A String Theory Flavor Model of Baryon Nodes and Lepto-Mesonic Links (Quantum Network Model)

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Abstract

Quantum systems are built of Elements of Quantum Circuits: baryons as nodes and lepto-mesonic links as channels / connectors. Various levels of connection lines, 1,2 or 3-quark lines, lead to a hierarchy of interactions.

The Hopf fibration, as a local model of a Gauge Theory approach to Quantum Physics, is investigated in parallel with the modern experimental data about the structure of nucleons and nuclei.

Complex quantum systems, like molecules, nuclei etc. are modeled using Riemann Surfaces and Belyi morphisms, "borrowed" from the String Theory approach.

This work continues a series of articles regarding the foundations of Physics, with input from Chemistry and Biology.

1 Introduction

Understanding of quantum systems has evolved tremendously, allowing for a technology proving we can build and control much of what Nature does. Yet compartmentalisation of Physics (Science) requires a unifying approach, rather than an "umbrella unification" in the sense of GUTs and TOEs. Indeed, less known advancements since 1970-2022 solved many of the questions regarding the SM (see Appendix A).

More importantly, there are other general aspects in Quantum Physics that need clarified, at a quite general level, following an obvious trend: the advantages of a systemic approach based on the Theory of Networks, their hierarchy and interactions (Systems that are networks, interacting as a stand alone autonomous systems; e.g. a network of Quantum Turing Machines etc.).

1.1 Collaborations and Knowledge Import-Export

To be more specific, recall that a unifying theme in Chemistry, Atomic and Nuclear Physics, but no so much in EPP, is that of *components* and *bonds*, yielding complex structures from "irreducible ones": molecules, atoms and nuclei, and "complete" scattering processes (creation and decays), beyond the limitations of "interaction vertex oriented" of EWT and QCD[1].

1.2 From observation and experiment to manufacturing

A notable progress in experimental domain is due to new technologies: from Kelvin force microscope to Webb Telescope etc.

In the microscopic domain we now can manipulate atoms and engineer new molecules (allotrope carbon cycles [3]), new nanostructures, metamaterials etc, and even see atoms and their orbitals, with a periodic spin of their anisotropic shapes [11, 2].

[1] And not ony in Nature, but artificially made: electronics, IT, Engineering etc.

1.3 From equations to graphical interface

The evolution of Science, R& D and mathematical structures and models used for Science as an Expert System (e.g.graph theory, 3D simulations, alternative, adapted theories of "electron": VSERP etc.), shows traits of stratification and evolution towards a *graphical interface* (symbolism, simplified icons etc.) which amaizingly match the actual objects of study:

1.4 From Quantum Particles and Fields to Quantum Circuits and Elements of Circuit

A general conclusion emerges: quantum systems are indeed Networks composed of Elements of (Quantum) Circuit, with Natural Parameters (units) [25] and refs within (see also [27]) [2].

1.5 Levels of Interface-Implementation

Briefly, while the Graphical Interface Format for Physics, Chemistry etc. matches the Quantum Network Model, computationally, one may use "Standard Models" (e.g. Schrodinger eq. for pedagogical purposes), or discrete models (lattice models), but ultimately a "Graphical-Abstract Algebra-Spectral Theory" approach is more adequate [14]:

Math-Physics Principle. ...

1.6 Analogies and Pictures

An analogy-picture approach to communicate the ideas provides rather the "graphical and conceptual" interface to an already existing Physics Theory; it allows for a unified approach to interactions and their regimes (dynamics and diverse experimental setups). Notably we borrow from Chemistry, as the theory of "electron" orbitals and bonds (1-quark EM connections / Gauge Theory), and use in Nuclear Physics (2-quark mesonic bonds and orbitals) and Elementary Particle Physics (Nuclear reactions, "elementary particle" scattering and 3-quark structures and their modes of vibration: DFT and Belyi Maps Models [14, 20]).

1.6.1 Electronics vs. Spintronics

Define spintronix as the Theory of $SU(2)$ (Gauge Theory or a QC version, on a Q-Network / Quantum Computer).

The analogy goes quite far: (complex) RLC elements of circuit just correspond to Hopf and Mobius Transformation parameters $(GL_2(C)/R_+)$ [25] and *transistors npn* and *pnp* correspond to *udu* and *dud*, to be explored later on.

This is no coincidence: cybernetic systems based on QC can be constructed using such elements, to build oscillators, transmission lines and control elements. The lesson from Classical Computing (VLSI, architecture of PC etc.) should be revealing; by analogy, we have *elements of circuit* (proton, neutron, orbitals or bonds) yielding a hierarchy of "components": nuclei, atoms, molecules and crystal "units", enzymes, cells etc.

Here we will compare some Chemistry facts (1q-bonds) and Nuclear Physics (2q-bonds).

1.7 String Theory and Quantum Computing

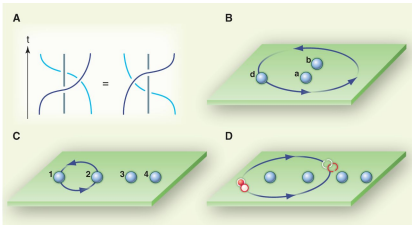
The QIC approach uses Riemann surfaces as cobordisms between Bloch spheres with punctures (Belyi maps; Hopf fibration as a local model in GT). This has connections with String Theory[3] and Topological QC based on annyons.

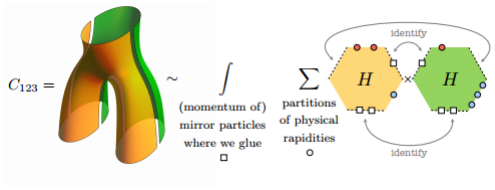
[2] This reminds the author of an electronic store for R, L, C and transistors, with quantized parameters: no $\sqrt{2}$ Ohms resistance to order, nor connector of such length ... Pythagoreans were right: "Number rules the Universe". It will be explained later on what algebraic numbers and periods are: rather AG-structures ...

[3] How the Landscape cab be controlled by a GT apporach with RS joining branching points, could be an idea worth pursuing.

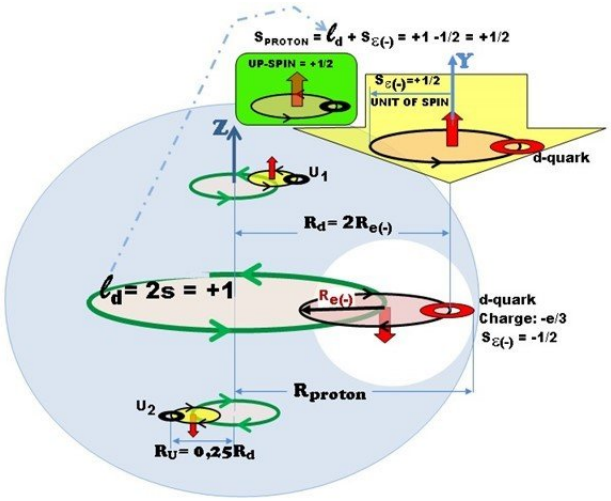
1.7.1 Braids, String Theory and Quark Line Diagrams

An attempt to combine the abstract formalism of braided tensor categories (Turaeev), well suited for abstract QC" (Cocke) with topological QC (Kaufman), in the geometric setup of String Theory, provides a model of baryons and mesons worth studying (figures from [18, 16]):





A tentative explanation of spin of quarks of a baryon is attempted in [17]:

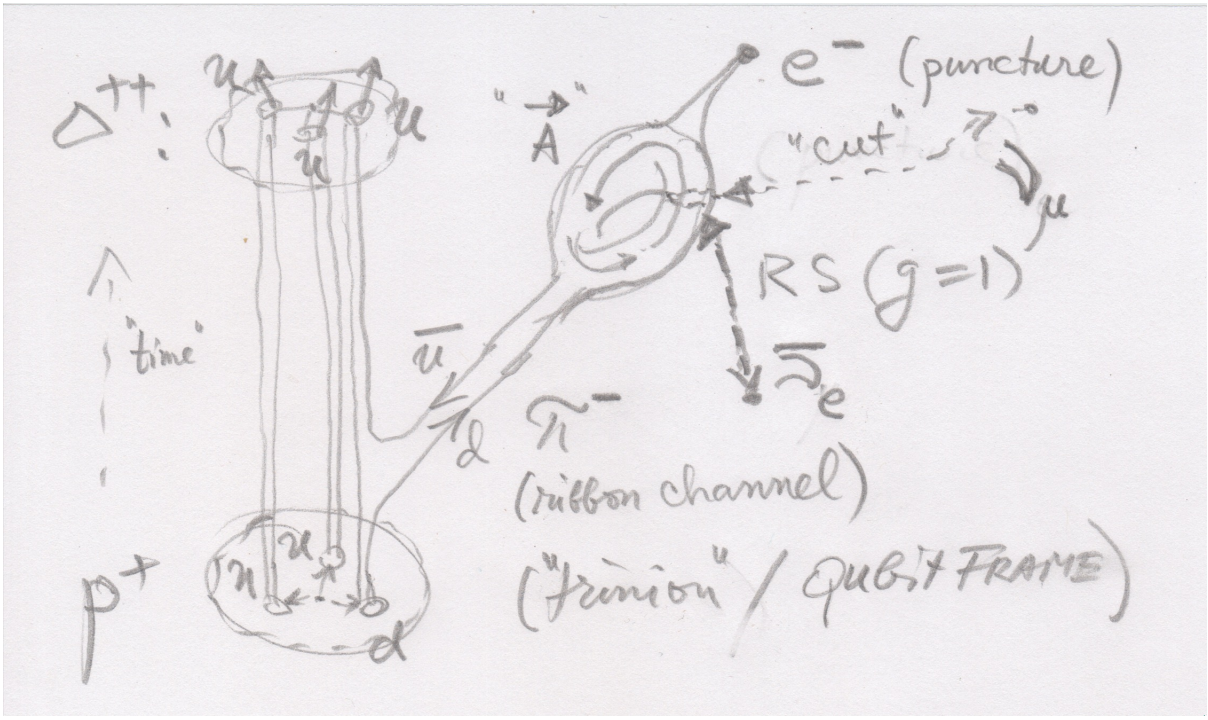


1.7.2 Baryon Field and Mesonic Bonds

We will consider instead a *baryon field model* of the neutron to be related with the toroidal model of H. Jehle, associated with the Hopf fibration with canonical connections, incorporating the idea of braiding in a pair of pants" version borrowed from ST (or 2D-TQFTs equivalent to Frobenius algebras).

Further more, the braiding of a two 1-quark ($SU(2)$-EM) line, is considered as a model for a *connection element of QC* which represents *mesonic channels* or *mesonic bonds* in nuclei.

While mesonic bonds in nuclei are stable, as for example in a nucleon-proton pair, like an a molecular *pi bond* in Chemistry [39], a mesonic 2q-line (e.g. pion) decays" from a turbulent regime to a linear regime, into a 1q-line (electron) with change of symmetry group, as suggested in [28], in an earlier stage of the research:



where Quark Line Diagrams were included. Note that these suggest also a *motion in space-time*, as part of the schematic representation; this will be isolated in the present investigation, from the structure of QS. The structure of the Network is presented as if embedded in Space-Time with an associated field, the *baryon field*, for compatibility and possibility of comparison with traditional theories (similar to lattice model in a ST, or String Theory approach etc.).

1.7.3 The Algebraic-Geometry Framework

Further leads towards an Algebraic-Geometric framework for Elementary Particle Physics, that departs from the Point Form QFT approach, is sketched in [44, 21]. It includes the basic idea in ST, but without a "Kaluza-Klein ambient dimensions", and upgraded frm the circle as geometric support for a physics string", to S^2 (Bloch sphere) as a model of a *unit of matter-space* and Hopf fibration to include a "periodic time" (quantum phase with a proper periodic clock - includes the idea of de Broglie pilot wave (proper vibrational aspect: "local, quantum, relativistic periodic time", and also a requirement of Einstein for a local time).

1.8 What is "Inside" a Proton?

Baryons are just forms of the nucleons n, p with various geometries and angular momenta modes. For the purpose of studying Q-systems are normal energies and how they interact, the neutron and proton sufies.

The HEP scattering experiments "reveal" a richer structure (see of quarks and gluons); these are not "inside" of the proton and gas models are not the adequate approach. [4]

One usually talks about *valence quarks*, and at normal energies and conditions (including the study of nucleosynthesis, or EPP below Higgs energies perhaps), the "zoo of baryons" and "mesons" maybe considered as described by 3-quarks (higher angular momentum states may involve additional nodes, though) with the usual six flavors.

In what follows we will consider the case of the first generation u, d quarks, tetrahedral symmetry and 3-quarks per baryon and two per meson (quark-antiquark).

[4] As a crude analogy, smashing a package and opening it to see thousands of glass debries might not allow to guess a crystal glass was carefully packed in it.

1.9 Regarding Antimatter

The Feynman-Suckelberg interpretation of anti-particles going "back in time" needs updated. For example in a creation of a particle anti-particle pair $\gamma \to e^- + e^+$ for instance, followed by annihilation (a loop), the energy-momentum is distributed to the entangled pair, but quantum phase has the opposite helicity, as if the partner has the conjugate charge $exp(\pm i\omega t$.

This can be understood in the context of the toroidal model. Antimatter is just matter with quantum phase evolving in the opposite direction, antiholomorphic. Analitic continuation on the loop will provide the above "particle moving back in time" interpretation.

1.10 Lessons from Chemistry

The theory of atomic orbitals and molecular bonds is similar to the theory of nuclear bonds via mesons in Nuclear Physics. This is justified by the unification of quarks, as space-like generators with $SU(2)$-fields of EM type, called *S-quarks* (R,G,B with color charges $\omega^3 = 1$) and electronic orbitals, as an $SU(2)$-field EM type, called *T-quark*.

The electronic covalent bonds are formed by a pair of $T-quark$ fields (orbitals), analog to mesonic bonds, formed by a pair of quark-antiquark.

1.10.1 Electron and quark generations

The "generations" of electronic orbitals s, p, d, f... (T-quark symmetry groups: TOI ...?), with *spin flavor* $s-up, s-down$, together with hybrid forms, e.g. sp^3 etc., are quite similar with quark generations and "isospin" flavors: $u/d, c/s, t/b$, together with the mixtures of flavors in baryons and mesons: $p = uud$, $\pi^- = d\bar{u}$ etc.

The *language* used in Chemistry and Nuclear Physics is similar, phenomena are similar (bound states, bonds, transitions etc.), except the $2 \times 2 = 3 + 1$ and ensuing classification of generators, one T (central) and three S ($SO(3)$ via adjoint representation of $su(2)$) lead to notable differences, hence to an apparent separation between subjects: electron theory vs. nucleon theory.

The unification via $su(2)$ is similar to that historical one in EM.

1.10.2 Dyons vs. Quarks

Dyons were introduced to couple electric and magnetic charges (monopole), which is not observed nor existent. The need is to unify them.

A unifying apporach relates qubits $q = (z_1, z_2)$, in a *qubit basis* (classical logic bit), as an element of $C \times C$ with $SU(2)$ symmetry group, and T, R, G, B) 1+3 Space-Time picture (quaternions as given by the adjoint representation, and rotations in 3D).

$$Quantum\ Computing : D(C) = C \times C, \quad Space - Time : \ H = R^3 \times R.$$

Relations with the theory of AG-Periods will be discussed in §2.

1.10.3 Goals: unification and enrichment

The goal is to implement a mechanism capable of transforming a 2-quark channel, i.e. a meson, into a 1-quark channel, i.e. a fermion: muon / electron (taon).

It is known that String Theory diagrams (or ribbon graphs / diagram) are referred to as Fat Feynman Diagrams", with a precise technical meaning attached and correspondences.

The above proposal aims to give a geometric-topologic framework for Quark Line Diagrams, including the brading as an essential element in the structure of tensor categories etc. (as well as in Topological Computing: knot theory, links and braids etc.).

1.10.4 Creation and Decays

In addition, the abstract idea of decay", an intrinsic (God given) transformation of a meson (quark / antiquark pair) into a lepton, without an underlying mechanism, seams in need of an explicit model (beyond the computational aspects).

By now it is understood that Quantum Physics is deterministic, but difficult to control because of the quantum phase etc. [26, 4]. The measurement issue is by now understood quite well. This prompts rethinking the concept of decay" as predictable: for example due to a anti-neutrino interaction in beta decay (see 1.9), or the decay of a pion into a muon etc. This of course requires redesigning EWT as a theory of the geometries of baryons and their mesonic bonds; the modes of vibrations are controlled by QCD, hence a unification is also required[5]

2 AG-Periods, Hodge structure, Feynman amplitudes etc.

To justify conceptually and the benefits in applications of *dyon-quark* alternative, we need to look at the larger picture involving *AG-Periods*.

The algebraic structure needed, is that of *Hopf structure* [19]. Before proceeding, the motivation comes from several directions.

2.1 The 2x2=1+3 Fundamental Correspondence

The Gauge Theory formalism is in fact correspondence between Quantum Computing vs. Space-Time Dynamics [5, 4], based on fibrations as a Mathematical tool (Framework). Fibre-wise it is the above "$2 \times 2 = 1 + 3$ correspondence (icon for a lot of structure and conceptual interface / translations: spinorial vs. relativistic etc.).

But there is much more structure to it: Hodge-de Rham, E/M-duality (Olive-Montonen, Langlands etc.), which leads to the *Periods rule Quantum Physics*: Feynman amplitudes are periods etc. (also related to Desins d'enfant, Belyi maps etc. where de Rham periods "live").

2.2 From AG-periods to Hodge structure and back

The above can be understood from the interpretation of AG-periods (topology included) as resulting from fiberwise *Hodge structure* (glued over Topology data). This is explained in §2.

Then *integration* over the manifold combines the Top data and representation data. The "picture" becomes quite complicated (and technical) to be discussed here (goes beyond gauge connections as a reduction of structure group; involves a fundamental group with algebraic conformal representations etc.).

2.3 Algebraic Periods and Hodge Structure

The Hopf algebra with duality structure $C \to C \times \bar{C}, C \times \bar{C}$ (copairing as a qubit basis and pairing as an inner product, usually considered hermitian $<,>: C \times C \to C$)) has in fact a *Hodge structure* [19] (algebraic conformal representation $h : C^* \to GL(V_C)$) with its associated Hodge decomposition and *periods coefficients*. One can trace-back this linear algebraic structure in the Daulbeaux Complex, Hodge-de Rham isomorphism etc. in Differential / Algebraic Geometry).

Hence the usual "Number Systems" are now better understood as Algebraic-Geometry structures:

$$Z \to Q \to Alg.\ Numbers \to AG - Periods.$$

Remark 2.1 *Note that Hodge structure is related to* modular forms, group, *RS, Belyi maps etc., the AG-tools needed in EPP [20, 21]:*

$$Hodge\ str.\ weight\ n : h(t) = t^n, \quad Modular\ Form : f(S(z)) = z^n f(z).$$

Here $S(z) = 1/z$ *is the* antipodal inversion *(geometric setup* CP^1*), but also corresponding to a Hopf algebra structure. Modular forms seem to be the holomorphic part of* Hodge characters *defining the eigenspaces of the Hodge decomposition [19]:*

$$\lambda^{p,q} = z^p \bar{z}^q,\ p + q = n; \qquad f(S(z)) = \lambda^{n,0}(z) f(z),$$

[5]The duplication between $W's$ for the Weak Force and $\pi's$ for nuclear force is quite apparent [15].

a kind of action equivariant condition, associated to a representation of $SL_2(Z) =< S, T > mod\ T$ *... Note that* non-commutative Hodge structures $h : SL_2(C) \to GL(V_Q)$ *restrict to* C^* *as* pure Hodge structures *(loc. cit., §4).*

Remark 2.2 *Modular forms are translation invariant* $f(T(z)) = f(z)$ *with* $T(z) = z + 1$ *(Fourier periodic), with* T, S *generators of the modular group* $SL_2(Z)$.

But the "key generators" for a Modular Analysis, *extending Wavelet Analysis (which "grades"/ extends Fourier Analysis), are* $S, L = TS$, *Mobius rational transformations of degree* $2, 3$.

These are related to electric and color charges $z^2 = 1, z^3 = 1$, *and also fundamental in defining a "valuation" on* Q *to complete it in a Number Theory friendly way [22], via continued fractions.*

What is the relation with periods, remains to be seen.

2.4 What are AG-Periods?

Algebraic numbers are "simpler" representations, e.g.

$$\sqrt{(2)}'' ='' \begin{bmatrix} 0 & 2//1 & 0 \end{bmatrix}, \quad i'' ='' \begin{bmatrix} 0 & -1//1 & 0 \end{bmatrix}.$$

Hence, loosely speaking, **periods**, *at the* Linear Algebra level *(Abstract Algebra structures / "Number Systems"), are algebraic numbers with conformal structure and Hodge duality*.

The presence of a lattice ("quantum aspect") is of course reminiscent of elliptic curves $exp : C/L \to C^*/q^n$, as a historical source for such a structure.

When considering the Algebraic-geometric setup (Hodge-de Rham), by "adding" Topology Data (gluing, RS, covering maps etc.), one gets a *geometric representation* of such an *algebraic conformal representation* (see [19]).

One may want to understand separately the *algebraic periods*, as representations, extending *algebraic number fields*, and see how the Galois group acquires a Hopf algebra structure.

3 Elements of a Quantum Network

The dawn of Science was marked by Newtonian Mechanics, Lagrange and Hamiltonian Mechanics, followed by Maxwell's framework for field theory; then quantum physics emerged and quantization led to QFT, GT and SM. 1970s, with "Quantum Mechanics is Quantum Computing" marks the begining of the next era where electronics, spintronics are just the beggining of the new paradigm of Quantum Theory: Networks and their *Elements of Quantum Circuit*.

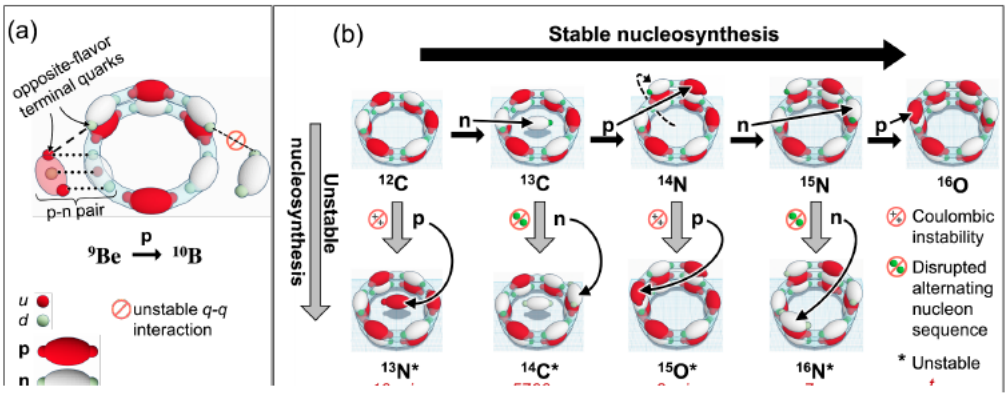
The above considerations lead to a new approach to modeling "elementary particles" and their interactions.

3.1 From Chemistry to Nuclear Physics Elements of Circuit

Nucleosynthesis [29] confirms the discrete approach to the structure of matter at all fundamental levels. In brief, the tentrahedral symmetry of baryons with basic quark flavors u, d (Tetrahedral Platonic group: 1st fermin generation) can be investigated by analogy, looking at the chemistry of Carbon C^{12}. The proposed *Average Quark Model* (loc. cit.) has firmer foundations in the Platonic (finite groups) of symmetry that model EPP (see F. Potter, L. Ionescu, Moon's Theory etc.).

3.1.1 Nuclear cycles and prisms

The *valence quarks* of neutrons and protons form *nuclear mesonic bonds*, with hexa-cycles similar to carbon aromatic cycles [29] Fig. 3, p.3:



3.2 Carbon atom as a unit

While the hydrogen atom is primordial, the chemistry of carbon is a better pedagogical tool to understand nuclear structures due to its tetrahedral symmetry of four covalent bonds (see Wiki: Diamond form).

Compare CH_4 and C_2H_6 molecular bonds, via Molecular Orbital theory with the 6-cycle of n,p pairs of lithium ^6LI and its double prism ^{12}C (loc. cit.).

3.2.1 Nucleus structures

It is apparent that the 3-quark (valence) geometry of neutrons and protons, like trinions, couple in "nuclear molecular" pairs, similar to the H_2-molecule: instead of a double T-bond, there is a mesonic $S-bond$ (π, ω etc.).

The nuclear molecule, as a unit, chains to form more complex nuclei. 3D-structures are expected (see Dr. Moon's Model) and allotropic forms of Carbon (see Wiki: carbon).

3.2.2 ... and Molecular Orbital Theory

Note that in MO Theory the electrons are delocalized, even beyond Valence Bond (VB) theory (VSERP), forming a *molecular orbital*. This just means that the EM-field quantum structure (with nodes and bonds, via e.g. wave function constructive and destructive interference: bonding and anti-bonding, sigma, pi-covalent bonds etc.), is a 3D-structure (in fact 3+1: Hopf bundle / RS apporach), with poles and zeros having periods: elementary localized charges (thought of as "electrons"). The total charge is rather the *degree* of some meromorphic function, in an AG-model (zero for an "isolated/irreducible" system: atom, molecule etc.).

3.2.3 2D vs. 3D Periods

The electric charge is a 2D-period (hence S^3-formalism is needed) and as mentioned elsewhere $e \cdot g = h$ is the E/M-decomposition of the unit of action (Planck's constant) into electric and magnetic quantum charge (1 and 2-periods).

We compare though, with Riemann Surfaces for simplicity; the spinorial 2x2=3+1 picture is more difficult to address, and it probably involves *complex surfaces* (Pickard-Fuchs equation etc.); or the unitary line bundle to a RS at least.

3.2.4 Localized Electrons

In conclusion, localized electrons are rather fixed points in the above formalism, e.g. as in the 2D-EM of Mobius transformations [30].

Yet molecules have molecular orbitals, with localized sources due to the finite group structures involved.

3.2.5 ... and quarks

Similarly for valence quarks, nuclei as *nuclear structures* (solid / liquid / gas models?), built via mesonic S-covalent bonds from the basic *nuclear molecule* $n - p$ ... and analogy to be investigated!

3.3 On Wave functions and Measurements

The Copenhagen interpretation of Schrodinger wave function, and the so called *partilce-wave dulity* can be understood as a consequence of the above localization vs. distributed (de-localization) of quantum numbers like electron charge.

For example, the "presence" of an "electron" in a molecular orbital means that in locations where the probability of "finding the electron" is low, the interaction via measurement is less likely to take place.

This is rather a place of stability of the two T-quark bond (molecular orbital), where the standing wave (destructive interference) has small amplitude.

The points of high amplitude (constructive), similar to those in a 2-slit experiment pattern on the recording screen, are the points where an experimental devise is likely to interact (record) an "electric charge": discharge / collapse of the wave function, similar to the excitation of a photo-detector (or similar devise) in the 2-slit experiment.

What happens when "measuring / seeing an atom" (Kelvin probe force microscope) is a micro analog of the macro phenomenon of fringes in the 2-slit experiment.

3.3.1 Quantum Phase and Periodic Time

In conclusion, "particle" aspects (localized) and wave behaviour need be modeled in a unified way, e.g. as in Molecular Orbital theory; Schrodinger Wave Mechanics is equivalent to Feynman Path integral, and quantum phase is the "periodic proper time" which is fundamental in EPP.

4 Importance of Hopf Algebra Structure

This combines the product and coproduct structures, antipode, braiding (quantum phase relevent) and hierarchy of structure via deformations (Quantum Groups). These are ideal for implementing *delocalization*, leading to entanglement and *re-localization*, essential in interpreting the role of *information as an agent of splitting the energy levels*: see Landauer principle, equivalence between energy-information (and well known contributions to what mass is $E = mc^2$).

The theoretical and experimental evidence for the above: molecular orbitals and bonding, anti-bonding and non-bonding.

4.1 Constructive vs. Destructive Resonance

Constructive interference (requiring resonance: same frequencies / geometric properties, symmetry groups) leads to an increase in amplitude (or experimental probability in measurements / interactions with the system), which represents an increase in *localization* of the "distributed partilce", i.e. irreducible quantum system considered, hence resulting in a "transfer" between Quantum and Classical amount of information (from distributed states to classical states, "particle like": localized).

Entanglement is a *delocalization process*, spreading the classical info into a quantum type of information (states).

Now energy distribution and levels are related to probabilities as well known $p = exp(-E/kT)$, with T "temperature" a Lagrange multiplier (related to optimization / extrema problems).

The "new equivalence principle" [31] is the proposed *quantum of energy per bit* [32, 33]:

$$E = kT \log 2.$$

An example to be analyzed in more detail is the formation of molecular bonds, from this point of view.

4.2 Creation / Destruction and Measurement Problem

This relates the process of creation of loops, involving particle - antiparticle pairs, with associated entanglement, or just distribution of classical quantities like momentum, or quantum spin [26].

How the classical amount of quantum information $-\log p$ changes, affecting the distribution of energy, and resulting in a split of energy levels, needs investigated in the context of Gauge Theory formalism: quantum intrinsic info at the level of fibers, vs. charge distribution (sources of fields) on the base manifold (Space-Time).

Creation of loops is indicative of a "turbulent" flow (Network type), controlled by the *Quantum Raynholds Number* α, while "destruction" (collapse) of loops (like reducing the genus of the Network) reduces genus, and the *hierachy of striucture* (Planck constant degree, corresponding to powers of *alpha*, in the deformation series: Feynman, Heisenberg group as the "tip of deformation quantization", an infinitesimal deformation with its extension from Witt to Virasoro algebra, its central extension).

The measurement problem has a perturbation aspect, but also an extraction of classical information, which leads both to a physical collaps of the structure and a projection / change in the description of the quantum system (model), not suited toa Diff. Eq. modeling, a a tool.

5 Standard Model Homochirality and The Arrow of Life

The CPT Theorem holds in Point-Form of QFT of SM, yet CP-violations are observed and partially explained.

At the origin, Left / Right assymetry in the SM (e.g. left neutrinos only) has deeper origins in the *braiding* structure of spinors / qubits in QC. This is documented in F. Potter's work: left vs. right quaternion multiplication [34].

The author conjectures that this implies (explains) the origin of Chiral-Indused Spin Effect (CISS) which is a uni-directional preference of spin flow, as in a *spintronics diode* (compare with Josephson effect in QC hardware).

Again conjecturally, this maybe the mechanism favoring a build-up of more complex structures (more subtle "bonding", allowing for more complex quantized magnetic flux structures: qi flow [36].

in conjunction with a re-evaluation of the laws of Quantum Information Dynamics, suggests a new "Universal Law", compatible with what we observe, that *quantum systems tend to agregate into more complex, more succesful structures* (in terms of responce to ambient inputs and interactions (Quantum Turing Machines, interacting).

The central concept is that of quantum information flow, changes in states of a system, but also growth in structure (or aquisition by a larger QS: electron capture, molecule formation, organic molecules, bio-systems etc. - if enough "random" transformations, meeting by chance with opportunities of combination, are allowed).

hence the "big picture" emerging is that "the emergence of Life is mandatory".

5.1 Bio-Homo-Chirality and Quantum Computing

The homochirality in chemistry and bio-systems is well known, from CISS, and an underlying reason was proposed [12]; yet the author's claim is that *this is built in the foundations of Quantum Computing*: the *braiding structure* of spinors $C \times C$, which manifests with quaternions via the adjoint representation.

How this is related to the *Hodge structure* (see §2) remains to be investigated.

5.2 Topological Quantum Computing

Topological QC is an alternative theory (see Kaufmann), focusing on topological aspects (braids, knots, links and their representations). This theory supports the annyonic formalism and also the "generic" QC of Turaev etc. based on tensor categories and Networks (finite case: quiver representations etc.).

5.3 Information-Energy Correspondence

The Landauer principle relates energy and classical information written or deleted $\Delta E = kT \log 2$.

Quantity of information $I = -\log p_i$ (where p_i is say the "ratio" of states of a certain type / level of energy, in the partition function of a system), is just a "scalar" measure of the amount of structure of a System (memory capability and reaction to I/O), not revealing its structure. Its average, entropy, is a global variable (like the weight of a person).

Further research into this equivalence suggests "information seeks order" [37, 38, 24] is consistent to the law of increase of quantity of info due to formation of more complex systems (molecules, solids, combinations of molecules, simple organisms etc.), since "order" is a generic term / quality of structures with hierarchy and more complex functions emerging from simpler ones (enough transistors build a VLSI, PC etc.).

5.4 Conclusions

The minimization of energy as a general principle conductive of formation of more complex structures (nuclei, atoms, molecules, anorganic-organic systems etc.) combines with an affinity due to resonance and constructive-destructive interference to yield quantum systems (quantum phase correlated irreducible systems, in their class of structure and functionality), which can be viewed / modeled as complex *Quantum Turing Machines*.

The built-in homochiral structure, at fundamental QC level, enables memory, structure growth vs. decay, suggesting a modern version of "Entropy Law": The Universe Evolves towards a growth in hierarchy (complexity) and Order", as well as a new take on the "Time Arrow": if "time" is a parameter for "change" (from Being to Becoming: Prigojine), then: 1) at QC level there is an "arrow": braiding implying homo-chirality vs. unitary transformations; 2) the "arrow of emerging time" needs be chosen in the direction of the quantum phase (holomorphic structure) associated to *particles*:left-handed fermions.

A more technical investigation needs relate braiding, spin, helicity and chirality.

5.4.1 Anti-matter?

Spin-up / down and pairing of electrons in the s-shell of hydrogen for instance, or bonds and antibonds in molecules, are analogs of quark-antiquark pairing in mesons, as bonds between nucleons; these are instances where we see "particle as well as antiparticle aspects", which are considered separate in "free interactions" (all are processes involving bonds, 2-channel interactions etc.).

5.4.2 ... and Arrow of Life

But the preference between Left/Right of "3+1-Physics" is (conjecturally) a result of QC / Spinorial '' 2×2-Physics (Hodge structure, categorical duality $C, \bar{C}$ and braiding structure).

On the other hand the "lower energy" of bonding (in-phase coherence) vs. "higher energy" of anti-bonding (opposite phase coherence), responsible for the "Arrow of Life", could be independent on choosing between C and $\bar{C}$ ... [6]

A Previous Research and Developments

Developments yet to be incorporated into the SM include: a) finite subgroups (Platonic) of $SU(2)$, accounting for fermion generations and quark flavors [35] 1994, [43], 2010-15; b) A Theory of Gravity, as a nuclear spin polarization effect, based on the quark model [40, 41] 2022-2023, explaining several other experimental evidence of Gravity field generation [42]; c) A unified model of spin, angular momentum and electric-magnetic charges, based on the Hopf fibration and toroidal model of baryon field [9, 27]; d) clarification of the role of the fine structure constant and how to be evaluated [27]; emergence of relativistic Space and Time from the Gauge Theory paradigm, based on a reinterpretation of what quarks are; e) The unification of fundamental interactions based on a reinterpretation of the role of $SU(3)$; f) A unified apporach to fermions and gauge bosons, via the Network Model.

Regarding Gravity, the lack of progress of mainstream science in this direction is due to several misleading and limiting assumptions: 1) General Relativity and QM have to be reconciled, *before* unification of the fundamental interactions; 2) EWT and QCD are fundamental interactions (independent);

[6] ... to be investigated ...

3) Gravity is a fundamental interaction of gauge type, which has to be modeled in terms of a *graviton* as a gauge boson.

In previous work it was explained how GR is precursor of QFT, representing Gravity as a consequence of a deformation of the metric (as we all know), but essentially recasting Newtonian Gravity in a framework adequate to model the "Universe", but with notable consequences: black holes, Big Bang, red shift etc.

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