Unifying Trends in Physics, Chemistry and Biology

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Abstract

A comparison of structures and interactions of quantum systems in Physics (Elementary particles, Nuclear, Atomic), Chemistry and Biology show the benefits of the Quantum Network Model, as a universal language, upgrading basic historically important similar models and theory (Turing Machine, Automata/Formal Languages).

The main and also starting point, is viewing the "electron" as the 4th, time-like quark, via the correspondence between the fundamental representation of $SU(2)$ and adjoint representation, with corresponding generators. Its iconic equation of dimensions is the well known $2 + 2 = 3 + 1$, underlying the Hopf fibration, and defining the correspondence between spinors and Lorentz vectors (Space-Time points), in the Gauge Theory paradigm.

1 Introduction

Recent progress in quantum physics, leads to an conceptual advancements upgrading the regarding the Standard Model, including unification of fundamental interactions, fermion-boson unification via a Network Model approach to interactions, and to clarification regarding the emergence of Space-Time-Mater from Gauge Theory integrating Quantum Computing viewpoint.

Extending the scope of modeling interactions from Elementary Particle Physics to Chemistry, provides a unified language and framework for quantum systems and their interactions, with feedback allowing to further develop the Standard Model in Elementary Particle Physics.

The article is a continuation of the unifying approach started in [55], with electrons (or rather orbitals and chemical bonds) and mesons treated on an equal footing, separate from baryons which are the only "matter particles" (various geometries and excitations of nucleon).

Prospects of a Universal Paradigm emerges, and to begin understanding that, contrary to the ingrained mentality resulting from the 2nd Law of Thermodynamics, life is mandatory to emerge and complexity of the universe increases acquiring more levels to its hierarchy of structures, to be reported elsewhere.

2 Quantum Network Model

2.1 Recall on the Standard Model and "Upgrades"

The SM was gradually established since the completion of QED, based on the Point Form QFT formalism [30, 31], with its *Gauge Theory* paradigm, yet in the non-commutative case (Yang-Mills Theory) for the *Electroweak Theory* [1] and *Quantum Chromodynamics*.

It reached its "final form" in the 1970s, with the introduction of Higgs mechanism and prediction of Higgs boson, confirmed later on that experiment, based on the theory, "strongly indicates that it is a Higgs boson" [32].

The difficulties and incompleteness of the SM are multiple, and relatively well known [33, 34].

In "parallel", point-particles (PFQFT) where later modeled as *strings*, giving rise to String Theory; Quantum Mechanics was recognized as Quantum Computing (Feynman etc.).

[1] Unification of QED and Quantum Flavor Dynamics - Glashow, Weinberg, Salam

2.2 The Quark-Qubit Model Unification

The modern description of scattering experiments in terms of *Quark Line Diagrams* implicitly suggest that the *irreducible QS* is of the type of a sphere S^2, with 3D-frame of quarks [36] and a cyclic periodic time [35], starting with Feynman's interpretation of quantum phase of an elementary particle.

The main conceptual change is that the three baryon quarks *should not be modeled* as pointwise particles, but rather as an irreducible physical object with structure that corresponds to *the the point-form gauge theory formalism to structure 'of 3 "independent", yet "tied " confined particles*.

A good way to grasp the change is to think of the *Hopf bundle* as the *element of circuit* of a *Quantum Network*, which is similar to a lattice as a special case, which in turn approximates the GT space-Time fibration, like it is commonly used in Lattice QCD.

Further details and comparisons were provided elsewhere [38, 39, 40, 36, 35, 41] etc. [28, 42].

In the following the conclusion that tha same "language" applies to Physics, Chem and then Biology, will be presented, rather as a claim, but based on "visiting nearby Sciences" (Chem and Biology).

2.3 The Hierarchy of the Universe

The Universe is structured hierarchically.

More complex QS interact non-necesarely coherently, as collections (ansambles) of individuals (QS) with interactions that are not quantum in phase correlated.

When several QS get synced (Q-phase), like Huygence clocks or fireflies on a hill, they form a "super-QS", which fits at the next level of complexity in the abobe hierarchy.

The difference of "behaviour" experimentally observed and type of phenomena differ precissely due to coherence (entanglement) or lack of it, leading to the pragmatic classification: "classical" (i.e. obeying our classical logic rules and physical laws) or "quantum" (obeying quantum logic, as well demonstrated by the QC technology, where quantum software and quantum hardware are just Q-logic and real quantum physics). It may appear "weird" when compared with the classical, especially due to some missconceptions regarding what a reference frame is, what an observable is, and mixing statistics (due to lack of experimental info about the system) with QM without a proper discernament for why we use it [41].

So, let's start from the building blocks, up ...

2.3.1 Baryon Nodes and Lepto-mesonic Bonds

The classification of the EP needs changed.

Baryons are the nodes of the QN and their interactions are mediated via quantum channels: mesonic bonds for the Nuclear Force and leptonic bonds for EM bonds.

here we need to acknowledge another unification needed:

2.3.2 Electron as a 4th Quark

That the electron is a 4th quark, was proposed before but not developed as an idea.

The correspondence ST / GT / QC is iconically captured by $2x2 \cong 3 + 1$. At a technical level the *adjoint representation* of su_2 and its complexification $sl_2(C) = su_2^L \times su_2^R$ (etc.: see SM), defines a projection that reduces to the Hopf bundle (the "Quantum Unit").

Hence, the generator for $SU(2)$-GT of the electron as a spinor (Dirac formalism), and its reduction to QED ($U(1)$-GT), i.e. *quantum phase*, plays the role of a 4th quark (as generator of symmetry, *not* as a "particle"). We will refer to as a *time-like quark* or T-quark for short.

The other three quarks of a baryon (as symmetry generators and eigenvectors of the baryonic field) with color labels R, G, B, have also $SU(2)$-GT field of EM type [43, 44]. They will be referred to as S-quarks, or *Space-like quarks*; they naturally define local 3D-frame of a baryon, from which Space directions emerge [4].

2.3.3 From Quantum to Classical: from 2×2 to $3 + 1$

Of course the 3 + 1 quarks description are a S-T emergent description, via conjugation, due to non-commutativity / curvature. This "reality" of what we see as permanent, when in fact everything is QC (*Panta Rei*), will be explained elsewhere [45]. It is a macro version emerging from the Lie correspondence *fundamental representation* vs. *adjoint representation*. Philosophically, it leads to Prigojine's *from being to becoming* [57], witch can be traced back to what the identity card of a particle is: its symmetries, like in Category Theory: what "defines" and object? its symmetries $Aut(Ob)$; but the picture is even more beautiful, since in fact the functor $om(Ob, \cdot)$ "determines" what the obeject is and how it behaves, i.e. its typical interactions with other objects ... sounds like behaviour, and in an automaton theory sense, it's just a matter of scaling the theory ...

So these ideas will be made more precise and expanded elsewhere, trying to clarify what a system "is", how "it" transforms, and combine both Democritus' viewpoint and Plato's, that "All is One", in consensus with Heisenberg's viewpoint on particle-wave duality.

3 Examples of Similar Concepts in Physics and Chemistry

The fundamental Element of Universe (Quantum System) is the *atom of Hydrogen*. It is an irreducible structure, with a complex field with three S-quarks as principal directions of the proton as a baryon, and one T-quark, the electronic *s*-orbital (Chem).

Examples of levels of structure will be given, without further developments at this stage, aiming to bring together the pieces of the puzzle" to assemble into a general patter/ language for interactions of particles / quantum circuits of a given functional level.

3.1 Elementary Particles Physics

In a typical Quark Line Diagram we see an input of baryons which interact via lepto-mesonic channels with loops (topology) and 3D-frame lines, yielding an output of the same number of baryons.

3.1.1 Movie Model

It should be viewed as a movie" with intermediary frames" of evolution, via transformations, which can be modeled as *generalized cobordisms* in a certain category [46].

These intermediate stages of the same baryons are excited states of the proton and neutron, to be modeled using Algebraic-Geometric Theory of Bely morphisms" [47, 20].

This is in contrast with the approach using an ambient Space-Time, a modern version of Einstein's *block-universe* picture. Indeed, *linear time does not exist* as a physical entity; the 3D-Q-Net changes, together with the stored info, that gives the persistent illusion" of time with an arrow.

3.1.2 Why lepto-mesonic bonds?

The claim that leptons in EPP are quite the same type of bonds as the mesonic nuclear bonds (S-quark-antiquark pair, i.e. duplex channel[2]) is justified by Chemistry, where we see that a *covalent bond* is formed from two electronic orbitals (T-quarks), with opposite spins $e^-_\uparrow$ and $e^-_\downarrow$. This process involves *hybridization* of atomic orbitals (T-quark), which is similar to flavored versions of S-quarks $(u/d, c/s, t/b)$ in mesons, as combinations of quarks of different flavors.

3.1.3 An example: Carbon and Pions

In Chemistry [48]:

"For example, in a carbon atom which forms four single bonds, the valence-shell s orbital combines with three valence-shell p orbitals to form four equivalent sp3 mixtures in a tetrahedral arrangement around the carbon to bond to four different atoms. Hybrid orbitals are useful in the explanation of molecular geometry and atomic bonding properties and are symmetrically disposed in space. Usually hybrid orbitals are formed by mixing atomic orbitals of comparable energies."

[2] Whether it is in a nucleus, as a stable bond, or highly energetic an short time lived as in scattering experiments.

The author claims that the same mathematical mechanisms applies to change of flavors of quarks for various mesons, forming *nuclear bonds* [49, 51] (and much more: see Dr. Moon's work on structure of nucleus).

The "only difference" is that in the former case a T-quark / $SU(2)$-field (vector potential) of EM type is involved, while in the later case an $S-quark$ field is at work (same type: $SU(2)-EM$ - see [43]).

Remark 3.1 *This is a preliminary investigation and several aspects not "fitting in at this stage are left for later on ... as with any puzzle! One disagreement is: why atomic orbitals favor pairs of electrons of opposite spins, while single electron orbital is still possible? On the other hand covalent bonds always consist of two such electronic orbitals, as in the case of mesons (S-quark/antiquark pair).*

3.1.4 What is an anti-T-quark?

A possible explanation is that, while with S-quarks in mesons charge conjugation-time reversal applies (equivalently P-symmetry), for T-quarks (electrons) $C-conjugation$ acts as Q-phase conjugation, which is equivalent to (local) time-reversal. Hence the *anti-T-quark* has the same electric charge, but opposite quantum phase ...

Remark 3.2 *A further investigation of the isospin and fractional elementary charge for S-quarks vs. whole charge for T-quarks, in the framework of Hopf fibration and adjoint representation of $sl_2(C)$ will follow [53].*

3.1.5 Same Platonic Geometry Applies

The relevance of the algebraic quadratic extensions $Z[i, \omega]$, the Galois Diophantine extension adjoining time-charge generator i and quantum fractional charge ω can hardly be overemphesized[3]

This regards the $U(1)$ aspects of the theory of the Klein geometry $U(1) \rightarrow SU(2)$ on which the Electroweak Theory is based (with its Weinberg angle and left/right asymmetry due to quaternion conjugation, or alternatively left/right module structure on states [51]).

Regarding the finite geometries of baryons (flavors), not only the Platonic symmetries are essential (Weyl groups of exceptional lie algebras) but also the Archimedian and Johnson polihedra (geometries of the Bloch sphere), acounting somehow for the *mixtures of flavors in baryons* (and hybridization of quark flavors yielding mesonic nuclear bonds).

Since Platonic symmetries apply to Elementary Particle Physics level and Nuclear Physics level (see structure of nuclei [50] and nucleosynthesis [54]), one expects that the same AG-mechanism of *modular curves and Belyi maps* may apply, be effective for model building in Chemistry.

And vice-versa, the extensive knowledge of Geometry of Molecules (Molecular Geometry) will provide insight into the structure of nuclei, and the structure of QLD viewed as "Quantum Integrated Circuits", not with atoms and electronic bonds as in molecules, but rather a true Geometry of S-quark bonding ($SU(2)$-connection Theory)[4]

3.1.6 Molecular and Nuclear Geometry

It is interesting to compare, and then to study in depth, the similarity between the *geometry of molecules* (T-Quark Bonds Theory, as a AG-Atomic Physics "upgrade" of Molecular Geometry, unifying the approaches of Linus Pauling, Lewis Theory etc.) and *Nuclear Geometry* with its recent advancements via the *Average Quark Model* explaining the extensive data on sizes of nuclei and stability of nuclei and rates of transmutations in *Nucleosynthesis Theory* [54].

Most notably is the similarity between the carbon based molecules [56], governed by *tetrahedral Platonic symmetry* (and cubic, since a *cube geometry* is a natural framework for a vibrational oscillator of a tetrahedron, between its two self-dual forms; $A_4 \rightarrow S_4$), and the *nuclear hexa-cylinders* which seam to model quite well the light elements:

[3] But as mentioned, it needs more study to be understood.

[4] The String Theory and Calabi-Yau / Kahler structures are not mentioned at this time, yet may provide additional insight. See [55] for details.

4 Impacts on Biology

Biological Systems are a case of "just" more complex *Quantum Systems*: made of subsystems (organs, organelle, sub-Networks, e.g. vascular system, nervous system etc.), quantum phase correlated and entangled (see the meaning and role of qi-flow, meridians etc. [37]).

Here we will just anticipate a few connections which will be documented later on [45].

One is the connection between chirality at the level of the Standard Model (e.g. [52]), and the *chirality selective spin effect* (CISS), which seams to be essential in the understanding on how *life emerges* [25, 26]. The signature of life is the qi-flow, or in abstract terms *quantum computing*, or the "flow" of quantum information on the biological "quantum hardware" [22, 23, 29]

Since biological systems are "made of" molecules, forming for complex systems (proteins, enzimes, cells etc.) it is clear that their functioning and functionality is "quantum" in nature (pertaining to a Quantum Physics perspective), and that entanglement, as a distribution via delocalization of quantum information is the norm. Gradual decoherence, build-up of lack of synchronization (see local relativistic time emergence from quantum phase [35]) leads to an increase of entropy as a probabilistic average of quantity of information, and hence decay and death; this is in contrast with the growth stage from birth and development, with coherence build up.

More specifically, it is apparent that interactions between simpler subsystems, and "bonding", i.e. forming a new level of structure as a whole coherent system, results in a decrease of entropy. Thus for such a process the "arrow of time", the later taken as an order parameter for change, opposes the increase of entropy; while in the former case, of decay, it coincides with the arrow of entropy change postulated by the 2nd Law of Thermodynamics.

Of course, Thermodynamics is concerned with systems as collections of essentially non-interacting at a quantum level (involving bonding, emergence of hierarchy etc.), and only mechanically interacting as particles, like gases for instance, hence being a very specific and restricted "law", by far not "universal". On the contrary, the Universal Law is the tendency of the Universe to self-build more complex systems, as we plainly see around us. What is remarkable, is that this tendency seams to be mandated by chirality, which is built-in the foundations (QC/SM).

More will be explained elsewhere [45].

5 Conclusions and Further Developments

This unification project is rather a program, and it will be kept at this level for now, to be expanded later on. It steams from an extensive research reported in previous articles available at vixra.com.

in brief, the foundational key idea is that the "electron" is a 4th generator, of "time flavor", i.e. corresponding to the quantum phase $U(1)$ in gauge theory, part of the $2+2- > 3+1$ decomposition via the adjoint representation. It arises via Hopf fibration as the building block, in QC formalism (Quantum software) or Gauge Theory formalism (Elementary Particle Physics quantum hardware).

Here the "electron" rather means *the Theory of the Electron* (classic EM, QED, orbitals and covalent bonds in Chemistry etc.), while the other genuine quarks R, G, B of SM (with flavors as baryon geometry) are the +3 in the decomposition: $S-$ *typequarks*.

The *Quantum Network* model approach to modern Science is quite mature enough, to convince the scientific community of its benefits in replacing the "old" Point Form QFT approach; yet the Gauge Theory paradigm is still the point of departure in this endeavour. At this stage is should be used as a mindset framework for rethinking Feynman Diagrams, Quark Line Diagrams (QLD), molecules, solid state physics etc.

As a consequence, the parallel between Chemistry and Nuclerar Physics should be noted; also the parallel Chemistry - EPP: a QLD is the analog of a molecule, or nucleus ("nuclear molecule"), with baryons as nodes and lepto-mesonic lines and propagators, as leptomesonic bonds (but "lone" leptons occur, since these are not stable, as the covalent bonds, or nuclear bonds *np*; also the later will exhibit declocalization of electric charge, similar as in Chemistry).

Obviously there is a lot of research to be done before a coherent and consistent model will be designed; in this sense the present article is a start-up R&D.

In summary, the Gauge Theory paradigm allows to explain the *emergent Space-Time structure* (below) from the QC/spinorial structure (above). There is only one type of interaction / field of EM

type $SU(2)$. The other fundamental interactions, modeled so far by recycling the gauge paradigm, are in fact: Geometry of baryons (finite groups / Platonic etc.), not a Weak Flavor Dynamics Theory (nor Weak Force), and QCD has to be imported as a theory of interaction between Cartan 3D-frames of these baryons, with stable or transient at high energies lepto-mesonic bonds (T-quark lone causal interactions or S-quark/antiquark bonds; to be refined and clarified later on; see [27] etc.).

The role of chirality, starting with the SM framework, and steaming mathematically from the passage from fundamental representation of $SU(2)$ (quantum Computing) via passage to the *adjoint representation* (Hopf fibration, quaternions and left/right module structure: see [52] is essential to understanding the emergence of life and biological systems.

Subsequent developments are in preparation, but we invite the reader to start his/her (using AI: "it"?) own Journey towards these unexplored directions.

For lots of additional insight and prior developments see [28].

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