A Quark Fields Emergent Space-Time and Gravity

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March 4, 2023

Abstract

The idea of using the gauge theory paradigm of the SM to couple Quark-Lepton Model of matter and fields to Space-Time, as an emergent structure, is suggested.

The color QCD quark fields, as $SU(2)$-connections of EM type, allows to define an adapted Space-Time metric compatible with the $SU(3)$-symmetry. It uses the double role of EM $U(1)$-connection, with the electric charge of the electron as a 4th color T, aside the RGB quark colors.

The Quantum Flavor-Dynamics (Weak Force) corresponds to the break of symmetry due to finite subgroups of symmetry of $SU(2)$, of Platonic type, and plays the role of a theory of transitions of states defined by principal quantum number in 3D, that we call "generation", similar to the case of electron transitions in an atom (2D finite subgroups).

Gravity is a nuclear spin-spin dependent interaction, resulting from the fractional electric charge of quarks, as $U(1)$-components of the quark fields. This allows to derive Newtonian gravity as an emergent force, always attractive, by averaging over quark spin directions, providing a solution to the Hierarchy Problem.

The compatibility between the fiber structure (SM Gauge Theory) and base connections (Space-Time and EM) is conjectured to allow in principle to relate the SM and General Relativity.

This approach provides a unified approach to the four fundamental interactions.

Several other remarks are included, e.g. regarding the relation between the emergent Space-Time approach and String Theory, GUTs, TOEs and Quantum Gravity.

1 Introduction

The Standard Model of Elementary Particle Physics faces experimental difficulties, while ignoring Gravity, conceptually and recent experimental evidence that micro Gravity is related to quark structure.

To further Physics understanding of Nature, revisiting old assumptions and rethinking the basic concepts is needed. Today's Physics is still "examining more data" or "asking Nature" [3], without re-examining the foundations of the SM.

In particular, the idea of quarks as point-like elementary particles, has consequences that prevents the SM from evolving since its "final form" of the 70s: QCD has to confine quarks, Weak Force as Quantum Flavor-Dynamics was designed independently from QCD and Gravity is left as Einstein modeled it 100 years ago.

In this article we argue that Weak Force and QCD are complementary theories, which in fact allow to derive Space-Time as emergent from the quantum structure of matter-fields, in the interaction picture. The process uses the Electroweak Theory which already combines the quantum theory and EM, at the level of the quark model.

The electric component of EM has a natural refinement in terms of fractional electric charges, part of the color-QCD quark fields, hence inviting for a way to derive Gravity as perturbation. Since this is spin-spin dependent, it will average to a very weak force, but at quantum level it is much stronger than expected.

Before recalling the main points of the SM and how some conceptual reinterpretations will go along way in its understanding, let us revisit a few general aspects.

2 Some General Remarks

A physics problem should not be solved in isolation. The conceptual difficulties in QM and Cosmology (particle-wave duality, 2-slit experiment, entanglement, dark matter, antimatter problem, Hierarchy Problem etc.) are related.

2.1 Democritus vs. Plato

Physics follows the Democritus path: divisibility towards constitutive elementary particles, but ignoring Plato "all is One" structuralist view [1].

A Democritus-Plato complementary (e.g. particle-wave) would benefit from both approaches. Specifically: 1) a hydrogen atom is an irreducible system and when divided we loose its structure and get a proton and an electron; 2) a proton is an irreducible quantum system ("elementary particle"), but with a complex structure, without "parts" that can be separated as above in (1); 3) the neutron is electrically neutral, but with a non-trivial electric charge structure; 4) quark-gluon plasma of a nucleus at a high temperature is just a different phase of matter, with symmetries and statistics that differ from the "low temperature" crystalline (ordered) structure where we can indentify the nodes (nucleons) and mesonic bonds (pions, omega, rho etc.).

Remark 2.1 *A mathematician would clearly see some universal themes: "categories", irreducible objects (generators), operations and fusion rules, and more importantly functors (Res and Ind for breaking symmetry framework), as quite indispensable to understand the* quantum/discrete *world of Elementary Particle Physics.*

2.2 Space-Time vs. Networks

One general trend is the evolution of Physics Models from particle-field interactions in Space-Time to Network Models.

In [2] evidence is provided that an interaction involve channels, of fermionic type, through which carrier bosons propagate. This will be used to establish an analogy and unify EM (electrons as bonds and photons as interaction carriers) and Nuclear Force (mesons as bonds, with gluons as carriers of quark fields).

The parallel between Chemistry and Nuclear Physics is quite poignant and useful [4].

2.3 Supersymmetry

Doubling the number of particles of the SM to have the same number of fermions and bosons is an ad-hoc idea, not justified by other reasons.

3 A Little History

SM was developed by various scientists building on top of previous theories, and aside of the theories developed by other physicists; we refer to: Fermi Theory, Gell-Man's 8-fold way, Quantum Flavor-Dynamics and QCD.[8].

Gravity was ignored, and left for GR to be explained, to the point of not even be open that it may be of a quantum origin.

3.1 Stage 1: Fermi andYukava

Fermi and Yukawa pave the way introducing the Weak force as an effective theory, and Strong force with mesons as carriers.

3.2 Stage 2: Gell-Man'and Greenberg

The 8-forld way is a brilliant idea and advancement. Claiming that quarks are elementary particles, constituents of nucleons (and baryons) was a clear mistake: 1) ignored Plato and Heisenberg's phylosophy, insisting on the "elementary particle physics" trade-mark concept; 2) Physics community opposed the idea for a while; 3) ignored that were not seen "free".

3.3 Stage 3: Weak Force and Strong Force

QCD was responsible for confining quarks and obtaining nuclear force as a consequence.

Weak Force was developed on top of Fermi Theory, introducing W bosons to resolve the 4-point singularity. Its task was to take care of transitions of baryons, decays etc. which involved changes of flavor.

Theories evolved in parallel, addressing separately flavor and colors, to achieve different goals.

3.4 In hindsight ...

It is natural to think that 3 quarks form a 3D-frame and give us the illusion of a continuum 3D-space via the dynamics and composite structures emerging from atoms. But Physics is pushed by experimentalists so much there was no time to think: "Shut-up and compute!"; this happened not just in QM but also in Elementary Particle Physics. The name of this physics area eventually changed to High Energy Physics, but still impacts the way physicists think and theory is developed (Democritus viewpoint).

Bottom line, the Electroweak theory is the "correct way" to model quark structure, and should just "add" the concept of color with $SU(3)$ as the symmetry gauge group of the $SU(2)$ frame bundle.

This also suggests to interpret the three color quark fields of EM type as three connections in the $SU(2)$-bundle, providing an affine connection which determines (or is related to) the connection on Space-Time (geometric connection).

Then limit the gluons role to baryon interactions and "elastic model" of vibration modes of baryons, while the roles of Ws and pions would be merged, as taking care of flavor as Platonic-Klein Geometry of baryons with mesonic bonds in nuclei, and gluon quanta of E-p through such channels, as carriers.

So a merger of EWT and QCD is in fact straightforward. In return, EWT should acknowledge the quark structure of Ws (flavor / geometry related) ... perhaps! Or maybe the exchange mechanism via Ws is independent of 3 generations and type of charge (isospin / weakcharge) ...

4 Reducing the SM

Consider an $SU(2)$-bundle over space-time as in flavor EWT, with associated 3D-frame bundle with $SU(3)$ symmetry as in color QCD.

The space-quark colors RGB are supplemented by time-quark color T, for electron: (q_R, q_G, q_B, q_T) are the sources of the 3+1 quark fields of EM type (see Wiki). These are $SU(2)$-connections and a $U(1)$-connection.

Each category of interaction has a source, charge type (group generator) and channel.

For EM, the electron and photon are separate aspects of an $SU(2)$ Q-channel, with associated connection (A, ϕ) in "time-like regime" (light cone / $U(1)$-theory for EM) and long-range.

The "space-regime" for S-quark $SU(2)$-connections (RGB) corresponds to flavor-mesons as channels (e.g. nuclear bonds between nucleons in a nuclei) and color-gluons as carriers in "open" interactions (decays / "fusion" - creation - excitation).

Recall that quark flavors in 3-generations corresponds to Platonic-Klein geomtries (and rep. theory incorporating spin: $SU(2)$). The generation number is in fact the 3D-analog of quantum principal number for T-color quark, the electron ($Z/n \to U(1)$)), labeling $\Gamma \to SU(2)$: Tetra, Octa, Ico / S^4, S^5. There is a non-trivial relation between them, via morphisms and duality, which when "adding" spin reps allow for mixing of "flavors" / geometries (subgroups and axes of rotation, Archimedian solids and Wythoffian operations etc.).

4.1 Flavors and "Principal Quantum Number" for Baryons

In analogy with the "T-quark", the electron, for S-quarks the generation number, corresponding to TOI symmetry groups, can be thought of as the "principal quantum number" for baryons.

The isospin / weakcharge corresponds to dual geometries: Cube / Octa, Ico/Dodeca; for 1st gen. At this early stage it suggests to relate with beta decay and proton-electron system (Hydrogen atom), to distinguish up from down quarks, within $Tetra \to Cube$ embedding.

On the other hand the asymmetry of electric charges $+2/3$ vs. $-1/3$ suggests a relation with the $SU(3)$ root system and cubic roots of unity, perhaps involving a different mechanism for distinguishing "up" and "down" type quarks (more later).

4.2 Sources and carriers

The S-quarks have color charges producing (sources) of quark fields with color-carrier bosons we will call *fluxons*: A_R, A_G, A_B, where A is the vector potential part of the quark field (A, ϕ) for RGB.

The gluons are massless "mesons", e.g. $g_{R\bar{G}}$. Since $3 \otimes \bar{3} = 8 + 1$ there are 8, usually interpreted as the number of generators of $SU(3)$, which we interpret as a 3D-frame symmetry group.

It is natural to look for a symmetry between the structure and theory of flavor-mesons (pions etc.) as carriers of the nuclear force and gluons as color-bosons "outside" the nucleon where they play the role of an elastic force to confine the suposedly quarks as particles. Then, e.g. $g_{R\bar{G}} = A_R \otimes \bar{A}_G$.

The correspondence between quarks states as spinors / qubits in $C \times C$ and EM-connection type 3+1 is done via quaternions $H =^{3,1}$ as a central extension of the cross product Lie algebra.

4.3 Gluons

We recap what was said above and add some speculations related to Gravity.

Gluons have a structure similar to mesons (quark-antiquark, e.g. $\pi = u\bar{d}$), with a color and anticolor, e.g. $g_{R\bar{G}}$.

Hence in view of reinterpreting $SU(3)$ as a symmetry group of a 3D-quark frame, gluons, instead of interpreting them as generators of $SU(3)$, correspond to $SU(2) \times SU(2)^*$ generators, $3x3 = 8 + 1$, where the one generator is the photon.

We call the independent generators *fluxons*, associated to the quark field connection 1-forms A_R etc.

What about the 8 gluons? Do they interact with each other? Looking at QED Feynman diagrams we may expect two quarks to interact via a more complicated network of qluons, as bosons. This is consistent with a non-abelian Yang-Mills Theory.

If we think of the general linear momentum $P = p + e/cA$ as relating macro from micro description (vector potential as a "store" of linear momentum in EM), it suggests that the above non-linearity of gluon interaction (including RGB theory) may be also related to the non-linearity connecting curvature of the frame bundle connection and Space-Time description, as in GR.

4.4 How many "elementary" particles are left?

Sources and carriers go together, as well as unified by Q-channels: S-quarks and fluxons, T-quark and photon (maybe a double too?).

We then derive gluons and mesons, via color and flavor theory of connections and finite subgroup spin geometry ("Platonic $SU(2)$-Theory"), as not primary ("elementary") and write Lagrangians etc.

Now are the 3+1 quarks "elementary particles"? No! they are a structure of the only one e.p. for matter: neutron, with maximal symmetry, which decays into proton and electron, separating the type of quarks (generators with charge etc.) into S and T, when breaking symmetry ($C \times C \to R^{3,1}$), from QC picture to S-T picture, decoupling EM and color QCD as a space-time connections: synchonization of clocks (quantum phase) and parallel alignment of 3D-frames (spin-angular momentum theory), as Einstein would say.

So, one derives $SU(2)$ Q-channels: mesons, of various flavors (TOI geometry) and channeling gluons of various colors (fluxons). The rep of spin adds the modes of "rotation", as 3D-cymatics of basic TOI geometries (recycling the "principal Q-number" n, corresponding to finite subgroups of $U(1)$, together with angular momentum and magetic projection theory for electron ... times 3!).

4.5 Chirality

The chirality aspect (left / right quarks etc.) has to do with generations, duality between geometries and perhaps I/O aspect: $f : A \to B$; a Q-process as a morphism in $Hom(A, B)$ is equivalent to a tensor in $B^* \otimes A$.

CPT on the other hand and CP-violation is related to the dual picture $C \times C = H = R^{3,1}$ and complex vs. sympletic structures on $C = T^*R$ and its double H (qubits-spinors vs. relativistic 4-vectors; parity and time symmetry are not well defined in view of Lorentz transformations / Mobius - conformal transformations: $PSL_2(C)$ vs. $Aut(R^{3,1})$ with various components).

4.6 Left/Right Handed Particles and Entanglement

Left/Right handed elementary particles (doubling quarks, electrons etc.) are not other types of particles, but rather the same, having different behaviour under transformations when in different dynamic regime, as "anti-particles". This can be interpreted as particles traveling "back-in-time", or rather via an entanglement description in a Feynman loop, similar to how a beam-splitter generates two entangled photon-"antiphoton pair" ($U(1)^* \cong U(1)$).

4.7 Flavors and Mass/Energy Levels

The "Zoo" of elementary particles is by now understood to originate from: 1) Flavors / generations, due to 3 finite subgroups of $SU(2)$ (Platonic). These should not be counted as "different elementary", except maybe until the precise theory is finalized; 2) Different spin and masses / energy levels of resonances are due to the spin theory (magnetic flow) and modes of "vibration" (periodic changes in the geometry, where Z/n-modes are included besides the three Γ 3D-geometries of baryons.

The massive flavor mesons are bonds between baryons at the level of nuclear force, of geometric origin and exchanging E-p affecting "vibrational modes" (states) via gluons (massless color bosons associated to the former flavor bosons). Here the pairing of fermionic channels and transmission quanta (unifying sources and carriers/bosons; e.g. electrons, EM-channels and photons) is applied too.

4.8 Neutrino and Higgs

from the 64 particles "elementary", of the SM only two are left "uncast" in this "new version" of the SM: neutrino and Higgs.

Higgs field is a nice device to trade potential energy and kinetic in the Lagrangian, which make sense IF there is a configuration space, so that the symplectic space is a T^M cotangent space.

The sea of neutrinos in the Universe, its role being associated with transformations of geometry (symmetry) of baryons (via flavor-mesons and color-gluons / space-time alignment etc.) suggests a geometric / GR framework type of role ...

Let's think it is the source of Gravity field, with gravitational charge and carrier the *graviton* (a pair of fermion-boson).

By definition, the neutrino interacts only with the weak force; but now, we will allow and have as a goal to include Gravity as part of the time-like EM associated to electron-photon pair, in the context of quarks and their fields / connections.

4.9 Types of Electric Charges

The main device for including Gravity in the SM is the RGB distribution of the electric charges and the break of symmetry, first between $+1$ and -1 ($z^2 = 1$ square roots of unity) and then from $Z/2$ to $Z/3$, as cubic roots of unity and Lie algebra real values.

Note that these roots of unity, referred to using Z/n, are: $Z/2$ center of $SU(2)$ and $Z/3$ is the center of $SU(3)$. The corresponding lattices are Gaussian and Eisenstein (root systems and Weyl group for $SU(2)$).

It is natural to extend ± 1 to all 4 roots of unity, as charges: $\pm i, \pm 1$.

But the main obvious point is, that the divergent aspect of the conformal group (grad and div operators) which we associate with the force that performs work and is conservative, "electric", has an asymmetry: negative charge e has a totally different role then the positive charge p^+ (Space), which in turn has a structure that breaks the symmetry again (not $SO(3)$ invariant / isotropic), but of the type $++, -, -$ (neutron).

4.10 Fractional charges or Complex charges?

One should explore in what way $w^3 = 1$ can be related to the color charges of quarks, and with fractional electric charges as "angles" (fractions of 2π).

Then the ddu configuration could have complex charges ω, ω^2 and 1, in relation with root systems theory. The up-quark type charge being real $Q(u) = +2/3$, double in absolute value to $-1/3$ could maybe due to a symmetry factor (conjugation orbit).

4.11 Neutron and Neutrino

Hence the neutron field is not isotropic, having 3 "principal directions" called quarks with quark fields In/Out as if it is a 'pump" of lines of force (fluxons). When it decays it breaks the QC $SU(2)$ symmetry "radially vs. spherically", if looking at steady-states $neutron \rightarrow Hydrogen\ atom$, with transient stage beta decay.

Gravity can be assigned to this lack of isotropy, perturbing the isotropic Coulomb field with 3-spin directions corrections; the resulting neutron field is quite complex, as the presence of the neutron's magnetic moment suggests.

A neutron is experimentally electrically neutral, but has a nontrivial electric structure in the near field regime.

The precision of experiments checking neutrality can't rule out macro-Gravity, which is very weak. Perhaps how the RGB quarks field interact at long distance is not yet modeled correctly. Experiments of DNO show weight can be affected, hence the quark fields are also the source of Gravity (via nuclear spin orientation control).

4.12 Electron and Quarks

The electron seems a natural candidate for considering four quarks for a "dynamic baryon" (or hydrogen atom as a fundamental Quantum System: irreducible, yet with "parts" and structure).

Electrons have both electric charge and magnetic moment (charge): (A, ϕ) of EM.

How the quark fields electric potential (scaling component of the conformal group) relate to the electron's electric potential should respect the charge decomposition and be compatible with Gell Mann-Nishijima relation / charge-isospin-hypercharge relation.

The neutron's zero total electric charge $Q = +2/3 - 1/3 - 1/3 = 0$ should correspond to the relation between $\phi_{EM}, \phi_R, \phi_G, \phi_B$. In general such a sum of gradients of the four potentials should yield $E + G$, with a weight depending on c (e.g. generalized linear momentum $P = p + e/cA$). Here we hypothesize that $A = A_T + A_R + ...$ corresponds to an affine connection as a sum of the 3D-frame connections for each quark field (TB investigated).

4.13 Space-Time emergent from quarks fields

This $SU(2)$-frame connection mirrors the (3+1)D-character of Space-Time, inviting to a model where the later emerges from the Quantum Network of baryons and their interactions.

4.14 Remarks regarding fractional charges

The symbolic decomposition $n = (+2/3, -1/3, -1/3) = (-1/3, -1/3, -1/3) + (+3/3, 0, 0)$ as a Coulomb isotropic field and a spin polar field suggests the above $E + G$ interpretation.

For a Hydrogen atom, as a composite quantum system $(+2/3, +2/3, -1/3, -3/3)$ (Space and Time components) shows again the lack of isotropy of the structure of electric charges. It also suggests a relation to the $2 + 2 = 1 + 3$ dimensions decomposition of $C \times C = H = R^{3,1}$.

4.15 Isospin conjugation and CPT

This should be correlated with dihedral group D_6 as the correct group of symmetries underlying CPT, since "charge conjugation" for nucleons is rather $(u, d, d) \rightarrow (d, u, u)$, related to cubic roots of unity (center of $SU(3)$). Hence perhaps in beta decay not just a W changes the flavor of one quark, but rather it is a global symmetry transformation of $u \rightarrow d$ and $d \rightarrow u$ (swap / isospin conjugation).

C and I_3 are related if we take $\omega^3 = 1$ in consideration: $\omega^2 \to +2/3$ corresponds to $-1/3$ under reversing orientation on the circle, i.e. swapping $U(1)$ charge generators i and $-i$ (complex conjugation / quantum phase and time reversal: e^{iwt}; Feynman interpretation: local proper time and quantum phase).

4.16 Weak Bosons and Flavors

The quark transitions modeled using W bosons do not distinguish the type of transition, except at the level of probabilities for the corresponding channel. This is a limitation of the EWT model using Ws in comparison with the QCD derived nuclear force model based on One Boson Echange model, which involves pions (omega, rgo mesons etc.).

Note that the TOI geometries involve the two basic algebraic structures, Gaussian and Eisenstein lattices, corresponding to electric charge as generators of $U(1)$ symmetry, $\pm i$ and to quark charges (ω^k Eisenstein).

How these $Z/4$ and $Z/3$ 2D geometries intervine in the TOI 3D geometry is not clear, but should be related with the weak charge (up/down-quark type) and fermion generations. It should explain the CKM / PMNS matrix probabilities [16].

Moreover the weka force "does not have bound states nor produces interaction energy" [20], hence concluding that it is not a force, but rather describes a "phase transition": change of structure / TOI-Spin geometry.

4.17 Using Platonic and Archimedean Geometries

A direct approach to model deacys, instead of a gauge theory / force, is suggested by the use of Platonic and Archimedean geometries to model elastic membranes and equilibrium of forces for tensegrity [10, 17]. Note how the transition between various geometries (think different baryons) corresponds to a change of ratio of areas and elasticity moduli.

4.18 What is the electron?

Depending on area of study, the electron is modeled as an orbital in atoms (bound states), point-particle in particle accelerator experiments, fermionic chanels in 2-slit experiments or entanglement.

Since it has spin and magnetic moment it has to have structure, whether modeled internally (abstractly in a $U()1$-bundle) or explicitly, associated with the vector potential.

An anomalous electric dipole moment for electron was hypothesized but not found experimentally. It is associated with CP-violation due to quark structure. Conceivably this aspect may be relevant for the quarks themselves, in connection with deriving Gravity from the fractional distributed electric charge.

Moreover a pion (quark-antiquark pair) may decay into an electron. Also muons and tauons are heavior versions, suggesting that the Platonic symmetry (finite subgroups of $SU(2)$) applies to them too.

Therefore it is natural to look for a unifying model, including electrons as 4-th quarks with structure, as long-range fermionic channels (or closed orbitals, related to toroidal magnetic moments and vector potential).

One interpretation of the pion decay is that the $q\bar{q}$ channel of $SU(2)$-Platonic symmetry degenerates into a laminar flow in a $U(1)$-String-like channel [5].

Overall, baryons can be pictured as Riemann spheres (Archimedian solids) with punctures for quark locations joined via mesonic bonds at low range in nuclei (like quasi-crystals), yielding the nuclear force, together with long range electronic channels joining their orbital envelope.

Again the parallel between Chemistry and Nuclear Physics just reflects the $U(1) \to SU(2)$ relation (static picture; $SL_2(C) = SU(2)^L \times SU(2)^R$ for the dynamic picture of quantum processes $S : I \to O$).

4.19 Resonances as Baryon Vibrations

The mxing of quark flavors could be related to a membrane model with discrete geometry (3D-cymatics) via symmetry axis of Archimedian solids (geometry) with different $U(1)$-finite subgroups (Z/n).

The transition between such geometries are controlled by "tension parameters" (see tensegrity [10, 11], probably related to the gluon description).

4.20 Elementary Particles as Elements of Circuit

The general approach emphasizes structure rather than particles, fields and forces, as in the gauge theory paradigm of SM (where "gauging" is in certain extent removing irrelevant degrees of freedom).

Then the main "elements of a quantum circuit", at hardware/software level are: baryons reminiscent of transistors as fundamental elements of our computers, with spin as quantum qubit registers, flavor-mesons as channels in "integrated circuits" (nuclei of atoms) and electronic channels (analog of conductors) and molecular bonds.

Atoms are basic resonant circuits (analog to basic circuits built of RLC-elements) and molecules are analog to dedicated boards for complex systems (processing QI and circulating qi etc.) analog to "electronic appliances" etc.

The rest is assembling macro matter materials and manufacturing objects (Quantum CAM/CAE).

5 Quark Fields Emergent Space-Time

The three quark field connections define an $SU(2)$-frame connection. The EM-type RBG quark fields form the *baryon field*. This is a candidate for (to be related with) the *vacuum field* of the superfluid vacuum theory (SVT), as a non-removable background (3D-frame connection).

A suggestion to make this precise is the following:

Definition 5.1 *The vacuum background field of Space-Time (landscape?) is the Cartan conformal connection associated to the $SU(2)$-bundle as a Hopf fibration / Cartan homogeneous space $U(1) \to SU(2)$.*

The quantum processes $S : In \to Out$ are equivariant with respect to $SL_2(C) = SU(2)^L \otimes SU(2)^R$.

The main idea (leaving dynamics for later) is that the conformal structure of theories in Space-Time emerge from the quantum physics description in terms of quark fields, as defining a 3D-frame of *principal directions* (axes of $U(1)$-QED spins of quarks, part of the corresponding RGB EM connections).

This structure is locally parallelizable and corresponds with the superfluid vacuum field. It also makes precise what the aether is as a medium for propagation of EM waves (Not just E, B orthogonal on p, but also in terms of the basic vector potential A defined by the connection.

5.1 Relation with GR

This "completes" Einstein analysis of (time) synchronization with what parallel frames are (space alignment), without postulating a God given global connection on the manifold. Of course, Levi-Civita connection defined by a metric satisfying Einstein's eq. is very close to this idea (rough form):

$$Ric(g) = g + \chi T,$$

showing how Ricci curvature is an infinitesimal "deformation" of the "background" metric by the E-p tensor.

5.2 Relation with superfluidity and superconductivity

The Meisner effect just says that the A-flow with B-curvature, turbulent, happens outside the lattice of baryons that achieved lowest SVT state (perfect quantum phase coherence and space alignment of the quark fields): laminar (conformal) flow.

5.3 Relation with Quantum Channels

Recall that interactions involve quantum channels of fermionic type conducting boson-carriers of the interaction ...

Hence the Couper pair mechanism could be associated to pairing electrons in streamlined fermionic channels (without "breading"), confined by the aligned transversal rotating A-flow.

5.4 Relation with Higgs field

SVT is an alternative mechanism for providing mass. Which one is primary, remains to be seen (or use both) [13].

Note that an SVT based on quark fields is a more solid approach, already in place, reducing the assumptions in SM. For example, the related *Logarithmic BEC Vacuum Theory* [13] has several advantages (see loc. cit.).

Hence the task of mass generation is left to SVT based on quark fields (related perhaps with a GR interpretation - see analog gravity).

5.5 Relation with "Gauging"

The role of the vector potential is known to be crucial, physical and not just a "gauge freedom" [18]. Rethink at this point "gauging" as synchronizing / aligning via a connection (fields), reducing the structure group horizontally.

5.6 Virtual particles and Quantum Space-Time

The role of vector potential of "storing linear momentum" (internal $SU(2)$-connection vs. space-time connection; $P = p + e/cA$) invites to rethink the "virtual particles" concept, off mass shell, as fluctuations / interactions within the SVT.

This may provide a meaning to quantizing the emergent space-time in this $SU(2)$-frame bundle framework with quark field connections.

5.7 ... and Unifying EWT and QCD

This opens the possibility to relate EWT and QCD, as hinted above, at the level of three color quark fields (as EM connections), relating teh W's with flavor-mesons and transitions of W-states analog to electron's transition between orbitals, but with 3D-Platonic groups (and Archimedian mixtures).

5.8 The Pion-Muon transition

The pion is a 1st generation quark-based bond (subject to Platonic symmetry), while the muon involves a different Platonic symmetry structure (flavor/generation), hence inviting to rethink what electrons (EM waves) are: from a 3D-turbulent propagation, including a longitudinal component (see torsion waves as a near field regime of EM) to a purely 2D-transversal propagation, with one space-direction (of the momentum) correlated with proper time ($exp(iwt)$ quantum phase; a reduction from $SU(2)$ to a $U(1)$ description.

6 Relation to GUTs, TOEs, String Theory, Quantum Gravity

6.1 GUT approach

GUTs looks for a unification of the gauge groups, maintaining EM, Weak Force and QCD as separate theories, as is. They do not unify these three "fundamental" interactions (or three, if considering EWT and QCD). GUT do not include Gravity, which emerges naturally from a deeper understanding of the SM.

6.2 TOEs

TOEs [7], e.g. Lisi's approach [6] starts from the "end": exceptional Lie algebras $E6-8$ have to be associated with the dynamics of baryons subject to Platonic symmetries as their geometry and static modes of vibration, which are Weyl group for $E6-8$.

Regarding some hints regarding the above (how to relate the static (classification) picture of SM and dynamics, to relate with TOEs, see [21, 22].

6.3 Supersymmetry

The SUSY approach, although provides a theory of Gravity, is not a physical theory for many reasons: unnecessarily doubling the number of elementary particles, taking the string only ($U(1)$) as fundamental object, using a background (landscape) instead of the bundle approach etc.

6.4 Quantizing GR

Taking GR as a basis and quantizing Space-Time is the wrong way to go. GR, as Einstein also said it 100 years ago, needs to take QM into account. While the geometric picture (curved space-time) is beautiful, it does not reflect the interaction picture responsible for Gravity; and this is in fact a correction to the SM in its present form: understanding quark fields and gluons vs. W bosons / pi meson theory.

6.5 How to implement the new paradigm?

The first step is to understand the role of quarks and electron, with fields as connections defining the macro-space-time. next, re-examine quark fields and the reduction from $SU(2)$ to $U(1)$ theory, which will lead to a Modified Coulomb Law, including nuclear spin-spin interaction, yielding macro-Gravity as emergent [19, 14].

7 Conclusions

The reason we perceive (and model) reality as 3D is the 3-quark structure of nucleons, with colors as labels for a local coordinate system, in internal (quantum) space. The space correlation of directions into a macro-coordinate system is provided by the frame bundle connections corresponding to (color) quark fields. The electron as a "vibrational system" with a quantum phase analog to a local "Einstein clock" (see Feynman interpretation) is a quantum level origin of "time" as an emergent parameter for change. The derivation by Einstein of Space-Time in fact reflects this via light propagation and synchronization process.

Hence there is one irreducible Q-system: neutron, its stable form: Hydrogen atom; and a lot of structure: p^+, e^- atom theory, quark structure, flavor-geometry theory, vibration modes (spin), interactions as 3D-frame connections with Q-channels (mesons and gluons, electron and photon, neutrino and Higgs) etc.

The four fundamental interactions have different roles, corresponding to breaking the symmetry of $SU(2)$ and separating 3D-frame aspects from quantum phase aspects: space and time; also allows to decompose the electric quark force into electric and gravitational, in the context of the quark model.

The electron is interpreted as a 4-th quark, with T-color. Together with the RGB local frame of space-like quarks forms a Space-Time local frame.

Gluons have structure, e.g. $g_{R\bar{G}} = A_R \otimes \bar{A}_G$ a pair of "fluxons" of different colors and with opposite time orientation (conjugates), in a similar way to mesons as fermionic bonds between nucleons for the nuclear force. This picture parallels the electron-photon T-color pair of source-carrier, in Chemistry and Atomic Physics.

Neutrino has a special role, conjectured related to Gravity of quark field origin. For previous work on this avenue see the author's articles on Gravity of a Quantum Origin and Gravity Control [15].

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