental verification of Stapp's theory'. `http://listserv.arizona.edu/lsv/www/quantum-mind.html`, 2000.

[J109] C. Gorski. Physicist Proposes New Way To Think About Intelligence. *Inside Science News Service.* `http://www.insidescience.org/content/physicist-proposes-new-way-think-about-intelligence/987`, 2013.

[J110] S. Grof and L. Halifax. *The Human Encounter with Death.* Souvenir Press, London, 1977.

[J111] S. Gupta and S. Hameroff. The Possibility of MAPs as Quantum Logic Gates in Neuronal Microtubules. `https://sbs.arizona.edu/project/consciousness/report_poster_detail.php?abs=1435`, 2013.

[J112] S. Hameroff and R. Penrose. Reply to criticism of the Orch OR qubitOrchestrated objective reduction is scientifically justified. *ScienceDirect.* `http://www.sciencedirect.com`, 2013.

[J113] S. R. Hameroff and R. Penrose. *Orchestrated reduction of quantum coherence in brain micro-tubules: A model for consciousness*, pages 507–540. MIT Press, Cambridge, 1996.

[J114] S. R. Hameroff and R. Penrose. *Orchestrated reduction of quantum coherence in brain microtubules: A model for consciousness.* MIT Press, Cambridge, 1996.

[J115] J. Hawkins. *On Intelligence.* St. Martin's Griffin, New York, 2004.

[J116] H. Hu and M. Wu. Action Potential Modulation of Neural Spin Networks Suggests Possible Role of Spin. *NeuroQuantology.* `http://cogprints.org/3458/1/SpinRole.pdf`, 4:309–317, 2004.

[J117] H. Hu and M. Wu. Thinking outside the box: the essence and implications of quantum entanglement. *NeuroQuantology*, 5:5–16, 2006.

[J118] J. Dai I. Bokkon and I. Antal. Picture representation during REM dreams: a redox molecular hypothesis. *Biosystems*, 100(2):79–86, 2010.

[J119] J. Jaynes. *The origin of consciousness in the breakdown of the bicameral mind.* Princeton University Press, 1982.

[J120] V. A. Lamme. Separate neural definitions of visual consciousness and visual attention: A case for phenomenal awareness. *Neural networks*, 17:861–872, 2004.

[J121] S. Lehar. *The world in your head.* Mahwah, NJ: Lawrence Erlbaum Associates, Inc., 2003.

[J122] B. Libet. Readiness potentials preceding unrestricted spontaneous and preplanned voluntary acts. `http://cornea.berkeley.edu/pubs/ccog_2002_0580-Klein-Commentary.pdf`, 1982.

[J123] R. Llinas. *I of the vortex: from neurons to self.* Cambrdige, MA: MIT Press, 2001.

[J124] C. Mahagita. Roles of meditation on alleviation of oxidative stress and improvement of antioxidant system. *J Med Assoc Thai*, 93 Suppl 6:S242–54, 2010.

[J125] D. McMillin. *The Pineal.* A.R.E. Press, Virginia, 1991.

[J126] T. Metzinger. *Being no one.* Cambridge, MA: MIT Press, 2003.

[J127] J. P. Miller. Brain Waves Deciphered. *Nature*, 384:6605, 1996.

[J128] R. Moody. *Life After Life.* Covinda, Gal: Mockingbird, 1975.

[J129] W. M. Neppe. The Out-of-Body Experiece: a Phenomenological Categorization. *Parapsychological Journal of South Africa*, 6(2):110–110, 1985.

[J130] P. Nogier. *Auriculotherapy to Auriculomedicine.* Sainte Ruffine, France: Maissonneuve, 1983.

[J131] J. O′Keefe and M. L. Recce. Phase relationship between hippocampal place units and the EEG theta rhythm. *Hippocampus. http://www3.interscience.wiley.com/cgi-bin/abstract/109711451/ABSTRACT*, (3):317–330, 2004.

[J132] J. K. O'Regan and A. Noe. A sensorimotor account of vision and visual consciousness. *Behavioural and Brain Sciences*, 24:939–1031, 2001.

[J133] R. Peoch. Chicken-robot interaction. *Medical Network. http://paranormal.se/psi/pk/djur.html*, 62, 1995.

[J134] M. Persinger. The tectonic strain theory as an explanation for UFO phenomena. `http://www.laurentian.ca/www/neurosci/tectonicedit.htm`, 1999.

[J135] M. A. Persinger and C. F Lavallee. Theoretical and Experimental Evidence of Macroscopic Entanglement between Human Brain Activity and Photon Emissions: Implications for Quantum Consciousness and Future Applications. *Journal of Consciousness Exploration & Research*, 1(7):785–807, October 2010.

[J136] C. B. Pert. *Molecules of Emotion.* Simon & Schuster Inc., 1997.

[J137] P. Pietch. Shuffle Brain: the The Quest for Hologramic Mind. `http://www.indiana.edu/~pietsch/shufflebrain-book00.html`, 1972.

[J138] K. H. Pribram. The Neurophysiology of Remembering. *Scientific American*, January 1969.

[J139] K. H. Probram. *Brain and Perception; Holonomy and Structure in Figural Processing.* Lawrence Eribaum Associates, 1991.

[J140] A. Revonsuo. Is synchronization the direct neural correlate of visual consciousness? `http://www.phil.vt.edu/ASSC/engel/revonsuo1.html`, 1998.

[J141] A. Revonsuo. *Consciousness. The science of subjectivity.* Psychology Press, `http://www.psypress.com`, 2010.

[J142] T. R. Sarbin and W. C. Coe. *Hypnosis: A Social Psychological Analysis of Influence Communication.* 1972.

[J143] H. Schmidt. The strange properties of psychokinesis. *Journal of Scientific Exploration. http://www.fourmilab.ch/rpkp/strange.html.*

[J144] J. R. Searle. *The rediscovery of the mind.* Cambridge, MA: MIT Press, 1992.

[J145] L. Sidoroff. The imprinting and transmission of mentally-directed bio-information. `http://www.emergentmind.org/sidorov_I.htm`, 2002.

[J146] L. Sidorov and K. W. Chen. Biophysical Mechanisms of Genetic Regulation: Is There a Link to Mind-Body Healing? *DNA Decipher Journal*, 2(2):177–205, 2012.

[J147] C. Smith. Learning From Water, A Possible Quantum Computing Medium. In *CASYS'2001, 5th international conference on Computing Anticipating Systems held in Liege, Belgium, August 13-18. Abstract book.* CHAOS, 2001.

[J148] J. Spottiswoode. Geomagnetic fluctuations and free response anomalous cognition: a new understanding. *Journal of Parapsychology. http://www.jsasoc.com/docs/JP-GMF.pdf*, 2002.

[J149] H. Stapp. Theoretical model of a purported empirical violation of the predictions of quantum theory. *Physica*, July 1994.

[J150] C. T. Tart. Psychophysiological Study of Out-of-the-Body Experiences in a Selected Subject. *Journal of the American Society for Psychical Research*, 62:3–27, 1968.

[J151] C. T. Tart. Six Studies of Out-of-the-Body Experience. *Journal of Near Death Studies*, March 1997.

[J152] M. Tegmark. The importance of quantum de-coherence in brain processes. `http://arxiv.org/abs/quant-ph/9907009`, 1999.

[J153] W. A. Tiller. Towards a Quantitative Science and Technology that Includes Human Consciousness. *Vision-In-Action. http://www.via-visioninaction.org*, 4, 2003.

[J154] W. A. Tiller and W. E. Dibble Jr. New experimental data revealing an unexpected dimension to materials science and engineering. *Mat. Res. Innovat.*, 5:21–34, 2001.

[J155] W. A. Tiller and W. E. Dibble Jr. Anomalous Temperature Oscillation Behavior Near a Source in a "Conditioned" Space: part I, The Spatial Variation. `http://tillerfoundation.com/newpapers.htm`, 2002.

[J156] G. Tononi. An integrated information theory of consciousness. In *Encyclopedia of consciousness*, pages 403–416. San Diego, CA: Academic Press, 2000.

[J157] M. Tye. *Consciousness revisited.* Cambridge, MA: MIT Press, 2009.

[J158] A. Vannini. Advanced Waves, Retrocausality, and Consciousness. 2007.

[J159] F. J. Varela. Reply to Owen and Morris. In *The view from within*, pages 271–273. Thorverton: Imprint Academic, 1999.

[J160] M. Velmans. *Understanding consciousness.* Hove: Routledge, 2009.

[J161] W. E. Dibble Jr. W. A. Tiller and M. J. Kohane. *Conscious Acts of Creation: the Emergence of a New Physics*, volume 17. Pavior Publishing, 2001.

[J162] E. H. Walker. Application of the quantum theory of consciousness to the problem of psi phenomena. In *Roll, W.G, Morris, R. L., Morris, J. D. (Eds), Research in Parapsychology, 1972*, pages 51–53. Metuchen, NJ. : Scarcecrow Prsess, 1973.

[J163] E. H. Walker. Foundations of paraphysical and parapsychological phenomena. In *In Oteri, L. (Ed.), Quantum Physics and Parapsychology*, pages 1–44. New York: Parapsychology Foundation, 1975.

[J164] K. Wilber. *Waves, Streams, States, and Self–A Summary of My Psychological Model.* Shambala Publications. `http://wilber.shambhala.com/html/books/psych_model/psych_model2.cfm/`, 2005.

[J165] C. Wang Y. Sun and J. Dai. Biophotons as neural communication signals demonstrated by in situ biophoton autography. *Photochem. Photobiol. Sci.*, 9:315–322, 2010.

[J166] Y. Yamaguchi. Laboratory for dynamics of emergent intelligence. `http://www.brain.riken.jp/reports/annual_reports/2003/2003-doc/0243.pdf`, 2003.

[J167] Y. Yamaguchi. Neural dynamics in Hippocampal Memory Formation via Theta Rhythm. `http://www.brain.riken.jp/bsi-news/bsinews22/no22/speciale.html`, 2003.

[J168] S. Zeki. Towards a theory of visual consciousness. *Consciousness and Cognition*, 8:225–259, 1999.

[J169] G. K. Zipf. *Psycho-Biology of Languages.* MIT Press, 1965.

Books related to TGD

[K1] P. Gariaev and M. Pitkänen. Model for the Findings about Hologram Generating Properties of DNA. In *Genes and Memes*. Onlinebook. `http://tgdtheory.fi/public_html/genememe/genememe.html#dnahologram`, 2011.

[K2] M. Pitkänen. 1983.

[K3] M. Pitkänen. Basic Properties of CP_2 and Elementary Facts about p-Adic Numbers. In *Towards M-matrix*. Onlinebook. `http://tgdtheory.fi/public_html/pdfpool/append.pdf`, 2006.

[K4] M. Pitkänen. A Model for Protein Folding and Bio-catalysis. In *Genes and Memes*. Onlinebook. `http://tgdtheory.fi/public_html/genememe/genememe.html#foldcat`, 2006.

[K5] M. Pitkänen. A Possible Explanation of Shnoll Effect. In *p-Adic Length Scale Hypothesis and Dark Matter Hierarchy*. Onlinebook. `http://tgdtheory.fi/public_html/paddark/paddark.html#ShnollTGD`, 2006.

[K6] M. Pitkänen. About Nature of Time. In *TGD Inspired Theory of Consciousness*. Onlinebook. `http://tgdtheory.fi/public_html/tgdconsc/tgdconsc.html#timenature`, 2006.

[K7] M. Pitkänen. About the New Physics Behind Qualia. In *Quantum Hardware of Living Matter*. Onlinebook. `http://tgdtheory.fi/public_html/bioware/bioware.html#newphys`, 2006.

[K8] M. Pitkänen. Basic Extremals of Kähler Action. In *Physics in Many-Sheeted Space-Time*. Onlinebook. `http://tgdtheory.fi/public_html/tgdclass/tgdclass.html#class`, 2006.

[K9] M. Pitkänen. *Bio-Systems as Conscious Holograms*. Onlinebook. `http://tgdtheory.fi/public_html/hologram/hologram.html`, 2006.

[K10] M. Pitkänen. Bio-Systems as Conscious Holograms. In *Bio-Systems as Conscious Holograms*. Onlinebook. `http://tgdtheory.fi/public_html/hologram/hologram.html#hologram`, 2006.

[K11] M. Pitkänen. *Bio-Systems as Self-Organizing Quantum Systems*. Onlinebook. `http://tgdtheory.fi/public_html/bioselforg/bioselforg.html`, 2006.

[K12] M. Pitkänen. Bio-Systems as Super-Conductors: part I. In *Quantum Hardware of Living Matter*. Onlinebook. `http://tgdtheory.fi/public_html/bioware/bioware.html#superc1`, 2006.

[K13] M. Pitkänen. Bio-Systems as Super-Conductors: part II. In *Quantum Hardware of Living Matter*. Onlinebook. `http://tgdtheory.fi/public_html/bioware/bioware.html#superc2`, 2006.

[K14] M. Pitkänen. Biological Realization of Self Hierarchy. In *Bio-Systems as Self-Organizing Quantum Systems*. Onlinebook. `http://tgdtheory.fi/public_html/bioselforg/bioselforg.html#bioselfc`, 2006.

[K15] M. Pitkänen. Configuration Space Spinor Structure. In *Quantum Physics as Infinite-Dimensional Geometry*. Onlinebook. `http://tgdtheory.fi/public_html/tgdgeom/tgdgeom.html#cspin`, 2006.

[K16] M. Pitkänen. Conscious Information and Intelligence. In *TGD Inspired Theory of Consciousness*. Onlinebook. `http://tgdtheory.fi/public_html/tgdconsc/tgdconsc.html#intsysc`, 2006.

[K17] M. Pitkänen. Construction of Configuration Space Kähler Geometry from Symmetry Principles. In *Quantum Physics as Infinite-Dimensional Geometry*. Onlinebook. `http://tgdtheory.fi/public_html/tgdgeom/tgdgeom.html#compl1`, 2006.

[K18] M. Pitkänen. Construction of Quantum Theory: M-matrix. In *Towards M-Matrix*. Onlinebook. `http://tgdtheory.fi/public_html/tgdquant/tgdquantum.html#towards`, 2006.

[K19] M. Pitkänen. Dark Forces and Living Matter. In *Hyper-finite Factors and Dark Matter Hierarchy*. Onlinebook. `http://tgdtheory.fi/public_html/neuplanck/neuplanck.html#darkforces`, 2006.

[K20] M. Pitkänen. Dark Matter Hierarchy and Hierarchy of EEGs. In *TGD and EEG*. Onlinebook. `http://tgdtheory.fi/public_html/tgdeeg/tgdeeg.html#eegdark`, 2006.

[K21] M. Pitkänen. Dark Nuclear Physics and Condensed Matter. In *Hyper-finite Factors and Dark Matter Hierarchy*. Onlinebook. `http://tgdtheory.fi/public_html/neuplanck/neuplanck.html#exonuclear`, 2006.

[K22] M. Pitkänen. Did Tesla Discover the Mechanism Changing the Arrow of Time? In *TGD and Fringe Physics*. Onlinebook. `http://tgdtheory.fi/public_html/freenergy/freenergy.html#tesla`, 2006.

[K23] M. Pitkänen. DNA as Topological Quantum Computer. In *Genes and Memes*. Onlinebook. `http://tgdtheory.fi/public_html/genememe/genememe.html#dnatqc`, 2006.

[K24] M. Pitkänen. Does TGD Predict the Spectrum of Planck Constants? In *Hyper-finite Factors and Dark Matter Hierarchy*. Onlinebook. `http://tgdtheory.fi/public_html/neuplanck/neuplanck.html#Planck`, 2006.

[K25] M. Pitkänen. Does the Modified Dirac Equation Define the Fundamental Action Principle? In *Quantum Physics as Infinite-Dimensional Geometry*. Onlinebook. `http://tgdtheory.fi/public_html/tgdgeom/tgdgeom.html#Dirac`, 2006.

[K26] M. Pitkänen. Does the QFT Limit of TGD Have Space-Time Super-Symmetry? In *Towards M-Matrix*. Onlinebook. `http://tgdtheory.fi/public_html/tgdquant/tgdquantum.html#susy`, 2006.

[K27] M. Pitkänen. Evolution in Many-Sheeted Space-Time. In *Genes and Memes*. Onlinebook. `http://tgdtheory.fi/public_html/genememe/genememe.html#prebio`, 2006.

[K28] M. Pitkänen. Expanding Earth Model and Pre-Cambrian Evolution of Continents, Climate, and Life. In *Genes and Memes*. Onlinebook. `http://tgdtheory.fi/public_html/genememe/genememe.html#expearth`, 2006.

[K29] M. Pitkänen. Fusion of p-Adic and Real Variants of Quantum TGD to a More General Theory. In *TGD as a Generalized Number Theory*. Onlinebook. `http://tgdtheory.fi/public_html/tgdnumber/tgdnumber.html#mblocks`, 2006.

[K30] M. Pitkänen. General Ideas about Many-Sheeted Space-Time: Part I. In *Physics in Many-Sheeted Space-Time*. Onlinebook. `http://tgdtheory.fi/public_html/tgdclass/tgdclass.html#topcond`, 2006.

[K31] M. Pitkänen. General Ideas about Many-Sheeted Space-Time: Part II. In *Physics in Many-Sheeted Space-Time*. Onlinebook. `http://tgdtheory.fi/public_html/tgdclass/tgdclass.html#newviews`, 2006.

[K32] M. Pitkänen. General Theory of Qualia. In *Bio-Systems as Conscious Holograms*. Onlinebook. `http://tgdtheory.fi/public_html/hologram/hologram.html#qualia`, 2006.

[K33] M. Pitkänen. Generalized Feynman Diagrams as Generalized Braids. In *Towards M-Matrix*. Onlinebook. `http://tgdtheory.fi/public_html/tgdquant/tgdquantum.html#braidfeynman`, 2006.

[K34] M. Pitkänen. Generalized Feynman Diagrams as Generalized Braids. In *Towards M-Matrix*. Onlinebook. `http://tgdtheory.fi/public_html/tgdquant/tgdquantum.html#braidfeynman`, 2006.

[K35] M. Pitkänen. *Genes and Memes*. Onlinebook. `http://tgdtheory.fi/public_html/genememe/genememe.html`, 2006.

[K36] M. Pitkänen. Genes and Memes. In *Genes and Memes*. Onlinebook. `http://tgdtheory.fi/public_html/genememe/genememe.html#genememec`, 2006.

[K37] M. Pitkänen. Homeopathy in Many-Sheeted Space-Time. In *Bio-Systems as Conscious Holograms*. Onlinebook. `http://tgdtheory.fi/public_html/hologram/hologram.html#homeoc`, 2006.

[K38] M. Pitkänen. Knots and TGD. In *Quantum Physics as Infinite-Dimensional Geometry*. Onlinebook. `http://tgdtheory.fi/public_html/tgdgeom/tgdgeom.html#knotstgd`, 2006.

[K39] M. Pitkänen. Macroscopic Quantum Coherence and Quantum Metabolism as Different Sides of the Same Coin: Part I. In *Bio-Systems as Conscious Holograms*. Onlinebook. `http://tgdtheory.fi/public_html/hologram/hologram.html#metab`, 2006.

[K40] M. Pitkänen. Macroscopic Quantum Coherence and Quantum Metabolism as Different Sides of the Same Coin: Part II. In *Bio-Systems as Conscious Holograms*. Onlinebook. `http://tgdtheory.fi/public_html/hologram/hologram.html#molephoto`, 2006.

[K41] M. Pitkänen. Magnetic Sensory Canvas Hypothesis. In *TGD and EEG*. Onlinebook. `http://tgdtheory.fi/public_html//tgdeeg/tgdeeg/tgdeeg.html#mec`, 2006.

[K42] M. Pitkänen. *Magnetospheric Consciousness*. Onlinebook. `http://tgdtheory.fi/public_html/magnconsc/magnconsc.html`, 2006.

[K43] M. Pitkänen. Magnetospheric Sensory Representations. In *Magnetospheric Consciousness*. Onlinebook. `http://tgdtheory.fi/public_html/magnconsc/magnconsc.html#srepres`, 2006.

[K44] M. Pitkänen. Many-Sheeted DNA. In *Genes and Memes*. Onlinebook. `http://tgdtheory.fi/public_html/genememe/genememe.html#genecodec`, 2006.

[K45] M. Pitkänen. Massless states and particle massivation. In *p-Adic Length Scale Hypothesis and Dark Matter Hierarchy*. Onlinebook. `http://tgdtheory.fi/public_html/paddark/paddark.html#mless`, 2006.

[K46] M. Pitkänen. *Mathematical Aspects of Consciousness Theory*. Onlinebook. `http://tgdtheory.fi/public_html/mathconsc/mathconsc.html`, 2006.

[K47] M. Pitkänen. Matter, Mind, Quantum. In *TGD Inspired Theory of Consciousness*. Onlinebook. `http://tgdtheory.fi/public_html/tgdconsc/tgdconsc.html#conscic`, 2006.

[K48] M. Pitkänen. Miscellaneous Topics. In *Quantum Physics as Infinite-Dimensional Geometry*. Onlinebook. `http://tgdtheory.fi/public_html/tgdgeom/tgdgeom.html#misc`, 2006.

[K49] M. Pitkänen. Negentropy Maximization Principle. In *TGD Inspired Theory of Consciousness*. Onlinebook. `http://tgdtheory.fi/public_html/tgdconsc/tgdconsc.html#nmpc`, 2006.

[K50] M. Pitkänen. New Particle Physics Predicted by TGD: Part II. In *p-Adic Length Scale Hypothesis and Dark Matter Hierarchy*. Onlinebook. `http://tgdtheory.fi/public_html/paddark/paddark.html#mass5`, 2006.

[K51] M. Pitkänen. Nuclear String Hypothesis. In *Hyper-finite Factors and Dark Matter Hierarchy*. Onlinebook. `http://tgdtheory.fi/public_html/neuplanck/neuplanck.html#nuclstring`, 2006.

[K52] M. Pitkänen. *p-Adic length Scale Hypothesis and Dark Matter Hierarchy*. Onlinebook. `http://tgdtheory.fi/public_html/paddark/paddark.html`, 2006.

[K53] M. Pitkänen. p-Adic Physics as Physics of Cognition and Intention. In *TGD Inspired Theory of Consciousness*. Onlinebook. `http://tgdtheory.fi/public_html/tgdconsc/tgdconsc.html#cognic`, 2006.

[K54] M. Pitkänen. p-Adic Physics: Physical Ideas. In *TGD as a Generalized Number Theory*. Onlinebook. `http://tgdtheory.fi/public_html/tgdnumber/tgdnumber.html#phblocks`, 2006.

[K55] M. Pitkänen. *Physics in Many-Sheeted Space-Time*. Onlinebook. `http://tgdtheory.fi/public_html/tgdclass/tgdclass.html`, 2006.

[K56] M. Pitkänen. Quantum Antenna Hypothesis. In *Quantum Hardware of Living Matter*. Onlinebook. `http://tgdtheory.fi/public_html/bioware/bioware.html#tubuc`, 2006.

[K57] M. Pitkänen. Quantum Astrophysics. In *Physics in Many-Sheeted Space-Time*. Onlinebook. `http://tgdtheory.fi/public_html/tgdclass/tgdclass.html#qastro`, 2006.

[K58] M. Pitkänen. Quantum Control and Coordination in Bio-systems: Part I. In *Bio-Systems as Self-Organizing Quantum Systems*. Onlinebook. `http://tgdtheory.fi/public_html/bioselforg/bioselforg.html#qcococI`, 2006.

[K59] M. Pitkänen. Quantum Control and Coordination in Bio-Systems: Part II. In *Bio-Systems as Self-Organizing Quantum Systems*. Onlinebook. `http://tgdtheory.fi/public_html/bioselforg/bioselforg.html#qcococII`, 2006.

[K60] M. Pitkänen. Quantum Field Theory Limit of TGD from Bosonic Emergence. In *Towards M-Matrix*. Onlinebook. `http://tgdtheory.fi/public_html/tgdquant/tgdquantum.html#emergence`, 2006.

[K61] M. Pitkänen. Quantum Hall effect and Hierarchy of Planck Constants. In *Hyper-finite Factors and Dark Matter Hierarchy*. Onlinebook. `http://tgdtheory.fi/public_html/neuplanck/neuplanck.#anyontgd`, 2006.

[K62] M. Pitkänen. *Quantum Hardware of Living Matter*. Onlinebook. `http://tgdtheory.fi/public_html/bioware/bioware.html`, 2006.

[K63] M. Pitkänen. Quantum Model for Bio-Superconductivity: I. In *TGD and EEG*. Onlinebook. `http://tgdtheory.fi/public_html//tgdeeg/tgdeeg/tgdeeg.html#biosupercondI`, 2006.

[K64] M. Pitkänen. Quantum Model for Bio-Superconductivity: II. In *TGD and EEG*. Onlinebook. `http://tgdtheory.fi/public_html//tgdeeg/tgdeeg/tgdeeg.html#biosupercondII`, 2006.

[K65] M. Pitkänen. Quantum Model for Hearing. In *TGD and EEG*. Onlinebook. `http://tgdtheory.fi/public_html//tgdeeg/tgdeeg/tgdeeg.html#hearing`, 2006.

[K66] M. Pitkänen. Quantum Model for Nerve Pulse. In *TGD and EEG*. Onlinebook. `http://tgdtheory.fi/public_html//tgdeeg/tgdeeg/tgdeeg.html#pulse`, 2006.

[K67] M. Pitkänen. Quantum Model for Paranormal Phenomena. In *TGD Inspired Theory of Consciousness*. Onlinebook. `http://tgdtheory.fi/public_html/tgdconsc/tgdconsc.html#parac`, 2006.

[K68] M. Pitkänen. Quantum Model for Sensory Representations. In *TGD Inspired Theory of Consciousness*. Onlinebook. `http://tgdtheory.fi/public_html/tgdconsc/tgdconsc.html#expc`, 2006.

[K69] M. Pitkänen. Quantum Model of EEG. In *TGD and EEG*. Onlinebook. `http://tgdtheory.fi/public_html/tgdeeg/tgdeeg.html#eegII`, 2006.

[K70] M. Pitkänen. Quantum Model of Memory. In *TGD Inspired Theory of Consciousness*. Onlinebook. `http://tgdtheory.fi/public_html/tgdconsc/tgdconsc.html#memoryc`, 2006.

[K71] M. Pitkänen. *Quantum Physics as Infinite-Dimensional Geometry*. Onlinebook.`http://tgdtheory.fi/public_html/tgdgeom/tgdgeom.html`, 2006.

[K72] M. Pitkänen. *Quantum TGD*. Onlinebook. `http://tgdtheory.fi/public_html/tgdquant/tgdquant.html`, 2006.

[K73] M. Pitkänen. Quantum Theory of Self-Organization. In *Bio-Systems as Self-Organizing Quantum Systems*. Onlinebook. `http://tgdtheory.fi/public_html/bioselforg/bioselforg.html#selforgac`, 2006.

[K74] M. Pitkänen. Riemann Hypothesis and Physics. In *TGD as a Generalized Number Theory*. Onlinebook. `http://tgdtheory.fi/public_html/tgdnumber/tgdnumber.html#riema`, 2006.

[K75] M. Pitkänen. Self and Binding. In *TGD Inspired Theory of Consciousness*. Onlinebook. `http://tgdtheory.fi/public_html/tgdconsc/tgdconsc.html#selfbindc`, 2006.

[K76] M. Pitkänen. Semi-trance, Mental Illness, and Altered States of Consciousness. In *Magnetospheric Consciousness*. Onlinebook. `http://tgdtheory.fi/public_html/magnconsc/magnconsc.html#semitrancec`, 2006.

[K77] M. Pitkänen. Semitrance, Language, and Development of Civilization. In *Magnetospheric Consciousness*. Onlinebook. `http://tgdtheory.fi/public_html/magnconsc/magnconsc.html#langsoc`, 2006.

[K78] M. Pitkänen. Super-Conductivity in Many-Sheeted Space-Time. In *Hyper-finite Factors and Dark Matter Hierarchy*. Onlinebook. `http://tgdtheory.fi/public_html/neuplanck/neuplanck.html#supercond`, 2006.

[K79] M. Pitkänen. TGD and Astrophysics. In *Physics in Many-Sheeted Space-Time*. Onlinebook. `http://tgdtheory.fi/public_html/tgdclass/tgdclass.html#astro`, 2006.

[K80] M. Pitkänen. TGD and Cosmology. In *Physics in Many-Sheeted Space-Time*. Onlinebook. `http://tgdtheory.fi/public_html/tgdclass/tgdclass.html#cosmo`, 2006.

[K81] M. Pitkänen. *TGD and EEG*. Onlinebook. `http://tgdtheory.fi/public_html/tgdeeg/tgdeeg.html`, 2006.

[K82] M. Pitkänen. *TGD and Fringe Physics*. Onlinebook. `http://tgdtheory.fi/public_html/freenergy/freenergy.html`, 2006.

[K83] M. Pitkänen. *TGD as a Generalized Number Theory*. Onlinebook. `http://tgdtheory.fi/public_html/tgdnumber/tgdnumber.html`, 2006.

[K84] M. Pitkänen. TGD as a Generalized Number Theory: Infinite Primes. In *TGD as a Generalized Number Theory*. Onlinebook. `http://tgdtheory.fi/public_html/tgdnumber/tgdnumber.html#visionc`, 2006.

[K85] M. Pitkänen. TGD as a Generalized Number Theory: p-Adicization Program. In *TGD as a Generalized Number Theory*. Onlinebook. `http://tgdtheory.fi/public_html/tgdnumber/tgdnumber.html#visiona`, 2006.

[K86] M. Pitkänen. TGD as a Generalized Number Theory: Quaternions, Octonions, and their Hyper Counterparts. In *TGD as a Generalized Number Theory*. Onlinebook. `http://tgdtheory.fi/public_html/tgdnumber/tgdnumber.html#visionb`, 2006.

[K87] M. Pitkänen. TGD Based Model for OBEs. In *TGD Inspired Theory of Consciousness*. Onlinebook. `http://tgdtheory.fi/public_html/tgdconsc/tgdconsc.html#OBE`, 2006.

[K88] M. Pitkänen. *TGD Inspired Theory of Consciousness*. Onlinebook. `http://tgdtheory.fi/public_html/tgdconsc/tgdconsc.html`, 2006.

[K89] M. Pitkänen. The Notion of Free Energy and Many-Sheeted Space-Time Concept. In *TGD and Fringe Physics*. Onlinebook. `http://tgdtheory.fi/public_html/freenergy/freenergy.html#freenergy`, 2006.

[K90] M. Pitkänen. The Notion of Wave-Genome and DNA as Topological Quantum Computer. In *Genes and Memes*. Onlinebook. `http://tgdtheory.fi/public_html/genememe/genememe.html#gari`, 2006.

[K91] M. Pitkänen. The Recent Status of Lepto-hadron Hypothesis. In *Hyper-finite Factors and Dark Matter Hierarchy*. Onlinebook. `http://tgdtheory.fi/public_html/neuplanck/neuplanck.html#leptc`, 2006.

[K92] M. Pitkänen. The Relationship Between TGD and GRT. In *Physics in Many-Sheeted Space-Time*. Onlinebook. `http://tgdtheory.fi/public_html/tgdclass/tgdclass.html#tgdgrt`, 2006.

[K93] M. Pitkänen. Three new physics realizations of the genetic code and the role of dark matter in bio-systems. In *Genes and Memes*. Onlinebook. `http://tgdtheory.fi/public_html/genememe/genememe.html#dnatqccodes`, 2006.

[K94] M. Pitkänen. Time and Consciousness. In *TGD Inspired Theory of Consciousness*. Onlinebook. `http://tgdtheory.fi/public_html/tgdconsc/tgdconsc.html#timesc`, 2006.

[K95] M. Pitkänen. Time, Spacetime and Consciousness. In *Bio-Systems as Conscious Holograms*. Onlinebook. `http://tgdtheory.fi/public_html/hologram/hologram.html#time`, 2006.

[K96] M. Pitkänen. *Topological Geometrodynamics: an Overview*. Onlinebook.`http://tgdtheory.fi/public_html/tgdview/tgdview.html`, 2006.

[K97] M. Pitkänen. Topological Quantum Computation in TGD Universe. In *Genes and Memes*. Onlinebook. `http://tgdtheory.fi/public_html/genememe/genememe.html#tqc`, 2006.

[K98] M. Pitkänen. Twistors, N=4 Super-Conformal Symmetry, and Quantum TGD. In *Towards M-Matrix*. Onlinebook. `http://tgdtheory.fi/public_html/tgdquant/tgdquantum.html#twistor`, 2006.

[K99] M. Pitkänen. Ufos, Aliens, and the New Physics. In *Magnetospheric Consciousness*. Onlinebook. `http://tgdtheory.fi/public_html/magnconsc/magnconsc.html#mantleufo`, 2006.

[K100] M. Pitkänen. Was von Neumann Right After All. In *Hyper-finite Factors and Dark Matter Hierarchy*. Onlinebook. `http://tgdtheory.fi/public_html/neuplanck/neuplanck.html#vNeumann`, 2006.

[K101] M. Pitkänen. Wormhole Magnetic Fields. In *Quantum Hardware of Living Matter*. Onlinebook. `http://tgdtheory.fi/public_html/bioware/bioware.html#wormc`, 2006.

[K102] M. Pitkänen. Yangian Symmetry, Twistors, and TGD. In *Towards M-Matrix*. Onlinebook. `http://tgdtheory.fi/public_html/tgdquant/tgdquantum.html#Yangian`, 2006.

[K103] M. Pitkänen. Motives and Infinite Primes. In *TGD as a Generalized Number Theory*. Onlinebook. `http://tgdtheory.fi/public_html/tgdnumber/tgdnumber.html#infmotives`, 2011.

[K104] M. Pitkänen. Quantum Arithmetics and the Relationship between Real and p-Adic Physics. In *TGD as a Generalized Number Theory*. Onlinebook. `http://tgdtheory.fi/public_html/tgdnumber/tgdnumber.html#qarithmetics`, 2011.

[K105] M. Pitkänen. Quantum Adeles. In *TGD as a Generalized Number Theory*. Onlinebook. `http://tgdtheory.fi/public_html/tgdnumber/tgdnumber.html#galois`, 2012.

[K106] M. Pitkänen. Quantum Mind and Neuroscience. In *TGD based view about living matter and remote mental interactions*. Onlinebook. `http://tgdtheory.fi/public_html/pdfpool/lianPN.pdf`, 2012.

[K107] M. Pitkänen. Quantum Mind, Magnetic Body, and Biological Body. In *TGD based view about living matter and remote mental interactions*. Onlinebook. `http://tgdtheory.fi/public_html/pdfpool/lianPB.pdf`, 2012.

[K108] M. Pitkänen. TGD Based View about Classical Fields in Relation to Consciousness Theory and Quantum Biology. In *TGD and EEG*. Onlinebook. `http://tgdtheory.fi/public_html/tgdeeg/tgdeeg.html#maxtgdc`, 2012.

[K109] M. Pitkänen. *TGD Based View About Living Matter and Remote Mental Interactions*. Onlinebook. `http://tgdtheory.fi/public_html/tgdlian/tgdlian.html`, 2012.

[K110] M. Pitkänen. TGD inspired view about remote mental interactions and paranormal. In *TGD based view about living matter and remote mental interactions*. Onlinebook. `http://tgdtheory.fi/public_html/pdfpool/lianPRM.pdf`, 2012.

[K111] M. Pitkänen. About Concrete Realization of Remote Metabolism. In *Bio-Systems as Conscious Holograms*. Onlinebook. `http://tgdtheory.fi/public_html/hologram/hologram.html#remotetesla`, 2013.

[K112] M. Pitkänen. Are dark photons behind biophotons. In *TGD based view about living matter and remote mental interactions*. Onlinebook. `http://tgdtheory.fi/public_html/pdfpool/biophotonslian.pdf`, 2013.

[K113] M. Pitkänen. Comments on the recent experiments by the group of Michael Persinger. In *TGD based view about living matter and remote mental interactions*. Onlinebook. `http://tgdtheory.fi/public_html/pdfpool/persconsc.pdf`, 2013.

[K114] M. Pitkänen. Comparison of TGD inspired theory of consciousness with some other theories of consciousness. In *TGD based view about living matter and remote mental interactions*. Onlinebook. `http://tgdtheory.fi/public_html/pdfpool/consccomparison.pdf`, 2013.

[K115] M. Pitkänen. *Hyper-finite Factors and Dark Matter Hierarchy*. Onlinebook. `http://tgdtheory.fi/public_html/neuplanck/neuplanck.html`, 2013.

[K116] M. Pitkänen. *p-Adic length Scale Hypothesis*. Onlinebook. `http://tgdtheory.fi/public_html/padphys/padphys.html`, 2013.

[K117] M. Pitkänen. *Quantum TGD*. Onlinebook. `http://tgdtheory.fi/public_html/tgdquantum/tgdquantum.html`, 2013.

[K118] M. Pitkänen. TGD and Potential Anomalies of GRT. In *Physics in Many-Sheeted Space-Time*. Onlinebook. `http://tgdtheory.fi/public_html/tgdclass/tgdclass.html#granomalies`, 2013.

[K119] M. Pitkänen. What p-Adic Icosahedron Could Mean? And What about p-Adic Manifold? In *TGD as a Generalized Number Theory*. Onlinebook. `http://tgdtheory.fi/public_html/tgdnumber/tgdnumber.html#picosahedron`, 2013.

[K120] M. Pitkänen and P. Gariaev. Quantum Model for Remote Replication. In *Genes and Memes*. Onlinebook. `http://tgdtheory.fi/public_html/genememe/genememe.html#remotereplication`, 2011.

Articles about TGD

[L1] M. Pitkänen. Biosystems as macroscopic quantum systems. *Journal of Non-Locality and Remote Mental Interactions*, 2002.

[L2] M. Pitkänen. Manysheeted DNA. *Journal of Non-Locality and Remote Mental Interactions*, 2002.

[L3] M. Pitkänen. Quantum model for nerve pulse, EEG, and ZEG. *Journal of Non-Locality and Remote Mental Interactions*, 2002.

[L4] M. Pitkänen. Quantum model for sensory receptor. *Journal of Non-Locality and Remote Mental Interactions*, 2002.

[L5] M. Pitkänen. TGD Inspired Theory Of Consciousness And Biosystems As Macroscopic Quantum Systems. *Journal of Non-Locality and Remote Mental Interactions*, 2002.

[L6] M. Pitkänen. Time, space-time, and consciousness. *Journal of Non-Locality and Remote Mental Interactions*, 2002.

[L7] M. Pitkänen. Biosystems as conscious holograms. *Journal of Non-Locality and Remote Mental Interactions*, 2003.

[L8] M. Pitkänen. Macrotemporal quantum coherence, quantum spin glass degeneracy, and number theoretic information concept. *Journal of Non-Locality and Remote Mental Interactions*, 2003.

[L9] M. Pitkänen. Basic Properties of CP_2 and Elementary Facts about p-Adic Numbers. `http://tgdtheory.fi/pdfpool/append.pdf`, 2006.

[L10] M. Pitkänen. Further Progress in Nuclear String Hypothesis. `http://tgdtheory.fi/articles/nuclstring.pdf`, 2007.

[L11] M. Pitkänen. Physics as Generalized Number Theory II: Classical Number Fields. `https://www.createspace.com/3569411`, July 2010.

[L12] M. Pitkänen. Physics as Infinite-dimensional Geometry I: Identification of the Configuration Space Kähler Function. `https://www.createspace.com/3569411`, July 2010.

[L13] M. Pitkänen. Physics as Infinite-dimensional Geometry II: Configuration Space Kähler Geometry from Symmetry Principles. `https://www.createspace.com/3569411`, July 2010.

[L14] M. Pitkänen. Physics as Generalized Number Theory I: p-Adic Physics and Number Theoretic Universality. `https://www.createspace.com/3569411`, July 2010.

[L15] M. Pitkänen. Physics as Generalized Number Theory III: Infinite Primes. `https://www.createspace.com/3569411`, July 2010.

[L16] M. Pitkänen. Physics as Infinite-dimensional Geometry III: Configuration Space Spinor Structure. `https://www.createspace.com/3569411`, July 2010.

[L17] M. Pitkänen. Physics as Infinite-dimensional Geometry IV: Weak Form of Electric-Magnetic Duality and Its Implications. `https://www.createspace.com/3569411`, July 2010.

[L18] M. Pitkänen. Quantum Mind in TGD Universe. `https://www.createspace.com/3564790`, November 2010.

[L19] M. Pitkänen. Quantum Mind, Magnetic Body, and Biological Body. `https://www.createspace.com/3564790`, November 2010.

[L20] M. Pitkänen. TGD Inspired Theory of Consciousness. *Journal of Consciousness Exploration & Research*, 1(2):135–152, March 2010.

[L21] M. Pitkänen. The Geometry of CP_2 and its Relationship to Standard Model. `https://www.createspace.com/3569411`, July 2010.

[L22] M. Pitkänen. DNA Waves and Water. `http://tgdtheory.fi/public_html/articles/mont.pdf`, 2011.

[L23] M. Pitkänen. Generalization of thermodynamics allowing negentropic entanglement and a model for conscious information processing. `http://tgdtheory.fi/articles/thermolife.pdf`, 2011.

[L24] M. Pitkänen. A Proposal for Memory Code. `http://tgdtheory.fi/articles/memorycode.pdf`, 2012.

[L25] M. Pitkänen. Evolution of TGD. `http://tgdtheory.fi/articles/howitwent.pdf`, 2012.

[L26] M. Pitkänen. How to build a quantum computer from magnetic flux tubes? `http://tgdtheory.fi/articles/fluxtubecomputer.pdf`, 2012.

[L27] M. Pitkänen. Quantum Model for the Direct Currents of Becker. `http://tgdtheory.fi/public_html/articles/DCbio.pdf`, 2012.

[L28] M. Pitkänen. Two attempts to understand PK. `http://tgdtheory.fi/public_html/articles/PKoptions.pdf`, 2012.

[L29] M. Pitkänen. Updated view about the hierarchy of Planck constants. *Prespacetime Journal,$http://prespacetime.com/index.php/pst/issue/view/34$*, 3(11), 2012.

[L30] M. Pitkänen. "Applied biophysics of activated water" and the basic mechanism of water memory in TGD framework. `http://tgdtheory.fi/public_html/articles/activatedwater.pdf`, 2013.

[L31] M. Pitkänen. Commentary on "Consciousness as a phenomenon in the operational architectonics of brain organization: Criticality and self-organization considerations" by Adrew A. Fingelkurts, Alexander A. Fingelkurts, and Carlos F. H. Neves. `http://tgdtheory.fi/public_html/articles/Fingelkurts.pdf`, 2013.

[L32] M. Pitkänen. Comments on the recent experiments by the group of Michael Persinger. `http://tgdtheory.fi/public_html/articles/persconsc.pdf`, 2013.

[L33] M. Pitkänen. Comparison of TGD inspired theory of consciousness with some other theories of consciousness, 2013.

[L34] M. Pitkänen. Hypnosis as Remote Mental Interaction. `http://tgdtheory.fi/public_html/articles/hypnosisarticle.pdf`, 2013.

[L35] M. Pitkänen. CMAP representations about TGD. `http://www.tgdtheory.fi/cmaphtml.html`, 2014.

[L36] M. Pitkänen. CMAP representations about TGD, and TGD inspired theory of consciousness and quantum biology. `http://www.tgdtheory.fi/tgdglossary.pdf`, 2014.

[L37] M. Pitkänen. New results about microtubules as quantum systems. `http://tgdtheory.fi/public_html/articles/microtubule.pdf`, 2014.

[L38] M. Pitkänen. Pollack's Findings about Fourth phase of Water: TGD View. `http://tgdtheory.fi/public_html/articles/PollackYoutube.pdf`, 2014.

[L39] Matti Pitkänen. Basic Mechanisms associated with magnetic body.`http://www.tgdtheory.fi/webCMAPs/BasicMechanismsassociatedwithmagneticbody.html`. 2014.

[L40] Matti Pitkänen. Basic TGD.`http://www.tgdtheory.fi/webCMAPs/BasicTGD.html`. 2014.

[L41] Matti Pitkänen. Bio-anomalies.`http://www.tgdtheory.fi/webCMAPs/Bio-anomalies.html`. 2014.

[L42] Matti Pitkänen. Biophotons.`http://www.tgdtheory.fi/webCMAPs/Biophotons.html`. 2014.

[L43] Matti Pitkänen. Biophotons.`http://www.tgdtheory.fi/webCMAPs/Biophotons.html`. 2014.

[L44] Matti Pitkänen. Cell membrane anomalies.`http://www.tgdtheory.fi/webCMAPs/Cellmembraneanomalies.html`. 2014.

[L45] Matti Pitkänen. Dark proton strings and genetic code.`http://www.tgdtheory.fi/webCMAPs/Darkprotonstringsandgeneticcode.html`. 2014.

[L46] Matti Pitkänen. DC currents of Becker.`http://www.tgdtheory.fi/webCMAPs/DCcurrentsofBecker.html`. 2014.

[L47] Matti Pitkänen. ELF effects on brain.`http://www.tgdtheory.fi/webCMAPs/ELFeffectsonbrain.html`. 2014.

[L48] Matti Pitkänen. Generalized Feynman diagrams.`http://www.tgdtheory.fi/webCMAPs/GeneralizedFeynmandiagrams.html`. 2014.

[L49] Matti Pitkänen. Geometrization of fields.`http://www.tgdtheory.fi/webCMAPs/Geometrizationoffields.html`. 2014.

[L50] Matti Pitkänen. Hierarchy of Planck constants.`http://www.tgdtheory.fi/webCMAPs/HierarchyofPlanckconstants.html`. 2014.

[L51] Matti Pitkänen. Key notions and ideas of TGD.`http://www.tgdtheory.fi/webCMAPs/KeynotionsandideasofTGD.html`. 2014.

[L52] Matti Pitkänen. Magnetic body.`http://www.tgdtheory.fi/webCMAPs/Magneticbody.html`. 2014.

[L53] Matti Pitkänen. Microtubules.`http://www.tgdtheory.fi/webCMAPs/Microtubules.html`. 2014.

[L54] Matti Pitkänen. Negentropy Maximization Principle.`http://www.tgdtheory.fi/webCMAPs/NegentropyMaximizationPrinciple.html`. 2014.

[L55] Matti Pitkänen. Overall view about TGD.`http://www.tgdtheory.fi/webCMAPs/OverallviewaboutTGD.html`. 2014.

[L56] Matti Pitkänen. Pollack's observations.`http://www.tgdtheory.fi/webCMAPs/Pollack'sobservations.html`. 2014.

[L57] Matti Pitkänen. Pollack's observations.`http://www.tgdtheory.fi/webCMAPs/Pollack'sobservations.html`. 2014.

[L58] Matti Pitkänen. Quantum antenna hypothesis.`http://www.tgdtheory.fi/webCMAPs/Quantumantennahypothesis.html`. 2014.

[L59] Matti Pitkänen. Quantum consciousness.`http://www.tgdtheory.fi/webCMAPs/Quantumconsciousness.html`. 2014.

[L60] Matti Pitkänen. Quantum gravity and biology.http://www.tgdtheory.fi/webCMAPs/Quantumgravityandbiology.html. 2014.

[L61] Matti Pitkänen. Quantum metabolism.http://www.tgdtheory.fi/webCMAPs/Quantummetabolism.html. 2014.

[L62] Matti Pitkänen. Quantum model for nerve pulse.http://www.tgdtheory.fi/webCMAPs/Quantummodelfornervepulse.html. 2014.

[L63] Matti Pitkänen. Quantum model for sensory perception.http://www.tgdtheory.fi/webCMAPs/Quantummodelforsensoryperception.html. 2014.

[L64] Matti Pitkänen. Quantum model for sensory receptor.http://www.tgdtheory.fi/webCMAPs/Quantummodelforsensoryreceptor.html. 2014.

[L65] Matti Pitkänen. Quantum model of EEG.http://www.tgdtheory.fi/webCMAPs/QuantummodelofEEG.html. 2014.

[L66] Matti Pitkänen. Space-time as 4-surface in $M^4 x CP_2$.http://www.tgdtheory.fi/webCMAPs/Space-timeas4-surfaceinM^4xCP_2.html. 2014.

Matti Pitkänen. TGD as unified theory of fundamental interactions.http://www.tgdtheory.fi/webCMAPs/TGDasunifiedtheoryoffundamentalinteractions.html. 2014.

Matti Pitkänen. TGD inspired theory of consciousness.http://www.tgdtheory.fi/webCMAPs/TGDinspiredtheoryofconsciousness.html. 2014.

Matti Pitkänen. The role of microtubules.http://www.tgdtheory.fi/webCMAPs/Theroleofmicrotubules.html. 2014.

Matti Pitkänen. Water memory and homeopathy.http://www.tgdtheory.fi/webCMAPs/Watermemoryandhomeopa html. 2014.

Matti Pitkänen. What TGD is.http://www.tgdtheory.fi/webCMAPs/WhatTGDis.html. 2014.

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TGD BASED VIEW ABOUT LIVING MATTER AND REMOTE MENTAL INTERACTIONS

Topological Geometrodynamics (TGD) is a modification of general relativity inspired by the problems related to the definition of inertial and gravitational energies in general relativity. TGD The notion of many-sheeted space-time allows re-interpretation of the structure of perceived world in terms of macroscopic space-time topology and becomes especially important in TGD based quantum biology.

The generalization of number concept based on the fusion of real numbers and p-adic number fields generalizes the space-time concept allowing to identify space-time correlates of cognition and intentionality and leads to an identification of information measure for entanglement as a version of Shannon entropy implying the notion of negentropic entanglement. Negentropy Maximization Principle (NMP) defines the basic dynamical principle of consciousness. A precise definition of self and understanding of the arrow of psychological time emerges. Magnetic body carrying dark matter carrying large Planck constant phases at its flux tubes and receiving sensory input from and sending control commands to the biological body becomes the basic intentional agent in living matter. This creates a novel way of modeling consciousness, intention, human beings and living entities in our reality.

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Ph.D. Matti Pitkänen started to work with the basic idea of TGD at 1977, published his doctoral thesis work about TGD at 1982, and has since then worked to transform the basic vision to a consistent predictive mathematical framework, to solve various interpretational issues, and understand the relationship of TGD with existing theories. The work with quantum consciousness and biology began around 1993 as possible applications of TGD vision.

TGD Web Pages: http://www.tgdtheory.com
TGD Diary and Blog: http://matpitka.blogspot.com