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Quantum Theory and the Nature of Consciousness[1]

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Keywords: Consciousness, Psyche, Philosophy of Science, Quantum Information, Evolution, Protyposis

Abstract

So far the main obstacle for a scientific conception of consciousness as a real and powerfully acting entity was not inherent to the realms of psychology or brain research, but rather the field of physics. A solution had to be sought here. Such a solution is afforded by a new foundation of the physical reality established by abstract and absolute quantum bits of information (AQI bits).

To avoid the popular misunderstanding of „information“ as „meaning“ it was advisable to coin a new designation for the free-of-meaning AQI bits: the AQI bits establish a quantum pre-structure termed „protyposis“ (Greek: „pre-formation“), out of which real objects can form, beginning with energetical and material elementary particles.

The protyposis AQI bits provide a pre-structure for all entities encountered in natural sciences. The AQI bits establish a common basis, from which, in the course of the cosmological and encompassed biological evolution, both the material reality of the brain and the mental reality of the consciousness has formed.

A real understanding of quantum structures can remove the resistance against establishing quantum theory in the field of brain research and consciousness. The key for an understanding lies in the conception of protyposis, abstract quantum information free of any definite meaning. With the AQI bits of the protyposis, massless and massive quantum particles can be constructed, and, ultimately, even quantum information with a special meaning, such as our grammatically formulated thoughts, can become possible.

As long as the fundamental basis of quantum theory is misunderstood as being formed by a manifold of some small objects like atoms, quarks, or strings, then the problem of understanding consciousness has no solution. If in contrast to this quantum theory is understood as a theory based on quantum structures that are not spatially small but truly simple, then there is no longer a fundamental problem for an understanding of consciousness.

[1] This is an extended version of a lecture given in German at the conference “Was ist Geist”, published as: Brigitte Görnitz, Thomas Görnitz: Das Geistige im Blickfeld der Naturwissenschaft – Bewusstsein und Materie als spezielle Formen der Quanteninformation, in Weinzirl, J., Heusser, P. (Eds.): *Was ist Geist*, Würzburg: Königshausen &Neumann (2014)
A comprehensive monograph is: Thomas Görnitz, Brigitte Görnitz*: Von der Quantenphysik zum Bewusstsein,* Heidelberg, Springer (2016), eBook ISBN 978-3-662-49082-2, see http://www.springer.com/de/book/9783662490815

1. Introduction

The brain is the very organ, whose functioning gives rise to what we experience as our conscious personality. At present, the publication of books on brain research is booming. However, as an attentive reader will not miss to notice, those books dwell at length on matters such as "neuronal correlates of consciousness", but fail to present an actual explanation of the nature of consciousness itself.

On the other hand, there is a wealth of publications addressing the various aspects of perception and consciousness. Here it is rightly understood that consciousness is a basic and undeniable reality in human life. That the consciousness of a living person presupposes a normally working brain is accepted as being obvious.

The important research results, in particular experimental findings, so far achieved and to be achieved further in the two mentioned topics, will not be the concern of this article. Rather it is the explanatory gap, mostly covered up rather eloquently and concealed from the unsuspecting reader: the gap between the material reality of the brain and the mental reality of the consciousness that cannot be bridged by the traditional concepts. That explanatory gap will be the topic of this paper. As will be explained, quantum theory, more precisely, the theory of abstract free-of-meaning bits of quantum information (AQI bits) has made it possible to close the explanatory gap.

As has rightly been pointed out, there is a large body of experimental and theoretical work addressing important aspects of the connection between neuro-physiological and psychological data. However, it is usually maintained that all that has nothing to do with quantum theory.

The fact that all the modern techniques of probing the living brain require devices inconceivable without quantum theory, such as MNR scanners or the comprehensive computer-based data processing, is of course only a secondary aspect. Much more important is that all biochemical processes ultimately base on the emission and absorption of real and virtual photons. Moreover, in unstable situations, a characteristic of living beings, the accuracy of quantum theory may become relevant for systems usually termed „macroscopic“, for example, nerve cells. Whenever high accuracy is required, quantum phenomena can no longer be ignored. Often, however, it will be sufficient to deal with the reduced accuracy provided by averaging a great many similar quantum processes, which then may create the appearance that the accuracy of quantum theory is unnecessary.

The most important aspect, though, is the role attributed to information.

Permanent feedback processes take place in the brain. As known from theories on non-linear dynamic phenomena, here permanently situations arise commonly denoted as bifurcation points. At least in such situations, the accuracy of quantum theory can no longer be ignored. In those situations, constantly and ubiquitously encountered in the body, meaningful information can act as a steering agent. This implies that the material or energetical carriers of the information are of less importance than the meaningful contents. Here the respective meaning is coded in a receiver-specific way, being, for example, different for the various types of cells in the body. The decryption of those codes is a wide and important field of research, directly relevant to human health issues.

The meaning of an information is strictly to be distinguished from the material or energetic carriers involved in the processing of information. Many previous concepts resort to magic formulas, such as „emergence“ or „functional link“, which, however, obscure the fact that an actual understanding of the essence of „consciousness“ is thereby not afforded. This applies also to the comprehensive and valuable studies on the correlations between activities in brain

regions and the conscious experience of visual, auditory, and mental impressions.[2] Of course, one can simply require that „consciousness“ is a well-known phenomenon, but obviously the acknowledgment of its existence does not make obsolete the need for a scientific foundation.

> „ART (Adaptive Resonance Theory) clarifies key brain processes from which conscious experiences emerge. It predicts a functional link between processes of Consciousness, Learning, Expectation, Attention, Resonance, and Synchrony (the CLEARS processes).“[2]

> „It is just a step from here to propose that those experiences which can attract our attention and guide our future lives after being learned are also among the ones that are conscious. Support for the predicted link between resonance and consciousness comes many modeling studies wherein the parametric properties of brain resonances map onto parametric properties of conscious behavioral experiences in the simulated experiments. Indeed, without such a linking hypothesis between brain mechanisms and behavioral functions, no theory of consciousness can be fully tested.“[3]

It is important to investigate and understand all the correlations between brain physiology and contents of the consciousness. However, that is not the purpose of the present article. Rather, what shall be explained scientifically is the „linking hypothesis between brain mechanisms and behavioral functions“.

> „I have predicted that such a consciously visible percept is supported by a surface-shroud resonance between visual cortical areas and the parietal cortex that is predicted to play a role in learning invariant object categories (Section 17). This prediction illustrates how ART clarifies mechanistic relationships between the CLEARS processes of consciousness, learning, expectation, attention, resonance, and synchrony.“[4]

The reference to correlation is not sufficient though; the challenge is to explain consciousness from a natural-scientific point of view. This has been achieved in a comprehensive recent monograph,[6] abandoning the path predefined by mainstream science, that endeavor could not succeed without a theory of abstract and free-of-meaning bits of quantum information (AQI bits).

In a very interesting paper, Coward und Sun[7] address the design of possible theories of consciousness. Sketching a hierarchical structure, they note:

> „Detailed descriptions are usually more accurate but information-dense and therefore often beyond human comprehensibility (unless limited to tiny segments of a macro-level phenomenon). High-level descriptions are usually much less information-dense but more approximate.“

As Coward and Sun let their hierarchy begin at the level of elementary particles, in the stages above atoms, molecules, cells, etc., there is no scientific approach to what constitutes consciousness, namely meaningful information, or to the so-called “hard problem”:

> „How does this relate to the so-called “hard problem”: “Why is it that when our cognitive systems engage in visual and auditory information processing, we have visual or auditory experience: the quality of deep blue, the sensation of middle C? How can we explain why there is something it is like to entertain a mental image, or to experience an emotion?” (Chalmers, 1995). This is not exactly a scientific question within the current

[2] Grossberg (2013), p. 2
[3] Grossberg (2013), p. 6
[4] Grossberg (2013), p. 15

> scope of science, although a scientific understanding will probably reduce the sense of mystery around the questions by giving a better perspective on the issue. “[5]

Hence, the authors end with the insight:

> „An argument has been made here that a scientific theory of consciousness analogous with theories in the physical sciences is likely to be possible, but the form of that science may be different from some existing (and often widespread) expectations because of the misunderstanding of what a theory in the physical sciences actually delivers. The rough general form of an eventual theory of consciousness has been outlined (to a very limited extent, of course), and issues with a few of the many approaches to understanding consciousness briefly identified.“[6]

In this context, it is important to distinguish „intelligence“ and „consciousness“. As „deep learning“ shows ever more clearly, multi-layered technical neuronal networks can be devised to acquire pattern recognition capabilities, building on huge data sets supplied by their - equipped with consciousness - constructors. As those technical constructs show, the distinction is essential of intelligent behavior that those systems have, and consciousness that they have not.

In the better books of major brain researchers, it is openly admitted that so far mainstream science has not resolved the issue „what is consciousness?“.

To the question "What is consciousness?" the brain researcher Christof Koch responds, "Your inner experience", adding "That experience is generated somewhere in the catacombs of the cerebrum. How this comes about, is a deep mystery."[7]

Rather cryptically, Wolf Singer speaks of a "phase transition". According to Gerhard Roth, consciousness is "a physical state sui generis obeying various particular laws of nature"[8], however, without further specifying what those laws might be. Hans J. Markowitsch, a leading German brain researcher, renowned in particular for his distinguished studies on memory, comments on the situation here as follows: "A fundamental paradigm change wouldn't be too bad!" However, as he has pointed out in a very interesting interview conducted by the science journalist Matthias Eckoldt, exactly that cannot be afforded due to the present structure of the sciences: "Scientists are under pressure to produce continuous output. That only works if one sticks to the familiar old stuff and addresses topics on the safe side."

One should expect that a new generation of young researchers will come up with new ideas so far wanting. However, Christoph von der Malsburg, leading neuro-informatics scientist in Germany, does not expect, given the present scientific environment, that the young academics will be in the position to trigger a decisive paradigm change in brain research:[9] "The young researchers stick even stronger to fashionable topics and refrain from pursuing dissenting ideas. Otherwise they couldn't publish their papers. When the referees keep saying we don't understand that and reject your articles, their young scientific career will be over after three years."

In view of this situation, one can hardly escape the following conclusion:

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[5] Coward, L A, Sun, R (2007), p. 953
[6] Coward, L A, Sun, R (2007), p. 953
[7] http://www.zeit.de/2013/44/christof-koch-bewusstsein-hirnforschung
[8] Roth G. Geist und Bewusstsein als physikalische Zustände. In: Dresler M. (Hrsg) Kognitive Leistungen. Intelligenz und mentale Fähigkeiten im Spiegel der Neurowissenschaften. Heidelberg: Spektrum Springer; 2011: 172
[9] Eckoldt, S. 20 f.

- *The necessary paradigm change will not come about within the brain research community, irrespective of how many millions of funding money will flow in. The impulse has to come from outside, from the foundations of natural sciences.*

Concerning the relation between brain research and humanities let us note that reservations against a natural scientific explanation of consciousness have been raised in particular from the side of humanities.

As we tend to assume, the rejection of physicalism and reductionism reflects the fear that the diversity and reality of life processes could ultimately be traced back to something like a "movement of tiny little balls". That this is impossible was already formulated in 1872 by the famous physician Emil Du Bois-Reymond at the Conference of Natural Research Scientists and Physicians in his speech "On the Limits of the Knowledge of Nature":

- "*It is definitely and forever incomprehensible that it should not be unimportant for a number of carbon-, hydrogen-, nitrogen-, oxygen- etc. atoms how they lie and move, how they lay and moved, how they will lie and move. There is absolutely no way to understand how consciousness could emerge from their connection.*"

As already noted, with regard to the appearance of a definitely different quality, namely, that of consciousness, the term emergence is often used these days. However, "emergence" is not an explanation at all, and we have to understand how to explain the new quality scientifically.

All the sciences dealing with nature and, in particular, human beings, are concerned with objects full of color, diversity, and beauty. And having perhaps learned in school that physics is the science of inanimate nature, then opposition and prejudice against the scientific explanation of consciousness have been preprogrammed. Also in that respect, quantum theory has initiated a radical change, as presently is realized by the researchers in various scientific fields. Only quantum theory can establish why in molecules something completely different from the original atoms can emerge, having entirely new characteristics. In the chemical bonding of atoms to a molecule the electrons of the atomic valence shells are 'socialized' forming a new whole, and all that can only be explained by quantum theory. Ultimately, quantum theory also allows us to understand the great leap from inanimate matter to the area of living beings in the course of the evolution.

In the following we shall discuss why and how quantum theory allows ourselves to go from the physiology of the brain to a scientific understanding of the conscious and unconscious components of its information processing, which, for humans, may be designated by the term psyche.

2. Explaining very briefly the essential structures of quantum theory

2.1. Quantum theory is realistic

- *Quantum theory – when correctly interpreted – is, in its general basic features, not at all "puzzling".*

When we attempt to comprehend essential specific features of quantic behavior without mathematics, then the type of images we know from our experience and dreams is more applicable than conceptions associated with the characteristics of macroscopic objects.

In the case of our living body, it is clear to us that it constitutes a whole, although we can distinguish distinct organs. After all, even pains in a toe can cause emotional effects. In our imagination, various possibilities can be present; in a factual action we can realize only one possibility at a time. Multiple possibilities coexisting as in art or dreams can create something

absolutely new. In our feelings we can be ambivalent. That means that not only one possible situation is vital for us, various others may be as well. All of these aspects can hardly be reconciled with a mechanistic point of view, but they readily conform to the ideas that follow from the structures of quantum physics.

In ridicule, it has been stated that since both consciousness and quantum theory are puzzling subjects, there should be connection between them, at least, according to some eccentric thinkers. The opposition to connecting consciousness and quantum theory, among other things, may be based on unconscious weltanschauung prejudices, as the following statement, amounting to a "Freudian slip", indicates:

> "Viewing the mind as a nonphysical phenomenon, discontinuous with the biology that creates and sustains it, is responsible for placing the mind outside the laws of physics, a discrimination to which other brain phenomena are not usually subject. The most striking manifestation of this oddity is the attempt to connect the conscious mind to heretofore undescribed properties of matter and, for example, explain consciousness in terms of quantic phenomena. The rationale for this idea appears to be as follows: the conscious mind seems mysterious; because quantum physics remains mysterious, perhaps the two mysteries are connected."[10]

What is interesting in this quotation is the probably unconsciously formulated antithesis: 'mind' is placed outside the laws of physics – and this becomes most apparent in the attempt to explain it, the 'mind' – by using quantum physics.

However, it is not clear whether this is indeed Damasio's ultimate opinion. In the next paragraph he writes:

> "Given our incomplete knowledge of both biology and physics, one should be cautious before dismissing alternative accounts. After all, in spite of neurobiology's remarkable success, our understanding of the human brain is quite incomplete."

There is much to be gained when we have to abandon popular and centuries-old views and direct our thoughts towards new ground. Our view of nature will be expanded in this way. As the physicists know, the essential features of any process in nature cannot accurately be explained without quantum theory. There is no experiment that would contradict quantum theory, and more than one third of the Gross National Product in industrial nations already relies on applications of quantum theory.

2.2. Basic principles of quantum theory

The basic principles of quantum theory describe features that are completely familiar to living beings, particularly to those with consciousness.

- *Quantum theory can be characterized as the physics of relations and possibilities.*

It is a way of designing a distinct mathematical structure for two fundamental experiences of everyday life.[11]

- *Relationships, in contrast to mere juxtapositions, establish wholes being more than mere sums of their parts. As a consequence, quantum theory also provides the scientific basis for explaining how something new can emerge.*

While classical physics describes composite systems by combining the parts in an additive way, quantum theory uses a multiplicative approach. This allows for new possibilities of the whole that cannot be anticipated from the properties of the parts alone.

- *Not only facts, but also possibilities yield real effects.*

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[10] Damasio, 2011, p.14
[11] Cf. Görnitz, Th. 1999

At first, it may sound unfamiliar that possibilities should be able to produce effects. However, upon some introspection, this is rather obvious: Not only the memory of past facts, but also the expectations associated with future possibilities influence our actions in the present. People often think about unrealized possibilities and are affected by them in the present. It may even take a psychological treatment to recall repressed possibilities and resolve compulsions. Accordingly, the effectuality of possibilities is – upon some reflection – completely obvious.

That effects can be induced by possibilities has the consequence that a fact results only with some probability. This means that actual chance exists in nature.

That new circumstances come about all the time in the evolutionary process is already evident in simple structures. The hydrogen and oxygen gases have completely different properties than water to which they can be combined.

That quantum theory offers a more exact and better description of nature does not mean, however, that we can do without classical physics.

- *According to its mathematical structure, quantum theory, strictly speaking, does not recognize facts nor separate objects. Nonetheless, both facts and separable objects are indispensable ingredients of our comprehension of nature.*

2.3. The dynamic layering structure

In our daily life we human beings cannot avoid having to understand and recognize past facts as something factual, even if seen from a universal quantum theory this would only represent an approximation. And neither can we avoid disassembling the real world around us into separate objects, although it follows from the mathematical structure of quantum theory that this, too, seems to be only a very reasonable approximation.

We will therefore require a description based on the dynamic layering structure from classical and quantum physics, especially when we want to comprehend the phenomena of living things. In the description of the real world, classical physics fragments it into separate objects, with forces acting between them. Quantum theory corrects the mistakes that arise in the process and sees the relationship connection of the real world as fundamental. For us human beings it is obvious that we are autonomous personalities separated from one another, and that it is inconceivable to deny the social relationships and integration in a cultural surrounding which we have in common with everyone else.

Niels Bohr introduced the concept of complementarity as a way of transferring the reality of quanta into the language and mindset of classical physics.

Within the framework of quantum theory a quantum state, that is the full characterization of the system at a given time – can be completely and exactly described. However, when one assumes that it should be allowed to use all the ways of description as applicable to the facts of classical physics, then there is a problem. The possibilities described by quantum theory comprise outcomes that, being taken as coexisting facts, would necessarily lead to contradictions. After all, it is the meaning of possibility that possibilities, excluding each other when realized facts, are present simultaneously as possibilities. There is the possibility that a train is punctual or not, but only one of the two possibilities can become factual.

It is certainly not necessary to go as far as Dieter Zeh[12] did in stating:

> »Complementarity has therefore rightly been designated a ‘non-term’, and it could perhaps, in agreement with a recent fashion, even be called ‘the non-term of science in the 20th century’«.

[12] Zeh: 2012, p.51

Nevertheless, there is definitely a certain truth in this criticism. What is all this actually about?

- *Possibilities that are clearly defined within the framework of quantum theory and that would be mutually exclusive as facts cannot all be simultaneously well-defined facts. Classical physics is less accurate; therefore it opens the illusion that this is possible in any case.*

The simplest examples of this are position and velocity. Since Zenon's paradoxes, since Greek antiquity, it has been known that they are already mutually exclusive conceptually. A position aims at a point; a velocity is well defined only for a distance. With the ingenious invention of differential calculations Newton and Leibniz discovered a trick for circumventing this problem. The idea of any small distance that can no longer be distinguished from a point led to the development of the illusion that position and velocity could exist simultaneously. The precision of quantum theory no longer permits this trickery. Either a well-determined position or a well-determined velocity exists – but never both at the same time. *This is the core idea of Heisenberg's uncertainty relation.*

In the context of quantum theory any factual outcome is the result of an event or an action – and that the order of actions can rarely be interchanged without altering the outcome is a matter of course in everyday life.

Quantum theory supplies the foundation for all physical descriptions. However, when speaking of physical situations we usually do this in a way adapted to facts. Here the concept of complementarity is crucial, as it allows us to use a classical manner of speaking in addressing quantum behavior. *Obviously, complementarity is only a makeshift, but not a basis for explanation.*

However, up to this day there are opinions that classical physics is the ideal worth striving for. Then quantum theory is held to be an inadequate theory, and it is made clear how dissatisfied people are with quantum theory.

Richard Feynman, for example, writes the following in his textbook on quantum mechanics, which is well worth reading:

> »Yes, physics has given up. We do not know how to predict what would happen under given conditions and we believe today that it is impossible – that the only thing that can be predicted is the probability of various events. *One must realize that this is a restriction of our former ideal, of understanding nature. It may be a step backward, but nobody has seen a possibility of avoiding it.* «[13]

In his bestseller, Stephen Hawking[14] explains in a similar manner**:**

> *»One certainly cannot predict future events exactly if one cannot even measure the present state of the universe precisely!« ... »Quantum mechanics therefore introduces an unavoidable element of unpredictability or randomness into science.«*

Such statements are of course hardly suitable for helping the reader recognize that quantum theory is the most exact and best realization of the real world by natural science. In addition, it should be our experience as human beings that the future is open and that not everything is determined.

- *According to quantum theory the time evolution of possibilities is determined, but not what the factual result will be.*

[13] Feynman et al. 1971, pp. 1-14
[14] Hawking, 1988, p.77

3. Protyposis as the basic substance and as the substratum for a scientific explanation of consciousness

3.1. What is really simple: from Becoming to Being

In order to be able to describe the transition from becoming to being it is unfortunately necessary to refer somewhat to the mathematical basis of quantum theory. Science searches for structures in the real world and the processes existing among them. Then an attempt is made to explain these structures and their alterations through mathematical structures. When this is sufficiently successful, this type of mathematical structure is then considered a useful description of that respective part of reality.

A not very easily understood metaphor in quantum theory is "state space". In modern mathematics many problems are translated into geometric language, which illustrates the problems better for the initiated, but for those without the background knowledge this seems very confusing. The term "space" means in this context that situations can be represented by vectors, by arrows. The drawing paper in school geometry is two-dimensional, because at most two vectors can be orthogonal to each other (stand perpendicular). An oblique vector can point slightly to the right and slightly upward, it excludes neither of the two directions. However, the upward vector does not point to the right at all. Upwards and to the right are mutually exclusive – this is expressed geometrically in that they stand perpendicular. In translating logical statements into geometric images mutually exclusive images are represented as being "orthogonal to each other". The space in which we live has the property that with length, width, and height at most three vectors can be orthogonal to each other. A two-dimensional state-space thus means that for a given state (its vector) there is exactly one other state being orthogonal to the former (which means in quantum theory: the latter state cannot be found if the former state is actual). One could perhaps object here that a two-dimensional state seems to be quite "flat". However, as mentioned above, quantum theory also takes into account the effect of possibilities. Future possibilities are not yet real. Here it is essential that in the mathematical framework of quantum theory in addition to real also imaginary numbers come into play, forming together the set of complex numbers.[15] As a consequence, the two-dimensional state space of the quantum bit, based on the use of complex numbers has a structure being mathematically as comprehensive as the four-dimensional manifold of space and time in which we live.

The relation character of quantum theory is reflected by the fact that, according to its theoretical structure, complicated and complex systems are being composed in a multiplicative way out of simpler ones. This means that the dimension of the state-space of the composite system is the product of the dimensions of the fragment state-spaces. This is the central difference to classical physics, i.e. of the mechanics, in which the composition occurs additively. Here, surprising relationships to complexity theory arise as well. As Mikulecky writes:

> »Analytical models which are expressed mathematically as direct products of state spaces are no longer equivalent to synthetic models which are built up from disjoint pieces as direct sums.«[16]

When we observe the multiplicative structure of the quantum theoretical build up of complex structures, we can ascertain that:

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[15] Whereas the square of all real numbers is positive, the square of an imaginary quantity is negative. Complex numbers can be represented by drawing the axis of the imaginary numbers perpendicular to the axis of the real numbers. This makes it clear that a complex dimension can be represented by 2 real dimensions. The state space of a qubit thus corresponds to a 4-dimensional variety.

[16] Mikulecky (1999)

- *The simplest conceivable quantum entity will accordingly possess a two-dimensional state space.*

It is however difficult to describe this entity with an illustrative term. If we would call it a "system", then unfavorable associations are suggested to systems we know in technology and society as complex objects. It is especially not an "object", because in the simplest case an object is a quantum particle, already with its infinite dimensional state space.

- *Such a "quantum pre-structure" with a two-dimensional complex valued (i.e. containing real and imaginary numbers) state space is the simplest and at the same time the most abstract construction that can be introduced within the framework of quantum theory and expressed mathematically.*

Any concrete meaning for this would demand a context, and thus much more of a structure than would be possible with a two-dimensional state space. However, with sufficiently many of these quantum entities, via the multiplicative composition, photons, that is, the quanta of the electromagnetic field, as well as electrons, protons, and neutrons, thus all the particles and fields of physics, can be generated.

Out of the Big Bang, of the pure possibility of a mathematically construed beginning of the cosmic evolution, based on such an elementary entity, there unfold all the phenomena we describe as factual occurrences, such as, for example, the explosion of a star.

- *In a philosophical interpretation one can consider the beginning of the cosmos as an intermediate phase between "nothing" and factual "existence". It can be described as a pure "becoming" and clearly indicates the process character of the cosmic evolution.*

In physics we are familiar with examples of these simplest quantum structures, with the spin of electrons or with the quantum bit. The spin of the electron is, however, always bound to a massive particle – and a particle, on the other hand, has, as mentioned, an infinite dimensional state space. A quantum bit has only a 2-dimensional state space. As an "atom of quantum information", in normal language usage it is always connected with a sender, receiver, and, above all, also with some meaning. Meaning always has, however, a subjective component and can thus not be the subject of an objectively oriented science like physics. That some meaning whatsoever only emerges in a complex interpretational process has also been noted by Werner[17].

3.2. Quanta and atoms - an opposite ignored

Why has the idea of atoms, ultimate indivisible building blocks, been introduced in the description of nature? In view of the abundance, diversity, and complexity of the reality one could barely hope to comprehend and explain it.

- *Fragmenting things into ever smaller parts, the parts were supposed to become ever simpler as well.*

Ultimately – as was expected and hoped for – the tiniest components would turn out to be fundamentally simple – and, thus, amenable to comprehension and explanation. Once those 'elementary building blocks' had been understood, it should be possible to explain the more complex phenomena as being composed of the former –as was expected and hoped for. For two and a half millenia, this has been the core paradigm in the natural sciences. Not only is this creed propagandized in countless popular scientific texts, but also it dominates, to a certain extent even subconsciously, the way of thinking of many scientists until today. So in the official website of CERN for example it is stated:

[17] Werner (2010)

> "The model describes how everything that they observe in the universe is made from a few basic blocks called fundamental particles, governed by four forces.[18]
>
> The theories and discoveries of thousands of physicists since the 1930s have resulted in a remarkable insight into the fundamental structure of matter: everything in the universe is found to be made from a few basic building blocks called fundamental particles, governed by four fundamental forces. [...]
> All matter around us is made of elementary particles, the building blocks of matter. These particles occur in two basic types called quarks and leptons. Each group consists of six particles, which are related in pairs, or "generations". The lightest and most stable particles make up the first generation, whereas the heavier and less stable particles belong to the second and third generations. [...]
> The quantum theory used to describe the micro world, and the general theory of relativity used to describe the macro world, are difficult to fit into a single framework." [19]

That the "basic blocks" can decay does not, apparently, do harm to their "fundamentality". That a similar way of thinking is being cultivated elsewhere, shows the following statement on the website of DESY (Deutsches Elektronen-Synchrotron at Hamburg):

> "What does the world consist of at the smallest level? What are the most fundamental particles of matter? Natural scientists have been looking into these basic questions since antiquity. In the course of their search, they have encountered ever smaller building blocks – first atoms, then atomic nuclei consisting of protons and neutrons, and finally tiny particles called quarks. Today, particle physicists are investigating the fundamental mysteries of the universe: what holds the cosmos together, and how do particles acquire their mass in the first place?"[20]

It is important to note that, down to the atoms of chemistry, this concept has been extremely successful. By the end of the nineteenth century, the triumphs of chemistry and, moreover, of the kinetic theory of gases had crushed the counter-arguments of continuum physics.

- *However, the question is whether a continuation of the 'atomistic' concept to spatially ever smaller realms can be justified by quantum mechanics?*

Let us recall Planck's formula from the advent of quantum theory: $E = h\,\nu = h\,c\,/\,\lambda$. The energy E of a quantum is inversely proportional to $\boldsymbol{\lambda}$, its characteristic length. In the case of massless quanta, λ is the wavelength. For a quantum with mass one may use Einstein's equation, $E = m\,c^2$, and assign to it the corresponding Compton wavelength**:** $\lambda = h\,/\,m\,c$. In both cases we find: the larger the energy or mass, the smaller is the characteristic length. In short:

In the atomistic concept the basic idea is:

the smaller, the simpler.

In quantum theory, since Planck, the finding is:

the more, the smaller.

Combining both statements, that is,

'the more, the smaller' and 'the smaller, the simpler'

would imply the statement:

the more, the simpler!

which, however, is patently implausible.

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[18] http://home.cern/about/physics vom 20.4.2016
[19] http://home.cern/about/physics/standard-model vom 20.4.2016
[20] http://www.desy.de/research/particle_physics/index_eng.html vom 20.4.2016

The fact that λ refers to a length suggests that, from the viewpoint of quantum theory, the very simplest will not be small, when 'small' refers to the spatial extension.

- *Quantum theory shows that the very simplest will be the utmost extended as well.*

Recalling that since Pauli postulated the neutrino the usual procedure in physics is to invent new hypothetical particles as the solution to any problem encountered. Here a typical and actual example:

> "Four research groups have proposed the existence of various new particles to explain an anomalous signal picked up by the two largest particle detectors at the Large Hadron Collider at CERN, Europe's particle-physics lab in Geneva, Switzerland."[21]

As was recognized already half a year later, that signal was a mere statistical deviation and it disappeared when a larger data set became available.

Therefore the following becomes apparent:

- *Weighing in the significance of the basic formula of quantum theory, an entirely new way of thinking is required, a radical change in the framework of physics.*

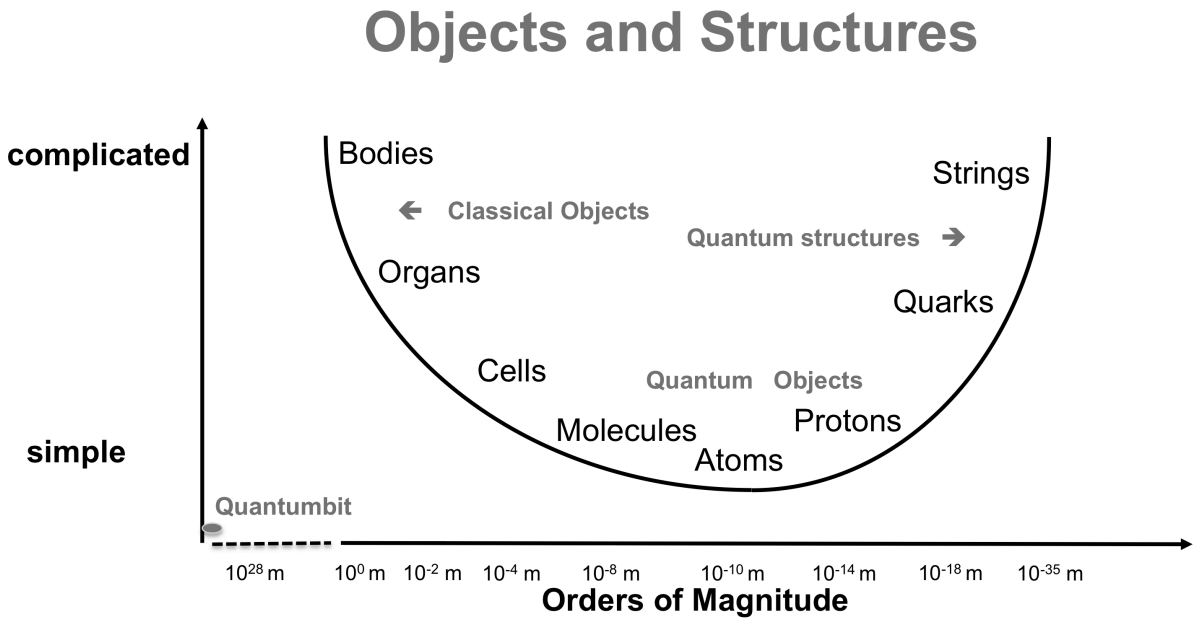

Fig.1: Simplicity and magnitude of structures

Science is always approximation to reality:

- *In natural sciences "explaining" means to reduce complex structures to simple ones, and to recognize the mathematical methods and approximation procedures required for that task.*

Presently, the fundamental problems in physics are treated using methods of quantum field theory. Quantum fields have configuration spaces of non-denumerable infinite dimensions. They are the most complex structures quantum theory deals with. According to Einstein's great discovery of the quanta of light, a quantum field can be understood as representing an indefinite number of quantum particles. Accordingly, quantum particles are significantly simpler structures than quantum fields. Using quantum-field structures allows one to describe the creation and annihilation of quantum particles.

[21] Nature 532, 284–285 (21 April 2016) doi:10.1038/532284d

A particle is defined as an object that can be moved in space and time. The group of motions in space-time is the Poincaré group. The infinitely many states of a quantum particle can be assigned to an irreducible representation of the Poincaré group. However, even such a corresponding countably infinite state space does not stand for actual simplicity.

Truly simple are quantum structures associated with the smallest conceivable state space, that is, a two-dimensional Hilbert space. That such entities can be structures of their own right has hardly been realized in physics so far. They are familiar as spin one-half or as qubits. The latter two structures are always seen in conjunction with another quantum acting as a 'carrier'. In the case of the spin, the carrier is a particle, and likewise a photon or a particle with mass in the case of the qubit. In both cases the carrier is a quantum object with an infinite-dimensional state space.

Really simple are qubits without any carrier. These entities enable by the same mathematical procedure, used to construct quantum fields from quantum particles, to generate quantum particles from qubits.

- *Qubits, being quantum structures associated with a state space of dimension two only, are the really simplest structures that can be conceived for logical reasons.*

They must not be seen as particles – though it will be difficult for many scientists, embedded in the conventional way of thinking, to break free of that picture. As a consequence of Planck's formula, they have to be associated with the largest conceivable "wavelength", that is, the radius of curvature of the closed cosmos.

Via the multiplicative combination, as suggested by the quantum structure, of ever more qubits ever more localized states can be constructed. The quantum structure necessarily leads to the conclusion: *"plenty of spatially extended can become spatially small"*. Obviously, the latter contradicts the unconscious perceptions hitherto prevailing in physics.

3.3. The interpretation of Protyposis

In order to avoid rash and erroneous associations, it was required to introduce a new conception for the simplest conceivable quantum structure, which – as explained – possesses only a 2-dimensional state space: ***Protyposis***.[22]

- *If we want to illustrate Protyposis and relate it to a well-known idea, then the quantum bit is the best choice, when the respective freedom from meaning is taken into account at the same time.*

Protyposis allows us to recognize that the basis of existence is more aptly described as a mental structure, although every material thing is generated from it. Analogous to the way a quantum field can be constructed from an indefinite number of quantum particles, a quantum particle can be generated from an indefinite number of qubits.

Ultimately, however, quantum information obviously is something that reminds us more of our thoughts, or of something mental, rather than of our bodies, something material.

As our daily experience indicates, there are many phenomena so lacking any concreteness that we cannot picture them. How, for instance, should one be able to imagine, without invoking physical theories, that, at this very moment, information from perhaps 20 TV programs and 5000 mobile phone conversations are streaming through our bodies, and we do not notice anything?

[22] This term was suggested to us by the Classical philologist Roland Schüßler of Frankfurt University: The Greek term Protyposis stands therefore for something that can be formed into matter, energy and also into meaningful information.

- *Protyposis can be perceived as a completely abstract, free-of-meaning quantum information, which is primarily not localized at all (i.e. having cosmic extensions) and which must be imagined without recourse to a sender and a receiver.*

It should only be noted that the principle of non-locality, which is expressed in quantum theory and particularly in Protyposis, can help us explain many non-localized phenomena of consciousness.

It should once again be emphasized that the qubits of Protyposis can under no circumstances be thought of as particles or "objects", as such systems must be granted an infinite state space. Only in a limit case of infinitely many qubits can particles be modeled from them.

The interpretation of the Protyposis as quantum information suggests that it will be possible to reach a scientific understanding of consciousness.

This Greek term has the meaning "pre-forming, exemplification". Accordingly, Protyposis is something that can be transformed into matter, energy, and, moreover, into meaningful information.

Quantum theory makes it obvious that the distinctions familiar from daily life and classical physics become increasingly obsolete, increasingly less fundamental when examined with sufficiently high precision. Since Einstein's famous formula, we know in physics that matter and motion (kinetic energy) can be converted into one another. While the formula $E=mc^2$ was discovered within the framework of the theory of relativity, the instance that anti-matter is always involved in these processes, means we are dealing here with quantum theory.

What follows from quantum theory furthermore is a relativization of localization and extendedness, as well as of force and material. While these insights have already been included in the accepted knowledge of science for a long time, only now has the insight begun to be accepted that *Protyposis,* imagined as quantum information, *is equivalent to matter and energy.*

Equivalence can be rendered as 'equal value'. In contrast to equality it means that things with a different appearance can be converted into one another. For this, a theoretical foundation in mathematical form was of course necessary. Matter is not motion, physically speaking, kinetic energy, but with the involvement of anti-matter the two can be converted into one another.

3.4. Manifestations of Protyposis

The first to suggest a foundation of physics based on quantized binary alternatives was C. F. v. Weizsäcker, as early as in the fifties of the last century. [23] He introduced the term 'Ur' (from the German prefix in words such as 'uralt' meaning 'very old' or 'Ursprung' meaning 'origin') for what presently is rather referred to as 'qubit'.

The idea of such an elementary quantum structure forming the foundation of the physical description of reality was taken up by other authors as well.

In his 'space-time-code', David Finkelstein devised a discretized space-time – a kind of a four-dimensional chessboard. He was in a long and friendly contact with Weizsäcker and later also with me. Finkelstein was often present at the "Tutzing conferences", initiated by Weizsäcker.

[23] Weizsäcker, C. F. v.: Komplementarität und Logik, *Die Naturwissenschaften* **42** (19) (1955), S. 521-529 & **42** (20) (1955), S. 545-555. Die Quantentheorie der einfachen Alternative (Komplementarität und Logik II), *Zeitschrift für Naturforschung* **13a** (1958), S. 245-253., Scheibe, E., Süßmann, G:, Weizsäcker, C.F.v.: Komplementarität und Logik III: Mehrfache Quantelung, *Zeitschrift für Naturforschung* **13a** (9) (1958), S. 705-721.

In 1980, v. Weizsäcker had invited also Archibald Wheeler to the conference in Tutzing near Starnberg, Germany, devoted mainly to the theory of urs and its ramifications.[24] Ten years later, A. Wheeler coined the slogan 'It from Bit'. This was commented by Claus Kiefer as follows:

> "Weizsäcker's Ur corresponds to the familiar bit; the term was chosen to indicate the fundamental character of those alternatives. Pursuing a similar approach with his idea 'It from Bit', J. A. Wheeler sets out to reduce the entire physics to 'Uralternativen', however, without in any way referring to the work of CFvW (Wheeler 1990)." [25]

Weizsäcker's already very abstract starting point was nevertheless not abstract enough, as for him a close relation of the Urs to knowledge and meaning was still assumed in this line of thought. However, as explained above, it is necessary to begin with an abstract notion of information dissociated from knowledge and meaning. This has been done successfully with the Protyposis concept.

The mathematical structures have been clarified previously; they show how the qubits of Protyposis can be formed into relativistic quantum particles.[26] It has also been shown how from Protyposis, since it must be seen as a growing number of quantum bits, the structure of cosmic space, with the expansion of the cosmos and also the effect of gravity can be derived.[27] The protyposis concept has also allowed for a rationalization of why the other three fundamental interactions, that is, the electro-magnetic, weak, and strong interactions, prove to be local gauge interactions of the three gauge groups U(1), SU(2), and SU(3), respectively.[28] The clarification of such mathematical connections is the prerequisite for progressing successfully from pure philosophical considerations to the field of natural science.

Thus, similar to the very different manifestations of H_2O we encounter, namely as ice, as water, and as steam, we can also subdivide the *manifestations of Protyposis:*

- *Matter* is one such form of Protyposis, which is inert, which resists change.
- *Energy* is one such form of Protyposis, which is necessary to set matter in motion in order to change it.
- *Information,* in the narrow and normal sense, is one such form of Protyposis, which is capable of releasing available energies.

4. What influences the forming of individual consciousness?

The focus here is on several general aspects of the development and function of consciousness as a highly dynamic process. This involves many factors that affect consciousness.

Living beings can be characterized as thermodynamically instable systems that stabilize and control themselves by internal information processing. Here „control" means the effect of information on the behavior of the system. Via that effect on the system, information becomes meaningful for it.

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[24] See Castell, L., Drieschner, M., Weizsäcker, C. F. v. (Eds.): Quantum Theory and the Structures of Time and Space 4. Papers presented at a conference held in Tutzing July 1980, Hanser, München (1981)

[25] Kiefer, C.: Weizsäckers Zeitbegriff aus heutiger Sicht, in: *Acta Historica Leopoldina*, Nr. 63, (2014) S. 179: »Das Weizsäckersche Ur entspricht dabei dem üblichen Bit; die Wortwahl soll aber auf den fundamentalen Charakter dieser Alternativen verweisen. Einen ähnlichen Ansatz verfolgt John Archibald Wheeler mit seiner Idee des It from Bit, mit der er die gesamte Physik auf Uralternativen zurückführen will, ohne dabei freilich auf CFvW in irgendeiner Weise Bezug zu nehmen (Wheeler 1990). «

[26] Görnitz et al 1992, Görnitz, Schomäcker, 2012

[27] Görnitz, 2011 (1)

[28] Görnitz, Schomäcker, 2016

The possibility of control by information of material systems was introduced in natural sciences by Norbert Wiener, coining the notion „cybernetics“. Wiener referred control both to living beings and machines. Technical cybernetic systems, by and large, should be stable, whereas living beings, by contrast, are unstable at all levels of organization, from the cells to organs and the entire organism.

According to Gotthard Günther, cybernetics can be seen as a necessary transition from the bivalent Aristotelian logic to a multi-valent logic, which allows one to construct analogues to consciousness. Assessing cybernetics as a science of direct importance for the essence of humans, he considers the theory of relativity and quantum theory as „relatively neutral scientific concepts affecting the moral essence of humans, at best, at the outermost periphery.“[29] Here the fundamental difference between classical physics, as in the theory of relativity, and quantum structures is ignored. Given Wiener's dictum „Information is information, not matter or energy“[30], at that time it could not yet be seen that the role of subjectivity, as rightly emphasized by Günther, is introduced in natural sciences by quantum theory. A further elaboration on these issues shall be given in a forthcoming paper.

Now turning towards biological topics, we note that our biological inheritance with the experiences accumulated over billions of years and stored in the genes enables the development of our human brain. The social relationships during our first years of life make it possible for us to survive and impart the knowledge and internalized intellectual content of the respective culture.

The repeated processing of the same or similar information produces anatomically recognizable transformations in the brain. The mental information, with its physical development and storage of information, for instance from the development of synaptic structures, causes a memory development induced by learning.

Around the age of 18 months the development of the human brain has progressed enough to sustain a consciousness that is capable of discerning its own reflected self in a mirror for the first time. Being embedded in cultural surroundings is the prerequisite for our being able to formulate our thoughts linguistically.

- *Our consciousness thus develops as a process of examining our natural, cultural and social surroundings.*

The experiences and interactions that occur during this process are retained in the memory, and from there they influence the present state of consciousness. This is influenced in addition by the meaningful information transmitted from the body and its sensory organs, especially perceptions and feelings, and also our expectations of future possibilities.

Information processing in the brain is “very costly” from an energetic point of view, in fact, approx. 2% of the human mass consumes as the brain approx. 20% of its energy. The greatest part of consciousness is not reflected, i.e. is not considered and assessed back and forth, instead, its processing ensues according to what has been learned, and in part, like automated patterns of the respective individual processing of information. This can be compared to the familiar proceedings in politics and economy. The general aims are, of course, prescribed by the management, but many secondary decisions do not reach the upper management level; moreover important decisions are usually initiated, but then being prepared without the definite knowledge of the upper level, to be finally decided “above”, that is, on the upper level.

[29] Günther, p. 20

[30] Günther, p. 22, quoted Wiener, p. 155

The consciousness is thus based on a great quantity of unconscious acts that are first presented to the consciousness to be decided on after being unconsciously and pre-consciously prepared.

When no essential objections from the "higher echelons", for example, ethical or moral reasons and objectives stand in the way, the preparation for a decision made by the unconscious will, as a rule, be "waved through" by the consciousness. Otherwise, in the process of reflection, the unconsciously prepared action will be interrupted or completely stopped. Here a second problem of reflection comes into play: Reflection requires time. Under stress and time pressure reflection, with its back and forth considerations and a contemplation of possibilities, becomes impossible. Lacking sufficient time, decisions are and must be made spontaneously, as a "knee-jerk" response. Such unreflected, and to some extent pre-conscious, decisions will succeed the better, the less the unconscious is burdened with unresolved conflicts of the respective person.

In relationship to the psyche the reflexive consciousness is only the tip of the iceberg. The largest portion of meaningful information is processed without the consciousness being bothered.

This is not a new insight. Carl Gustav Carus had already written comprehensively about the unconscious. Sigmund Freud, and later C. G. Jung made it the foundation of their psychology.[31]

5. The autonomous reality of consciousness

As we will argue in the following, a close examination of consciousness has to resort to the dynamic layering structure of quantum theory and classical physics.

- *It is a clear scientific insight today that no area of reality can actually be understood in depth without quantum theory.*

And this finding is not affected by the instance that there are scientists who are still in doubt. The problem, however, is that the specific results of this theory can often be obtained upon an intensive and arduous training, involving extensive mathematical efforts and, on the experimental side, extreme precision.

- *Protyposis appears in the cosmic development in the form of quanta of energy and material, from which macroscopic objects later form, being finally able to become meaningful information in living beings.*

It follows from the equivalence of Protyposis with matter and energy that Protyposis in the form of our thoughts is not less real than Protyposis in the form of atoms as constituents of our brains.

With Protyposis it consequently becomes possible to comprehend the relationships between the brain and consciousness. As long as one thinks that only the brain can be a reality, consciousness can be at most something like a feature of the brain that can produce no independent effects. With Protyposis one no longer has to be limited to the so-called material aspect as exclusively real.

- *With Protyposis one must no longer speak of the brain when, instead, consciousness or, in general, the psyche, is meant.*

To draw on a simple analogy: in a book review no one would limit himself exclusively to the quality of the binding, paper and color used, even if they have a considerable influence on the aesthetic effect of the whole. On the other hand, without the paper or the computer screen the

[31] Cf. Görnitz, Th., Görnitz, B., 2002

print could of course not be seen, even though the content of the text is what is really important.

Quantum theory accounts for, in addition to the already mentioned equivalences, also an equivalence of object and feature.[32]

- *This makes it clear that on the one hand, consciousness can be understood as a feature of the brain, together with its emitted and absorbed photons, and on the other hand, as an independently effective real entity of quantum information.*

An objective and independent existence of consciousness is the key to understand it scientifically.

A scientific definition of consciousness can thus be considered as follows:

- *Consciousness is a special form of Protyposis, namely the type of such quantum information that experiences and recognizes itself.* [33]

When Protyposis allows for a scientific description of consciousness, it is also clear that the role of the observer as "standing outside of physics" is no longer needed. In an extension of the Copenhagen interpretation of quantum theory it was shown how the origination of facts is also possible without an observer.[34]

- *Consciousness, on the other hand, can be understood as an independent form of Protyposis, as quantum bits that change their carriers, e.g. transmitter molecules and photons – carriers which themselves are ultimately built up out of Protyposis.*
- *The effective power and reality of the meaningful information of consciousness are also recognizable in that they can produce independent effects that are not dependent on special carriers, e.g. photons or molecules.*

In all of this we should also repeatedly remind ourselves that a special folding of a single molecule probably is only accorded as much "meaning" as some characters in a long text. On the other hand, some characters can of course – we think e.g. of $E=mc^2$ – be accorded as much meaning as a complete article.

One can write with a computer, a pencil or a pen on loose sheets of paper, in a notebook, or in a bound book. The carriers of consciousness information in the brain can appear with similar diversity. They can, as mentioned, be virtual or real photons, but also ions or molecules; we think, for instance, of molecules of a transmitter whose exchange at the synapses determines an important portion of the information processing. When we speak of these objects, we envision particles. However, by means of the Protyposis we can now understand that particles are not the simplest physical entities. The change in the situations of these particles proves to be an addition or a reduction of qubits. These qubits can develop, depending on the context, a meaning in the living being – just as letters of the alphabet in a text also only acquire meaning within this context. Since qubits can and must be seen as an independent reality, this reality character also applies for the qubits of our consciousness. Consciousness thus extends from the quantic possibilities of our thinking and feeling to our factually formulated thoughts.

What is also important is that consciousness is not localized at one place in the brain, but that its carrier is the whole brain and the whole body.

At this point it is required to briefly readdress, in the framework of quantum theory, the issues of localization and extended wholes without parts. Brain researchers had posed the rhetorical question, where in the brain the „site of the I" was to be – after all, no such site had been

[32] Cf. Görnitz, Th. and B., 2008
[33] Görnitz, Th. and B., 2006, p. 285, 322
[34] Görnitz, Th., 2011 (2)

found. From a quantum theoretical point of view, it would have been most peculiar if there were a corresponding site, as a small area in the brain. Rather one should expect that a substrate of the „I“ proves to be extended, covering at least the entire brain.

The question whether a whole can be understood as being without parts, depends on the mass or rather the energy of the system. The Planck mass, about 10^{-5} g, characterizes the most massive quantum object lacking actual parts. In more massive systems, an absence of parts can only be virtual. However, it is always possible that subsystems, in particular, ones pertaining to quantum information only, may act as a unity without parts, even when residing on a rather massive substrate.

For example, the quantum information of the consciousness represents a quantum system, the size of which is far below the 10^{61} quantum bits of the Planck mass. This makes understandable that we rightly perceive our consciousness as a unity, extending over the cells, the brain, our entire body, and, in certain situations, possibly even beyond.

When we define consciousness as quantum information that experiences and recognizes itself, then the already present consciousness supplies the meaning framework, the information of the surroundings that is necessary for the incoming information to be integrated as meaningful.

A definition for matter would be:

- *Matter is a special form of Protyposis, namely quantum information localized in space and time.*

6. The evolution of intellectuality and the forming of meaning

The long course of cosmic development was required before information could become meaningful in the biological evolution.

With single cell organisms, meaning will be created from incoming information when the single cell organism reacts to it. If it reacts in such a way that it promotes its stability and further existence, the cell gives the information the “right” meaning, in the opposite case, it gives the “wrong” meaning. When it is the “wrong” meaning, the cell will drop out of the evolutionary process more quickly. With more highly developed forms of life secondary meanings can replace mere survival. As mentioned above, that can pertain to reproduction and, at a tertiary level, to all cultural influences of civilization.

That it is the information and not the carrier, which is important, is a familiar daily experience for us. A warning can thus produce for us human beings the same effect no matter whether we perceive it as an acoustic or optical signal. One time it is the air that is the carrier, another time it is the light. But of course this is not rigidly valid; there are, after all, blind and deaf people, and for them these two carriers create a different meaning.

That this meaning is not something “objective” is particularly evident in medicine. Apoptosis, or the “suicide” of defective cells, is vitally necessary for the organism, not of course for the affected cell. When growth is important for a tumor, because of its separation from the meaning context of the whole organism, it is extremely dangerous.

A processing of information is dependent upon being able to preserve the information over a long period of time so that a form of memory is established. Living things are flow equilibria bound to chemical processes, which enable and promote a differentiated processing. This means they are based entirely on catalytic processes. A catalyst can be understood as a molecule or a surface that exerts a strong attraction on the initial molecules and deforms them in such a way that they can easily react with each other. The resulting products, by contrast,

are quantum systems differing completely from the initial materials, having entirely different features, so that they can again disengage from the catalyst. Catalytic processes are not based on brute force – like perhaps a real fire, even if one speaks of the "burning of nutrients in the body" – so that they can run parallel and simultaneously with other processes, without destroying the entire system. Living things rely therefore on enzymes, which are complex molecules with very special catalytic characteristics. Molecules that can function as memory, as well as enzymes, are the ribonucleic acid RNA. At the beginning of life they were probably the essential components of cells. With the development of life-forms the functions of memory and enzymes became separated. The deoxyribonucleic acid DNA is more stable, and is thus more suitable as a memory carrier for longer preserved information than RNA. Proteins are more efficient catalysts than RNA.

In more highly developed animals, at least in birds and mammals, the development of the brain has reached a state where consciousness is able to arise. In consciousness essential aspects of experience can be represented.

- *Normally almost all control processes proceed unconsciously. Consciousness makes it possible, in a theoretical model, to simulate some of the planned processes and inspect their results, without having to carry them out in the body, that is, in reality.*

This will enable us to play through trial actions in the consciousness so that possible unfavorable results under real circumstances can be avoided.

In very highly developed animals consciousness becomes capable of reflection. One becomes capable of recognizing oneself reflected in a mirror. Up until now this capability has been proven e.g. in apes, in macaques, elephants, dolphins and ravens. Human beings acquire it, as mentioned, at about 18 months. When reflecting, a part of the consciousness can think about the whole consciousness.

- *During reflection, quantic possibilities are condensed into a fact: Facts are sufficient for classical logic, thus a consciousness capable of reflection is also capable of logical thought.*

Such a transition from quantic possibilities to a linguistically formulated fact is probably familiar to everyone. We have a certain idea – and when we formulate it in spoken language, perhaps even in writing, we may have the impression that something has been lost which had resonated for us before in an indefinite way.

7. The relationship between the brain and consciousness

The dismantling of an organism into cells, and in turn into molecules, atoms and ions, is useful and extremely effective for understanding many processes. However, according to numerous accounts and the perception of many scientists, the reactions in living beings – such as the formation, transport, and reorganization of molecules – are depicted as a mere resorting of "small particles". What is not adequately recognized is the quantum nature of all those processes.

Any reaction in a biological system is an electro-magnetic phenomenon. Actually, any biochemical reaction involves an exchange of photons, more specifically, of real and virtual photons. The motion of ions, electrically charged molecules or atoms, is often described as a response to the action of electro-magnetic forces. According to a precise – i.e. quantum physical – description, it is the action of virtual photons. Real photons are emitted when the motion of charges is not uniform, e.g., when being accelerated from rest or slowed down. In view of the small energies acting in the living brain, it is often assumed that one might ignore quantum aspects and only consider here electro-magnetic waves. For a mere pragmatic

description this may sometimes be appropriate, though not for a real understanding of those processes.

This finding is of particular importance when dealing with the relationship between brain and consciousness.

- *In the field of biology all of the interactions among atoms, ions, etc. are transmitted by real and virtual photons.*

Since massive objects, atoms, etc., are ultimately built up from Protyposis, they can also gain or loose Protyposis in its form of energy, as well as in its form of meaningful information.

- *The equivalence between matter and energy has been well known for over a hundred years; that between quantum information and matter is an essential result of modern quantum theory.*

Molecules, atoms, ions and photons thus always appear in the body in a double role. They are carriers of meaningful Protyposis and at the same time were formed out of Protyposis. For that reason, too, the boundary between carriership and meaningful information is fluid and dependent on situation and context. The possibility that meaningful information can change its carrier is very important for understanding consciousness.

Living things are unstable systems. Therefore, they cannot – like something stable – be influenced only by matter and energy, but also through information. Living things become widely stable through the processing of information that thereby acquires a meaning for the living thing. To be remembered here is that meaning is always bound to processes of encoding and decoding. Incoming images of predators or nutrients only become meaningful with the help of already existing information, by being decoded and associated with something that is known. Through quantically parallel processing it can proceed with great rapidity. Even more obvious is the necessary decoding in the case of spoken and written language when sound vibrations or scribblings on paper are accorded a meaning that is in no way applicable to them without a meaningful context.

The more highly developed animals have developed a specialized organ for processing information, a nervous system with a brain as the center. According to current representations, the information flows along specialized nerve fibers to the subordinate processing centers formed by evolution. This concerns primarily classical, or factual, components of information processing.

From the significance of photons, as seen, for instance, in the determination of brain death, it follows that the information can also be transmitted in a different way – non-locally.

The individual research results for information processing in the brain are important. Thus, it has been shown that in the brain various possibilities for storing and encoding are used – as was to be expected from quantum theory, with its possibilities of position and impulse representation[35] – or in other words: with more localized as well as more delocalized storage. The latter was related to the principle of holography by Karl Pripram.[36]

Whereas for a long time the idea of a "grandmother cell" was propagated, in which the recognition of the grandmother would result, research today has progressed much further. Thus Christof Koch and his co-authors speak, for instance, of concepts that are distributed over a long distance – as population encoding – as well as being localized "sparsely" represented in the brain.[37] When considering the quanta as features of Protyposis, it is very

[35] The impulse is the product of mass multiplied by velocity. It is – in contrast to velocity alone – a strictly preserved quantity like energy.
[36] Karl Pripram (1971, 1991)
[37] Koch, 2005, Koch et al., 2013

easy to understand these two forms of storage. Other authors, like Greenfield[38], emphasize more strongly the holistic character of information processing in the consciousness, without however referring to the quantum physical foundation. The holistic character can be connected very well with the idea of networks.[39]

The models of technical neuronal networks are an important aid for the modeling of information processing – however, only for their classical, i.e. factual components. For all that is rapid and non-local, quantum features remain essential.

For a further understanding of information processing in the nervous system and in the consciousness we will again refer to several quantum aspects.

For one, quantum systems can penetrate spatially and can remain completely separate at the same time, if absolutely no interaction takes place between them. Secondly, quantum systems can be spatially extended, without being disassembled into something like "natural parts" or disintegrating into them because of it.

- *Quantum theory recognizes extended and partless integral wholes.*

Furthermore, quantum theory demonstrates that not only what is factual but also already possibilities can evoke effects. Such anticipated possibilities are constantly elicited and considered in the process of quantic information processing in our consciousness.

The knowledge about everything that exists is conveyed to us through our consciousness.

- *Our brain is only a carrier and processing organ.*

When we are unconscious, e.g. in deep anesthesia, neither our body nor surroundings exist for us.

Our consciousness is given us directly; however, to explain our brain we have to use analogies and technical aids. (It is a matter of fact that all insights from intact living brains, like e.g. PET or fNMR, are based on quantum physical methods.)

Just as we need the dynamic layering structure of classical and quantum physics for an optimal description of the world, this applies as well to the task of describing consciousness and its essential carrier, the brain. As long as in natural sciences only cells or molecules are seen to be relevant, it cannot be understood how the mental realm can become a likewise effective agent. By contrast, this is enabled by the Protyposis.

8. The dynamic layering structure and consciousness

The transition from possibilities described by quantum theory to facts described by the less exact classical physics is called in physics the "measurement process". In the end, a measurement result should be a resilient fact and not a mere possibility. Thus, for example, the firing of a nerve cell can be seen as a fact that concludes a quantum process, and, at the same time, as the possibility for the preparation of a new quantum process.

- *The preparation of a quantum system means to isolate it from its environment to such an extent that the relationship between system and environment is practically no longer perceptible.*

Under such conditions, the quantum features can become effective; failing this, the system would become a part of a larger compound comprising both the system and the environment, so that the system would no longer be perceived as having an independent existence.

[38] Cf. Koch & Greenfield, 2007
[39] cf. Werner 2011

The measuring process interrupts the linear time-development of quantum theory. Thus, a non-linear element comes into play. This is in so far consistent, as a result of a measurement, a fact, has been generated – and something like this belongs to the realm of classical physics.

- *Consistent with the sense of the dynamic layering structure, in psychological phenomena we encounter an interplay of quantum and classical information.*

Classical information, as is well known from the visual process, can be and is very often copied. What is valid for the information, in contrast to energy and matter, is that there is no local law of conservation.[40] Out of the classical result, a new quantum situation is prepared, which, of course, is based on it as the initial condition. Upon measurement, a fact is produced, reflecting to some extent the originally extant possibilities.

In daily operations we will, thus, always be confronted with processes in which possibilities and factual results alternate; from the facts new possibilities will emerge, while other previously extant possibilities can no longer be realized. Still, one may retain memories of some of the past possibilities.

Memories, on the other hand, will usually not be carved in stone, but rather are subject to changes, sometimes considerable ones, while being recalled and stored again, and, moreover, due to unconsciously performed processes. This not only plays a role in statements of witnesses, as here too frequent questioning can change memories and renders them less exact.

When human consciousness is sufficiently developed, it becomes feasible that a part of it can interrogate another part. For example, one can ask oneself which decision options had been available. Such a self-reflection can be seen as a measuring process performed by the consciousness onto itself.

The answers can be stored as facts, i.e. as classical information. Such classical information can be copied at will and, thus, retrieved and processed anew.

Quantum information processing is reversible. It produces no waste heat. That is also why, in comparison to a computer, the energy consumption of the brain is so low.

- *The generation of a possible result leads to a fact, e.g., a word, a decision, an insight in linguistic form, a storage in a long-term memory, etc.*

However, this process involves energy production, since information on the previously extant quantum possibilities must be taken out of the system, here the human being. As a rule, this involves the emission of photons.

The processing of meaningful information in consciousness does not only function via carrier transport within nerve fibers – like blood in the veins; rather, the photons produce non-local effects, not necessarily being bound to axons. All of the various carriers – the photons, molecules, synapses, etc. – establish a common uniform system of quantum information that preserves its uniformity, being always built up anew and preserved in depth, even while the carrier parts on the surface of the manifestations are changing.

- *Because of the non-locality of the photons, the most important carriers of the stream of consciousness, the consciousness can be thought of as extended: in the nerve cells, between them, and possibly in part even outside the brain.*

It is for this reason that the personality of a person is legally considered lost irretrievably when no photons can be detected any longer in the EEG.

[40] Locally energy and matter are strictly conserved; globally, i. e. in cosmology, this is not valid.

8.1. The path of what is seen from the eye to consciousness

When light falls on the retina, single photons trigger a process in individual nerve cells, in the cones and rods. When the cells are activated, the neighboring cells are simultaneously inhibited, which produces a contrast-based intensification. Because always a single nerve cell is stimulated, the incoming light is virtually broken down into pixels – similarly to a computer screen. Each cell corresponds to a pixel. In this process, which must be described physically as a measurement process, the absorbed photon triggers a whole cascade of reactions. Here the energy of the photon is used directly, besides ATP, which serves as energy supplier in living beings and which – caused by the photon – becomes operative. In this process, the incoming photon activates approximately 6 million molecules (Müller et al. 1998), which are then moved by electromagnetic forces, i.e. virtual photons, from the cell in the eye into the nerve fibers and further into the brain. Such a macroscopically effective reaction is described as the firing of a nerve cell. In the usual descriptions of this process the exactitude of quantum theory is disregarded. Thus, the sophisticated differentiation of the whole process is reduced to a mere "flip of the switch".

The incoming photon is, as mentioned, a special form of Protyposis, here primarily free-of-meaning abstract quantum information. A tiny part of the approximately 10^{30} qubits of the photon, roughly a few hundred, become meaningful in the process, beginning in the visual organ of the eye and gaining actual meaning in the brain. The by far larger part of the Protyposis of the photon serves practically as the carrier of the information, which in this process is recoded into meaningful information. In the visual process, the absorbed photon only procures the initial conditions for the evolution of a potentially meaning for the recipient.

What is the meaningful information we are concerned with here?

The location of the retina cell, from which the molecules start flowing into the fibers, encodes the direction of the incoming photon. Its color is encoded in the type of the retina cell, whether it is sensitive to red, green or blue. The 3 colors offer a rough division of the photon frequencies, that is, their energies. Red light has along wavelengths, about 800 nm, and is of lower energy than blue light, at about 400 nm. The information (in the usual sense of this expression) given by a single photon, its direction and color, has, by itself, certainly no meaning in the first place. Only upon the processing, upon correlating the information carried by many photons, somewhat more meaningful structures can be generated; for example, many photons arriving in the shape of a line can create the perception of an edge, others that of a colored surface, etc. Such structures in the eye will be further processed in the brain, in the visual cortex.

The simple functions of optical perception are dealt within the brain in a way similar to that familiar from the motoric and sensory homunculus. Neighboring locations in the retina are first dealt with in neighboring locations in the visual cortex. This makes it possible, for example, that a computer can learn by analyzing the electromagnetic activity of the visual cortex, that a proband just sees something, which e.g. has the form of a letter. It still is not clear, however, whether the proband also understands this form as "this letter".

These primary activities and the germs of meaning they produce are now compared in the next higher processing step in which the information is taken from the memory into the consciousness. In the process, factually stored memories are transformed into quantum states, which on their part will usually have photons as carriers. The comparison of the primarily perceived structures with the activated memory contents will proceed to a large degree unconsciously. Here, the quantum character of this step becomes particularly obvious. The procedure must be understood as a practically infinite parallel processing. At the same time, it

is understandable that the ensuing results are always only probable ones. Errors can always occur.

To be capable of having a conscious perception we must already "be conscious". Our consciousness is a "stream" of meaningful information, which is carried from the brain as a whole and from its subdivisions to the photons. Information is constantly entering this highly dynamic structure from the environment and the body, and constantly discarded again. Internally and externally perceived images are compared with already stored forms in which similarities are sought. Although, as a rule, this proceeds very successfully, mistakes are always possible, though. Occasionally, when we encounter something completely new, and relating it to somewhat already known, may then be difficult.

With these processing steps it is important to keep in mind that meaning only originates in a context. Whether a line is part of an "i" or an "l" or is a dash only becomes clear in a textual context. This is similar to the information content of the respective photons. Here, too, an eventual meaning emerges only in the correlation with lots of other information.

All these direct entries into the consciousness are dealt within the brain, so that, of course, they depend on our physical condition. The information processing is considerably influenced by our emotional state.

When given in a linguistically reflected form, information has a clearly classical character. Processing will be slower here and always subsequent; but it is amenable to the laws of logic.

9. Body, psyche, and self

Even if the division of the human being into psyche and body is not fundamental and, ultimately, not feasible, it is nevertheless useful.

What portion of Protyposis should be categorized as material objects and massless photons, and what, on the other hand, as meaningful information, is not irrefutably determined, but rather crucially dependent on the respective situation.

What in the case of a hormone molecule should be classified as meaningful information inducing an effect, and what, on the other hand, is to be classified as mere carriers, depends, for example, also on the location of the effect.

Despite a certain variability, it is a fact that as long as a person is alive, a particular amount of quantum information organizes how he is controlled. In psychology, the "I" is defined as the "organizer of the psyche".[41]

There is therefore an authority in the psyche that coordinates the internal, and for the individual, the meaningful external information, and, in close connection with the consciousness, supervises the control mechanisms. The reflexive psychic structure is described as the Self:

> »The I takes itself as the object of perception and in this way becomes itself (self-image). The self evaluates itself and feels evaluated by others (self-esteem). The self experiences itself as constant and coherent (identity). The self integrates all psychological functions and dispositions into a whole, it controls itself and organizes the relationship to others.«[42]

The model proposed on the basis of Protyposis makes it possible to comprehend that one can experience oneself and also observe oneself as someone else. In this way a unity of the first and third person results.

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[41] OPD -1, p. 67
[42] OPD -1, p. 67

- *Since quantum systems are, as a rule, extended, it cannot be expected that something like a special "location of the I in the brain" will be found.*

The I will have the entire brain as a carrier and can even be understood as being extended over the body. Relying on quantum theory, we can understand that there can be something such as a system of quantum information forming a unity and, at the same time, being extended in space. Devices for helping the body and mind to function, like prostheses, heart and brain pacemakers, can also be incorporated in the extension of the I.

It is likewise useful to assume that, in addition to the unconscious, the pre-conscious, and the waking consciousness, there is also a core-self, where, of course, a highly dynamic interplay will constantly take place among these 'participants'.

Our "core-self" can be considered as an "individual quantum process" – almost in the sense in which Bohr used the term – which is only ended by death and which, as long as we remain mentally healthy, is subject to no measurement process that would alter it in a fundamental way.

- *The "core-self" ensures our core identity, and its impairment or loss would mean a serious illness.*

When we wake up, the waking consciousness links up with the core-self and remains active. This part of the psyche, the waking consciousness, is constantly subject to influences from the environment, the body and the memory. All of these processes influence the "attention spot" of the consciousness.

10. Psychosomatics as an expression of the unity of body and consciousness

It has been increasingly apparent that psychosomatics, for a long time a disparaged side aspect, has become a regular facet of orthodox medicine. The former theoretical concepts were, however, not free of problems in these contexts. Thus, according to Hoffmann and Hochapfel:

> »The central problem of psychosomatic medicine is the body-soul problem. It is a question of how they can mutually influence and alter psychological and physical processes. It concerns the puzzling leap (Freud) from the psychological to the physical and vice versa. For these questions there is no satisfactory answer today.«[43]

For a long time nothing has essentially changed in this assessment.

- *If only molecules are real and the psyche is not a reality then the influence of the psyche on the body remains mysterious.*

A top-down effect of this kind, as in psychosomatics, from the psychological to the physical body, is now explainable by means of the Protyposis concept, and, thus, also the variety of forms of psychosomatic manifestations.

- *The areas of influence on human beings have "meaningful information" as a common base for their effects. The information is the uniting idea that indicates the positive and negative influences.*

We must realize that living things, from cell components through cells and organs to whole living things, are unstable flow-equilibria. Every moment there are countless situations in which any number of weak influences can produce a great change. In other words: quantum

[43] Hoffmann and Hochapfel (1987) p.168

information can continually affect other quantum information and thus produce changes in the course of processes. Photons affect catalytic processes in cells; the strength of information interchanges alters synaptic conditions, etc.

As described, the carriers of meaningful information and this information itself are, at the very foundation of the natural scientific description, the same basic substance. For that reason, depending on the situation, a particular part of the carrier can develop a specific effect as meaningful information. This can be, for example, the energy or polarization direction of a photon, which can thus intervene in a catalytic process. Or, it can be the forming of a further synaptic connection, which then assigns a particular data stream a stronger meaning. It must, of course, reiterated that the meaning for the living thing can only unfold when a large amount of such single events function together. The meaning a photon, a molecule, or a synaptic transition also depends on the location in which the effect occurs. This is exactly as in a text in which a meaning can only arise where many letters produce a combined effect and the meaning of a letter emerges within the context of a word.

Psychological conflicts are an expression of various inner conflicts or a discrepancy between inner authorities and external conditions. They can have a negative influence on the psychological processes and lead to real symptoms of disease, which are physically visible. It is especially the psychosomatic symptoms that often make the symbolic core of a psychological conflict recognizable, making apparent also strong cultural influences. This can, as for example, the unsolvable psychological conflict involving whether one would rather move back to northern Germany or stay with the family in southern Germany, become expressed through a psychosomatic paralysis. Many similar examples can be found in the literature.

Symbols represent a strong condensation of meaning. This is possible because it is very strongly related, above all, to the cultural context. Decoding the enormous amount of meaningful information available there explains the great effectiveness that does not result alone from the almost meaningless information of the symbol itself without its cultural context.

In all, also in the physical course of events in living things, Protyposis intervenes in the form of meaningful quantum information, controlling the life processes.

- *When consciousness exists, there is naturally a Bottom-Up-Effect – from the absorbed nutrient and the microbiome as well as from the body in general – upon the contents of the consciousness. However, of course, at the same time there is likewise the effect in the reverse direction, namely as a Top-Down-Effect, from the unconscious and even the consciousness, upon the control of the life processes in the body.*

Therefore, the broad field of psychosomatics can be included in a description of natural science.

10.1. Explaining the placebo

How could it be that a pill without any molecule of an active substance can make the same effect like a medicament?

- *The Placebo is a form of the way meaningful information takes effect.*

With the reality of psychological contents and their interaction with the physical forms of Protyposis, the *Placebo-* and also the *Nocebo-phenomena* become conceivable and understandable.

As long as only the material phenomena were considered real and psychological phenomena seen as so-called epiphenomena – which has been the principal theoretical paradigm, even in

large areas of medicine for a long time – such effects, alone the psychological effect on the physical body, could not be understood given the absence of effective material components. On the other hand, such effects must be seen as absolutely natural from the viewpoint of Protyposis.

- *All Top-Down-Effects from the psyche on the body remain unexplainable without the Protyposis concept, and so, therefore, does any Placebo effect.*

When we however understand that it involves the effect of quantum information, which affects experience, an extended quantum state, and the body, a form of structured quantum information, then it is understandable that such processes are possible, on the one hand, and that, on the other hand, they can have no definite cause-effect relationship in the form of a one-way street. As quantum phenomena, for these effects there exist at most probabilities and these probabilities depend on the individuality of each patient.

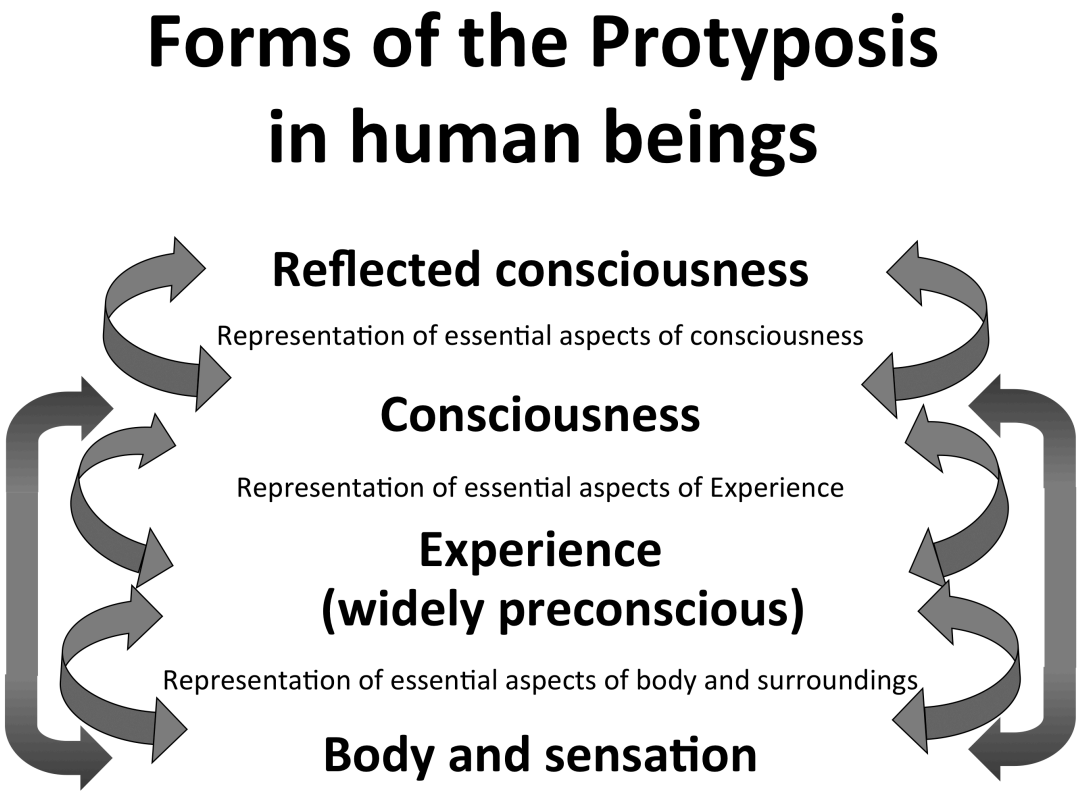

Fig.2: Forms of Protyposis in human beings

11. From reflection ability to free will

For understanding the ability of the consciousness to reflect, quantum theory is indispensible. Self-reflection means that a portion of the consciousness could, in principle, think about the whole consciousness. In fact, on the one hand, we are not forced to exclude something in the contents of the consciousness. On the other hand, we are likewise not obliged to think of different contents of the consciousness as something that must be understood as identical and as a consequence reducing its extent. So a part can see the whole without any necessary loss. When we therefore want to model something like self-reflection, infinite quantities are mathematically necessary. In infinity only there are exactly the same amounts of integers and even numbers; only in infinite quantities can a part be as powerful as the whole. Since a single

hydrogen atom possesses an infinitely dimensional state space within the framework of quantum theory, the required potential mathematical infinity represents no problem.

- *The human consciousness is an activated entity of meaningful quantum information, within the living brain being its carrier.*

After childhood consciousness is so comprehensive that a part of it can observe another part of the consciousness, which means – in the terms of physics – can "measure" it.

What is important here is that a quantum state is always something extended in time; we call it an *extended present.* Thus we can keep our thoughts present over a certain period of time, so that we can reflect upon them. For that reason, it is not surprising that in brain research a "3-seconds-now" was discovered, though the connection with quantum theory is not addressed there.[44] In this 3-second-present, memories of past facts and expectations of future events, together with the ethic values and behavior patterns that have been learned, can be included in this quantum state as *present possibilities*. In meditation such a "now" can be extended.

11.1. Self-reflection – the prerequisite for free decisions

We human beings are capable of thinking about what we are just thinking. With a reflection we end this extended present, of course, we arrive at a fact, the result of measurement. This can then prove to be again the starting point of a new quantum state.

Being capable of self-reflection is the prerequisite for being able to make free decisions. A free decision may not be confused with arbitrariness. Freedom would already be logically inconsistent with deterministic developments.

- *It is obvious that with the arguments of natural science it can only be shown that these two conditions cited, which would in principle exclude a free decision – i.e. unfounded willfulness and determinism – are not fulfilled.*

In many scientific representations the human being is portrayed as a determinated machine. We well understand the offence implied by such an abuse of human dignity, and, therefore, would like to emphasize that such a portrayal must be rejected. It both repudiates the dignity of human beings and ignores the insights of modern science.

The unconscious part of the psyche prepares a decision. Now the pragmatic, cultural and ethnic standpoints that we have internalized are activated and consciously confronted with this prepared decision. The result is that this quantum state is reformed and represented in the form of a series of possible answers to the formulated questions we have activated out of our memory.[45]

This means that because of the reflective examination the result cannot be purely arbitrary. Rather than just an arbitrary quantum state, only those can possibly become an answer that is sensible in the given context. From the infinite manifold of possible quantum states a very rigorous selection leads to sensible answers. The actual result of the examination, i.e. the resulting final state, is not determined by the laws of quantum theory. So what can be said from the natural scientific point of view is that for an examination not affected by temporal or other restrictions the result is neither strictly determined nor completely arbitrary.[46] Hence, natural science demonstrates the possibility of free decisions, beyond both determinism and arbitrariness. Moreover, it becomes clear that external or temporal restraints are in conflict

[44] Pöppel 2004, p.298
[45] Mathematically speaking, the quantum state turns into a sum over the amount of eigenstates on the question, therefore of sensible answers to the question.
[46] cf. Görnitz, T and B, 2008, p. 273 ff.

with making free decisions. Ultimately, natural science demonstrates that free decisions are possible, but not necessary. Being obliged to make a free decision – instead of being able to do so – would be a contradiction in terms.

12. Artificial intelligence – yes; artificial consciousness – no

In the process of the evolution of the protyposis some biological entities with consciousness – like humans – eventually become able to construct artificial entities – like computers – which are able to perform complex types of intelligent information processing. The success in constructing systems of artificial intelligence is already overwhelming.

The simulation of behavior that appears reasonable from the outside is astonishing. Technical artifacts can behave as if they had some implemented understanding. For this the information processing must be "embodied". This can be arranged by putting the computer into a robot and connecting it with sensory tools. Cars that drive without human drivers already exist.

The scientific thinking about artificial consciousness sometimes gives the impression that it is based on a dualistic view, e.g. Cardon writes:

> "On the reality of the life we have, on one hand, a neural network made of very numerous cells. We have, on the other hand, our mind and the impression we can have about this component of ourselves as generating sophisticated representations about things of the world."[47]

However, in the natural sciences there is no room for a dualistic worldview. Intelligent beings evolved from non-intelligent creatures. Living beings evolved from non-living matter. Science dos not only have to declare that something has "emerged", on the contrary, natural sciences have to explain the emergent transitions.

Up to now in all artificial information processing systems there is a strong distinction between hard- and software. However, biological systems are distinguished by the unification of hard- and software into an "uniware". This is a precondition for the possibility that consciousness can evolve. This can be explained because the protyposis constitutes the common background for both, matter and mind. Sometimes, constructivist aspects are emphasized.

> "It is really necessary for the construction of an artificial consciousness, to have a specific theory of the mind, and a really constructivist one."[48]

The reference to constructivism can evoke the impression that "mind" or "consciousness" is nothing that exists in a scientific sense as a realistic entity that can cause real effects like the brain. Here again the protyposis has provided a scientific explanation.

13. The cultural evolution and its consequences

In humans and their ability of speech, and finally written language, the information processing reaches a new stage in the cosmic evolution. Now, information processing and dissemination becomes feasible far beyond the temporal and spatial limits of their biological existence. Here, it is important to maintain a view of the differences between consciousness and human culture. One often reads accounts implying that the consciousness is a "third entity" "between human beings". Obviously, the forming of the human consciousness is crucially dependent on being embedded in the respective cultural environment. And, of course, there is an interplay between the psyche of human beings and the evolution of their culture. Human beings form their culture, especially language and symbolic thinking, and the cultural contents retroact on

[47] Cardon, 2016, p 245
[48] Cardon, 2016, p 266

human language and thinking. In this sense, culture and consciousness are closely interrelated. Nevertheless, the essential carrier of a person's respective consciousness is the own brain.

Quantum theory, however, allows us to imagine psychological phenomena in which the carrier is constituted by several people at the same time, thus manifesting a kind of non-local correlations. C. G. Jung's model of the "collective unconscious" could be based to a certain extent on such phenomena. It is, however, problematic, if such non-local correlations are to be understood as cause-effect relations, in the sense of classical physics.

As many examples show, there is a large controlling cultural influence, extending even to our physical condition. For example, fainting hysterically was an accepted common cultural behavior some hundred years ago, whereas this is no longer the case in the present cultural sphere (notwithstanding pop concerts or people of other cultures); while today conflicts have physical manifestations of different forms.

Let us thus note that the cultural environment can impact the psyche and body, acting, like a placebo, via their meaning.

14. Summary: The Closing of the Explanatory Gap between Mind and Matter

- *Today modern quantum theory indicates how the age-old conceptual opposition between what is mental and what is material can be overcome.*

The one reality must be founded, also theoretically, on one unitary substance. That is the abstract cosmic quantum information, a conception, which, in everyday speech, would be more related to the notion of mind rather than that of matter.

Quantum theory makes it possible to replace the spatially small entity, an "atom" (in whatever form), with a really simple elementary structure. The simplest conceivable quantum structure is already completely characterized by its 2-dimensional state space. Most aptly, it can be envisaged as an AQI, an abstract, free-of-meaning qubit, referred to as *Protyposis*.

From Protyposis, the well-known manifestations of physical reality can be derived, the material quanta, as well as the quanta of energy, and the forms that we encounter as psychological quantum information, and finally as consciousness.

- *In the natural scientific context, consciousness can be defined as Protyposis, being in a form that can experience and recognize itself.*

All the processes and manifestations of nature can only be understood in the light of cosmic evolution. An initially formless quantum structure, the Protyposis, which is interpreted as abstract and free-of-meaning quantum information, reshapes itself, in its evolution, into the form of elementary particles.

- *This allows for a new understanding of matter as a special form of quantum information.*

Elementary particles and black holes bring into being galaxies with stars and planets, and on some of the planets life can develop.

Living beings are unstable flow-equilibria that control and stabilize themselves by means of quantum information. In life, for the first time, Protyposis can acquire meaning. A "correct interpretation", the right assignment of meaning to the information, increases the life-expectancy of the living being; a "false" one lowers it. Such a control is a real effect of quantum information on macroscopic material objects. It is possible because both the material

body of the living being and the quantum information involved in self-control are only different manifestations of Protyposis.

Living beings that require rapid information processing develop specialized organs to that task, brains. In very highly developed living beings, such as birds and mammals, the information processing becomes so comprehensive that the ability of experience and even a consciousness originate.

Quantum theory provides us with the framework required for the modeling of self-consciousness. It allows us to understand that the Protyposis, experiencing itself as consciousness in its form of meaningful information, is to be interpreted, depending on to the situation, as a feature of the brain, or as an independently acting quantum system. The different manifestations of Protyposis – as brain and as consciousness – close the "explanatory gap" between the two, consciousness and brain, and, moreover, between matter and mind as well.

Acknowledgments:

We thank Jochen Schirmer for much helpful advice.

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