Our Universe: To Model and To Simulate*

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Abstract

Due to advancements in Quantum Computing, now we can simulate "Our Universe", based on observations, experiments and models we already have. A comparison between Low Energy Physics and HEP benefits us understanding the foundations, including the role of vector potential, quantum phase and how Space, Time and classical concepts emerge from the quantum formalism, e.g. The Standard Model.

We will focus on the U(1)-gauge theory, as a paradigm not only of Electromagnetism, but also for the quark fields of QCD. The ultimate test: understanding the fine structure constant!

Preamble

We observed, experimented and modeled the Universe, and now, due to the advancements and solid state physics and technology we are able to literally reproduce and control quantum phenomena in Quantum Computers, beyond the probabilistic interpretation and strong measurements phase of the 20th century.

More importantly we see how the quantum phenomena at Low Energy Physics reveal the foundations we coin theoretically in HEP; e.g. quantum Hall effect, Josephson effect, supraconductibility, Meisner effect on one hand, and Superconductive Vacuum Theory, Higgs mechanism etc.

From these we learn that reality is a Quantum Network [1], and some of us claim that Feynman diagrams, Quark line Diagrams and Riemann surfaces model a "real" / actual topology of the processes we call interactions ...

In addition, there is a convergence of ideas, starting with QM is QC, that the Universe can be modeled as a Quantum Computer, and even thought of as a simulation (Simulation Hypothesis), in an atempt to take into account and unify many other areas of Scientific knowledge, as well as more ancient [2]

Now, to get closer to this, we should understand the *fine structure constant* and how Space-Time and classical field-particle theories emerge, from "your best implementation of "Our Universe".

1 What is the "Speed of Light"?

1.1 Quantum Theory vs. Emergent Classical Model

In a previous article it was explained how Space and Time emerge from the quantum description (SM gauge theory), from quark fields and EM $U(1)$-gauge theory.

$$Quantum\ Theory: \quad Principal\ Bundle: P \to M^{3,1}: Space - Time \quad Classical\ Theory.$$

At the level of Maxwell's equations, quantum effects are "hidden" in the polarization and magnetization vectors (2-forms):

$$\epsilon E = D - P, \quad \mu H = B + M.$$

"Decoupling the two equations, results in a 2nd order wave equation for both fields, with an invariant parameter c, we call "speed of light".

*... and to cherish :)

[1] Pythagorean / Platonic view "all is one".

[2] Plato's cave idea etc.

1.2 Quantum LC-Circuit parameters

The main point is that c is emergent, and the relative contributions of electric and magnetic interactions, are in fact represented by ϵ and μ.

So far we have, with $g_E = e$ the electric charge (2-period) and $g_M = h/e$ the magnetic charge (fluxon: 1-period):

$$g_E \cdot g_M = h, \quad \epsilon \cdot \mu = 1/c^2.$$

Both h and c are "deformation parameters" (central extensions as infinitesimal deformations), and expressing also a duality: Fourier duality (Heisenberg uncertainty relation) and relativistic time as a central extension of the Lie algebra of rotations" $(R^3, \times)$:

$$\Delta p \Delta q = h, \quad R \to H \to (R^3, \times).$$

The "speed of light" c[3] is therefore a universal emergent parameter, expressing a duality, between electric and magnetic components of the ElectroWeak Interaction (quark fields RGB and electron field T-like)[4].

Then the quantum relation between these fundamental aspects is:

$$\frac{g_E^2}{g_M^2} = \alpha^2 \cdot \frac{1}{\epsilon\mu}.$$

To better understand their role in building c and for α we need to analyze the emission-propagation-absorption process in more detail.

1.3 The resonant Quantum LC-line

The usual Feynman diagram for electron-electron QED interaction captures the "scattering" aspects; the resonant aspects, including constructive / destructive interference phenomena (resonance) ar studied by spectroscopy and Quantum Optics.

Consider a "complete" system consisting of an emitting H-atom H_+, EM wave (near and far fields) and absorbing H-atom H_-. The first is excited somehow, the transition (e.g. $n \to m$ principal QN) is a change of geometry of the orbital, the emotion is analogous to a "closed-to-open" orbital, which forms a transmission line (EM wave in vacuum) etc.

The main point is to use the quantization conditions and parameters or the bound state / system, to analyze the "free propagation, and understand the quantized aspects of space and time, hidden in the universal constant c (QC / Space-Time correspondence) and using "Einstein's Law" $E = mc^2$ to understand the role of the magnetic quantized field in the "superconductive vacuum" of impedance and frequency:

$$Z_0 = \frac{|E|}{|H|} = \sqrt{\frac{\mu_0}{\epsilon_0}}, \quad \omega = \sqrt{\frac{L}{C}}.$$

For the correspondence between variables and significance, see Quantum LC-Circuit [24] and [1].

Remark 1.1 *Recall that relativistic time emerges from quanta proper time, which is proportional with the quantum phase:*

$$\textit{Proper Time} : exp(i\omega\Delta\tau), \quad 2\pi = \omega T = \Delta\phi = \frac{1}{g_M}\oint A dr.$$

Each unstable particle / process has a lifetime determined by its "quality factor". Photons don't decay, so the above process can be thought of as a standing waveguide "pumping photons", if the 1st atom is part of a LASER for instance.

Thus the "photon" has not only a frequency, but a rate of propagation depending on the impedance of "free space" (conductivity), which should be related to how Space emerges from the quark fields of EM type ($SU(2)$-connection), when viewing the SM gauge theory as a Cartan Theory of moving frame.

[3] Not really that: light can have various speeds, even slowed down to hundreds of feet per second.

[4] THis does not clarify much why it holds, at this stage.

1.4 Metric vs. Connection

The apparent "flat space" when using light rays geometry is missleading, since matter is charged at quantum level, and electric charge trajectories are geometrically curved (energy conserved) by EM fields.

The "correct" coordinate system is that of streamlines of the vector potential (quantum phase section dependent: synchronization of emergent relativistic time), and equipotential surfaces of constant quantum phase (essential to resonance, constructive / destructive interference).

1.5 The Electric-Magnetic split of curvature

The EM curfature $F = dA$ (4-dim) at the level of QC (spinors) is "split" as electric E (responsible of work / energy change) and magnetic B, responsible for "etheric vortices" (curvature), with the emergence of relativistic Time (Planck dual to energy) and Space (dual to momentum).

The 1+3 D split of CxC (spinors) reflects in the relative strength of electric / magnetic quanta of charge $e/(h/e)$. Counting number of generators for the $SU(2)$-frame (topology S^3 Hopf fibration) yields: 2 per quark color (with quark fields of EM type; rotation (quantum phase) and divergence / fractional electric charge) and 2 more for the electron EM-field. This should reflect as a coefficient in α (rather $4\pi\alpha$ approx. 12).

It should also reflect in the *impedance of free space* $Z_0 = \mu/\epsilon = \mu c = 1/\epsilon c$ in some common "spinorial units".

1.6 Electric vs Magnetic mixture oscillation of EM

The oscillation in opposite phase of amplitudes of E and H, should have a natural explanation in the spinorial model. It also reflects that Space" is not light ray linear", unless the particle has no electric charge and no mass (quark field magnetic interaction): the photon.

Decoupling E and H from Maxwell's equations yields the 2nd order wave equation, exhibiting the global invariant" c. Otherwise Hodge structure (duality) yields ϵ and μ separately.

1.7 What oscillates?

The Network Model of Quantum Physics easily explains 2-slit experiment etc., when topology is obviously not trivial. But fields may exhibit *solitons* as topological defects (monodromy of connection) which gives the impresion of a particle proagating through empty space".

It seams that the vector potential A streamlines discribe the Physics", as a flow of quantum phase", the internal mechanism of the Universe for synchronization (us humans use clocks to meet at a place in time"). The change of gauge $A \to A + df$ via a local section $f : M \to P$ amounts to a change of same quantum phase" synchronization.

yet an interaction should constructively / destructively reset" proper time, perhaps, hence dismissing the mathematical arbitrariness of the gauge potential.

Especially if the connection has singularities (points, lines connecting points etc.) at matter points, with monodromy etc. with an underlying ramified cover of a topological nature (The "Network"?). Dirac string were simulated and observed in spin ice [2].

1.8 Other oscillations in Particle Physics

Flavor / type of neutrino, quark mixture etc. show similar changes of geometry"/symmetry.

In the case of EM waves, if the photon is a soliton on the fermionic channel connecting the two orbitals of H-atoms, what geometry" changes to account for E and H? Or maybe our "light ray flat metric" is misleading, and when reprizenting an EM field using it, and not using A streamlines and quantum phase equipotential surfaces, we see this oscillation: electric force in one direction x, then magnetic in the y direction (assuming $z = ct$). The electric component is due to $\partial A/\partial t$, with time correlated with quantum phase.

Then what is Z_0, intrinsically?

2 Quantum LC-Circuits

Spin of elementary particles is considered an abstract quantum property, yet has mechanical interpretation as a rotation, e.g. of the electron as a charged sphere.

This is an analogy, rather then a model as in gauge theory of QED (Point Form QFT).

A better alternative is to describe quantum processes as quantum circuits, with localized elements of circuit, in analogy with electric circuits. Such an approach is closer to Quantum Computing model (software and hardware), and focuses on the internal degrees of freedom and parameters, rather then on dynamics of position and momentum.

2.1 Inductance and Capacitance

The main idea is to model charge and magnetic current as conjugate Hamiltonian variables [1].

L as a measure of inductance stores magnetic momentum (source of vector potential) and C capacitance stores charge (source of electric potential).

2.2 Q-LC resonant circuit

A bound state / loop of QED is modeled as a resonant LC-circuit. The main observables are: resonant frequency ω and impedance Z:

$$\omega = 1/\sqrt{LC}, \quad Z_0 = \sqrt{\frac{L}{C}}.$$

When there is a damping or a lifetime of the process $\tau = 1/Q$, the quality factor corresponds to a resistance in the classical case:

$$Q = \frac{Z}{R}, \quad Q = \frac{\omega}{\Delta\omega}.$$

For "free particles" this corresponds to energy / mass $E = mc^2$ and lifetime, together with de Broglie frequency and Compton wave length.

Note that in decay processes theer are no "free particles", but rather portions of a large quantum circuit, which can be thought off as resonant cavities / wave guides.

2.3 Impedance and Alpha

Then the speed of light is analog of the "resonant frequency of free space"[5]:

$$c = \frac{1}{\sqrt{\epsilon_0\mu_0}}, \quad \omega = \frac{1}{\sqrt{LC}},$$

the length of a quantum phase cycle λ per unit of time T.

The Electric/magnetic charge ratio, is the analog of *quantum Hall conductance* $1/R_{Hall}$, with R_{Hall} also known as the von Klitzing constant R_K:

$$\frac{g_e}{g_M} = \frac{e}{h/e} = \frac{1}{R_{Hall}}, \quad R_{Hall} = \frac{U_{Hall}}{I_{channel}}.$$

Compare it with the *impedance of free space*:

$$Z_{free} = \sqrt{\frac{\mu_0}{\epsilon_0}} = \mu_0 c = \frac{1}{\epsilon_0 c} = 2\alpha R_{Hall}.$$

Then that the free space inductance and bound states inductance are related by the fine structure constant[6]:

$$Z_{free} = 2\alpha R_{Hall}.$$

Then the *fine structure constant* is essentially the ratio between the impedance of bound states ("closed strings") and open "free states" (propagator / "bonds" between bound states / "open strings").

[5] an EM wave thout off as a wave guide; or electron-electron interaction via a photon, as a channel between two H-atoms.

[6] The factor of 2 comes from Couper pairs responsible for superconductivity.

2.4 Interpretations

2.4.1 Loop corrections

This is consistent to having one factor of alpha per loop correction of the scattering amplitude in perturbative QED.

2.4.2 Mass and lifetime

The "grading" of lifetime (inverse of quality factor, related to the impedance of a QLC circuit) by powers of alpha is an indication that the "loop number" correction (or genus in a Riemann surface ST/CFT version) corresponds to the free space oscillation of an EM wave (E vs. B), which is an indication that a more complex model is needed (channels / Network Model).

Mass is of "magnetic flow" origin (fluxons), hence will exhibit a similar "grading" or dependence on alpha (see also / analyze Regge trajectories).

2.4.3 Classical Mechanics analogy

The mechanics analogy interpretation of the alpha constant is:

$$\alpha = \frac{v}{c},$$

where v is the "speed of an electron" in the Bohr model of the s-orbital of an H-atom. This is consistent with interpreting "speed" as impedance, for bound states (orbital) and free propagation (light wave).

2.5 Resonance: bound vs. free state

The theory of Quantum LC-circuit has resonant frequency and impedance formally similar to the above formulas:

$$\omega = \frac{1}{LC}, \quad Z_0 = \sqrt{\frac{L}{C}}.$$

Maxwell's Eqs. as a two linear 1st order DE exhibit the two parameters ϵ_0, μ_0, which when eliminated to get the wave eq. (2nd order PDE) yields the speed of light as a geometric ratio ("average"; the determinant of Hodge duality is $1/c^2 = \epsilon_0\mu_0$).

The frequency of an EM wave $\omega = 2\pi\nu$ is in fact the ratio between the quantum phase rate of change and reference frame (Lab) time change:

$$\nu = 1\ cycle/T\ sec.$$

The Lorentz dilation of time intervals (and space contraction) are but emergent aspects of the fact that the processes are quantum, without an intrinsic "space-time" natural significance.

2.5.1 Muon lifetime

Analyze for instance the lifetime of a muon (or other processes) using the QLC-circuit formalism, and reinterpret in terms of QC ($SU(2)$ gates and qubits).

The extended lifetime of a muon, as measured on Earth (traversing the atmosphere) is a clear indication that "true" proper time is in fact given by the quantum phase; the de Broglie frequency relates to relativistic time.

The lifetime is related to the Q-factor of the channel, its geometry (symmetry group) and the decay reflects the transition from one "phase of matter" (geometry) to the next (electron phase). There is no specific model yet capable of unifying the three types of "flavors" / geometry. Quality factor is associated to dissipation per cycle, and entropy should be part of the description. The neutrino interaction (by now conjecturally associated with the Gravity, as a correction to EM), triggers the change. There is a need to analize the whole QLC circuit including the other decay / creation process the neutrino is involved in.

What emerges from this is the role of QI as a "charge" that enters the conservation laws: Noether Th. generalized to acount for the change of symmetry groups (entropy is the everage quantity of information, quantum and with a reduction of structure group, classical).

2.5.2 The "speed" of light as transmission rate of QI

It is apparent that a similar "non-squeezing theorem" holds, and that the the parameter $1/c$ is analogous to Planck's constant; it is a unit of "internal action" (electric charge and magnetic flux as conjugate variables) while h is a unit of "external action".

But for a qubit to be transmitted (phase qubit, charge qubit etc.) a quantum state needs be transmitted; what is the corresponding observable, if not the energy level or quantum phase? A model combining the QLC (hardware) and QC (software) is needed, with a correspondence with the classical observables: A, ϕ, ϵ, μ.

2.5.3 Time vs. Space

An EM propagation is a complex process, as the alternation of E and B, together with the polarization ("spin") aspects show.

In terms of an EM gauge connection, the vector potential stream lines and equipotential quantum phase surfaces should reflect this oscillation. Hence the $SU(2)$-gauge theory with fermionic / spinorial fields is needed (QED).

yet, it is not clear what "oscillates", if there is no "empty space" (Mach philosophy, Einstein's GR etc.); unless we literally take Feynman diagrams as ubiquitous for normal wave propagation (not PI, i.e. not irreducible Feynman diagrams).

Note also that the phenomenon of oscillation is quite generic (neutrino oscillations; quark flavor oscillation).

This is reminiscent of the infinite ladder model of EM-waves, in terms of LC- elements (see [1]; Caldeira-Legget Model).

2.6 On Quantization: Mechanics vs. Electronics

This invites to reconsider what "quantization" of classical theory is. Instead of Dirac, deformation, geometric quantization etc. of classical *mechanics* or fields, one should take advantage of the "lump" features of electric circuits, and use a Kirchhoff model of electric circuits, with topology, together with the Hamiltonian formalism, e.g. [1].

In addition, the gauge theory approach with an $SU(2)$-principal bundle and Cartan moving frames will supplement the theory to make contact with SM (see Voltage Graphs / Networks theory).

The use of quantum elements of circuit (LC / harmonic oscillator; storing electric and magnetic energy / momentum), including non-linear elements (Josephson junction playing the role of a transistor) allows to simplify the Schrodinger equation formalism (Dirac etc.), a direct approach to quantization.

It also allows to interpret α in more basic terms of effective parameters associated to the detailed description using finite groups of symmetry.

In essence, one would apply the Hamiltonian formalism to EM for instance, with generalized momentum $P = p + eA$, except for the "internal states" one would use discrete elements of type L and C, for storing electric and magnetic momentum, following the interpretation of the scalar and vector potential. Each such basic pair LC corresponds to a harmonic oscillator.

2.7 Speed vs. distribution

The light cone is defined as a distribution. Physically is a "speed": one wave length λ (distance between two surfaces with the same quantum phase: 1 cycle) divided by T as measured in the LAB (reference frame).

The "constance" of speed of light is a combined effect of how time and space emerge from the gauge theory description (spinors), from which Lorentz transformations ensue ("hermitean correspondence"):

$$\begin{bmatrix} z - ct & x + iy \\ x - iy & z + ct \end{bmatrix}$$

3 Comparing mechanical and electric models of elementary particles

We will focus on the interpretations of the fine structure constant and concept of quantum spin.

3.1 Quantum LC Circuits

For an introduction see [1]. The main advantage of using such a model is the mix of quantization (lump elements) and main reason for oscillations / interference etc.: capacitors stoding electric energy and inductors storing magnetic energy. This on top of a "Static Network" (downplaying position and momentum q, p), focusing on bound states and resonance phenomena. It avoids the complication of classically measuring quantum particles and involving Schrodinger eq., probabilistic interpretations etc.

3.2 Mechanical vs. Electric Interpretation

The mechanical interpretations are a substitute for the EM interpretation. Both have Hamiltonian description which makes the analogy precise. The use of QLC-circuits with "lump" elements of circuit allow to avoid the use of quantum fields and PDEs (gauge theory etc.).

3.3 Alpha

There are several constants related to the ubiquitous FSC α: mass ratio for proton-electron (magnetic currents: fluxons); TOI masses of the electron-muon-taon; magnetic moments of neutron and proton; lifetimes of elementary particles (states with different geometries of nucleon and different vibration modes of the corresponding faces, regular polygons as Bohr orbits) etc.

A finite Cartan Geometry understanding of the $U(1) \to SU(2)$ gauge theory approach is missing, an essential ingredient in understanding *the structure behind alpha* (electron and the three quark fields of a baryon are all of EM type: $SU(2)$-connection theory; mesons and photon are bonds / wave guides in matter / free space: alpha is the ratio of their inductances, bound resonant channels vs. open transmission channels).

3.3.1 Proton-to-electron mass ratio

The proton-to-electron mass ratio $\mu = m_p/m_e \approx 1836$ should be a consequence of the extended framework to understand alpha, in terms of electric charge quanta and magnetic flux quanta. Note that it is close to the normalization constant of the j-invariant 1728, which seems to justify the ratios of leptonic masses (see [22]).

3.4 On fine tuning hypothesis

There is no fine tuning. The basic language of reality is QC: qubits and gates, Quantum Turing Automaton and levels of structure, one on top of the other, towards more complex systems and relations / interactions. There is a self-organizing and selection mechanism, reminiscent of advanced AI, but on a quantum level.

3.4.1 The "Hardware"

At hardware level, the parameters like the mass of the proton or strengths of EM interaction are (will be) computable, when we will understand better the finite aspects of the SM. The basic elements: neutron (quasi-stable state) and proton-electron orbital (break of symmetry / vacuum state etc.); electronic bonds as connectors and pi mesons as nuclear bonds, accounting for basic matter.

The key element still needed to be understood is the nucleon: modeling the quarks fields beyond the initial stage of QCD, separated from EWT.

3.4.2 Built-in or self-emergent

The emerging biology is less clear to understand, how it evolved and if there is a Quantum CAD process behind it; but knowledge from other areas, like ancient wisdom, texts, OBE and hypnotic regression hint towards a much more complex reality than science, technologically oriented, is concerned with or compliant and willing to accept. This is not an area that should concern Science and Technology at this stage.

The fine tuning is needed for now as a substitute for our lack of knowledge of the elementary particle physics foundations.

3.4.3 learning from Computer Science and IT

We can learn from the evolution of Classical Computing, society driven and the solutions and methodologies that "we" have found and created.

4 Conclusions

Physics Theories are not only related "horizontally", when comparing scope and level of detail (historical development), but more importantly "vertical", with quantum description ("actual / factual aspects"; quantum / imbrication of levels of structure: solid state / condensed matter, molecular, atomic, nuclear, elementary particles physics) on top of classical description via Space-Time-Matter approach.

Deriving the macrosopic concepts as emergent is a must to correctly understand "Reality", and accepting that "classical info/logic" is a truncation of the description of the underlying structure: the probability (Copenhagen) interpretation is misleading and Quantum Systems are Networks which when probed in the strong way, collapse, are perturbed etc. Heisenberg Uncertainty Relations reflect that continuum Space-Time is emergent and "unreal"; "particles" may be related (entangled) as part of a Q-Circuit, hence some quantum properties are "real" and not local, refering to the behaviour of the system, not its components.

4.1 Quantization vs. Quantum Theory

Deriving Quantu Theory via quantization (Dirac, perturbation/ deformation etc.) is limited by the Classical Theory itself, and, while historically natural and convenient, will not lead to the "full' theory: Quantum Theory designed based on the aposteriori understanding of reality.

Now we are in position to derive Classical Theory from the Quantum Theory, not in the limit $h \to 0$, but rather as in gauge theory (bundle) over an emergent Space and Time, with matter as a network of geometric-topologic special points / monodromy (solitons) etc.

A step towards formulating Quantum Theory is to "quantize" electric circuits and considering Quantum LCR-circuits (dissipation as a Quantum-to-Classical info transition, decoherence and entropy generating).

4.2 Alpha

The ultimate test and goal of the above QLC-quantization approach of SM gauge Theory approach is to derive / compute the fine structure constant as an emergent ratio of impedances, from the 3-to-1 quark fields-to-electronic field (EM type connections), together with the finite subgroups $Z/n \to U(1)$ and $TOI \to SU(2)$ input, controlling the geometry and transmission / standing waves properties of "closed/open orbitals/channels" (compare with open/closed Strings and M-branes).

4.3 Is Alpha a free parameter?

Since alpha is the ratio of impedances, of emergent free space from open interaction channels (the "sea" of Maxwell's molecular vortices are formally similar to a chain of Feynman loops of propagators and e^-e^+ loops) and bound channels (orbitals), one may wonder if in fact this is like a "resolution parameter" of a hardware implementation of "Reality ("What-we-see-is-not what we get!), sort of a 3D VR Display (Medium).

4.4 ... and the Ether

We refuted the ether (we hailed Einstein as a champion) but even He came back to reconsider the issue. There is a vast literature why the ether and its other theories translations (chi, prana; dark matter; etc.), exists.

So, how does QI propagates in a D-Wave QC? with what speed? Does it look like the speed is the same in the reference frame of a Space-Time Lattice superimposed on the QC process (too small for a Coordinate System compatible with an Operator Product Order?.

4.5 Key parameters

Not only c, h, e are essential, but also mass ratios m_e/m_p, lepton generations masses (different TOI geometry of the same physics object / structure, "The Electron", which is not pointwise and comes in two main instances: closed orbitals and open bonds / channels).

4.6 Duality and Space-Time Distinction

The electric-magnetic aspects (energy - curvature) are complementary aspects, due to the separation of a QC process in "Space" (parallel) and "Time" (sequential), which is inadequate for describing a Q-Network (or Operator Product Ordering).

It also corresponds to the "homology" viewpoint: loops vs. propagation (feedback vs. "causality").

So, there is no true "electric - magnetic duality", but rather a Hamiltonian viewpoint of conjugate variables: p, q, charge and flux etc.

There is another "fibration aspect", Quantum / Classical (Principal bundle picture), "Internal / External" (factual and emergent), which may appear as a duality, e.g. $P = mv + eA$.

Together should yield the meaning of mass as of magnetic origin and the celebrated $E = mc^2$ ($E^2 - p^2 = (m_0c)^2$). The magnetic current A is in fact of geometric origin ("true charge geodesics", e.g. free fall of electrons), and the misleading light ray geometry / inertial physics is just a result of balance of forces / interactions, due to cancelation of charges in "neutral" particles (total charge zero).

4.7 The Micro-Lab H-atom

The atom of Hydrogen is the QLC that must be studied in detail, from a finite quantum oscillator / QLC point of view, instead and beyond the Schrodinger eq. approach (reinterpreting Dirac eq. as a QC theory).

To understand alpha, a QLC-line H-H bond / molecule should be revisited in the light of QLC quantization.

The mechanical analogy is misleading, since alpha results from a *comparison* of the electric analogy (involving geometry and periodic structures: Fourier Analysis of finite groups) and mechanical analogy (involving Space-Time concepts).

4.8 Chemical vs. Nuclear

The analogy is poignant, corresponding to $U(1) \to SU(2)$ and quarks as Cartan frames. The systemic approach and idea of bonds and phases of aggregation are universal, applying to both; we can learn from Chemistry what to expect for Nuclear Physics.

4.9 QLC approach in Particle Physics

The QLC model in Elementary Particle Physics is especially useful, since the various mesons and gauge bosons are "bonds and geometry" of a Network of oscillating baryons with various QLC-parameters due to finite group geometry.

Baryon masses are emergent from QLC data; mesons are characterized by QLC parameters, including lifetime (Q-factor of the process); gauge bosons are transmission quanta etc.

The "Power of Alpha" clearly shows the role of the number of loops in such Quantum Chips, with baryons as non-linear elements like a transitor for electric circuits or Josephson junction for QLC-Circuits.

A Miscellaneous

A.1 On Riemann Hypothesis

The finite fields (p-adic) version of RH was proved by Delignes part of Weyl Conjectures (now a theorem).

An approach to prove RH is to relate the p-adic version with the char zero version, as suggested in previous works [25].

A.1.1 The Geometrization of the Reals

The real numbers can be represented using continued fractions, which in turn can be interpreted as sequences of $SL_2(Z$ (modular group), yielding a natural grading (filtration) [26, 27].

In this way the theory of adeles can be reformulated in "pure" terms of p-adic numbers and modular group.

A.1.2 The rationals as a projective space

The (projective) modular group $PSL_2(Z)$, i.e. the integral Mobius transformations, is in fact the $Aut(P^1(Z))$ ($Q \to P^1(Z)$), the conformal transformations of the rational numbers, allowing to rationalize and grade the context of RH, bringing the theory within the Algebraic / Analytic Number Theory realm.

Note that the rationals are rather elements of the projective integral line, and series of integral Mobious transformations avoid a metric, linear ordered context of the reals, as a deformation of a finite circle in the "wrong direction" (carry-over addition unit to the "left", opposite to the analytic completion / l-adic deformation to the "right").

A.1.3 Questions

Is there a way to reformulate the Local-to-Global Principle in this context, of p-adic numbers and modular group (reals as CF via modular transformations)?

How are Weil Conjectures related to the RH via modular group, and CF as a substitute of"Cauchy sequences" completing the rationals?

A.2 On Schrodinger's Cat

There are three main logics and propositional calculus: classical, binary logic with T/F or 0/1; probabilistic, a kind of interpolation of the previous two values $[0, 1]$; quantum logic with qubits "interpolating" T/F on a 3D-sphere (its projection: Yin-Yang symbolic diagram).

A.2.1 Modeling: Alive or Dead

The Scrodingers Cat "counterexample" for the incompatibility between QM and Classical Logic is at fault in several ways.

Considering the Cat "Alive or Dead" as a description of its state is clearly a truncated model, which cannot be defined: where is the threshold?

Second, the model of the decay is "time probabilistic", hence uncorelated with a QM model of the trigger and the Cat.

A.2.2 What is Life ...

To substantiate the first idea above, note that an H-atom is in fact (like any quantum particle) a local clock with just one dial: quantum phase (see Feynman's QED and [23, 10]). How can we test this? See how engineers build our Quantum Computers with bulky elements (L,C and Josephson junctions).

Now a system like The Cat is a complex system with many leyers correlated like an operating system. Death usually is assumed when it does not function as a whole; but some parts are still functional and the cells, definitely live much longer.

What matters is the "chi flow" (QI) and in particular, quantum phase correlation, which synchronises the various parts and processes like a Swiss clock.

A.2.3 ... and "getting old"

It is essentially a separation of a system into classically interacting parts ...

The "decay" is a decoherence process, separating the Quantum System into a Classical Automaton with quantum parts; the breakdown evolves into more subsystems with smaller parts, uncorrelated, break of interactions, channel transport etc. a general increase in entropy.

This can be modeled by QM on top of a Classical Mechanics description (QC / CC master-Slave Hierarchy).

In conclusion, the paradox results from using a probabilistic model instead of a QM model (Schrodinger Eq.), due to the fact that the decay is apriori modeled probabilistic-ally as a random process.

A.3 Is beta decay a random process?

Decay is not a random process; it is triggered by the neutrino interaction, which in the author's opinion is associated to a change of symmetry group. If resonates with Gravity (via structure / mass / GR) but it is not a genuine *gauge boson* as for a "pure" (and traditional) gauge theory.

A.3.1 On Gauge Theory

After Noether's Theorems, prompted by Hilbert's homework assigned to the "most influential woman" in math-physics (per Einstein's gauge) Weyl's Gauge Theory became the universal tool in Quantum Physics for modeling quantum interactions (QFT).

In some sense it was "abussed" as Weak Flavor Dynamics (resolving Fermi's problem with the 3-vertex) and by QCD: there is no evidence a force exists, acting at distances less than the "radius" of a proton ...

But with a Gauge Theory, as a theory around a Principal Bundle $G \to P \to M$, comes a Category of such objects, with morphisms that can be used to model transitions ("Cobordism Category"), as well as Functors between such G-categories:

$$\textit{Break Symmetry} \quad \textit{and} \quad F : G - PB \to H \to PB,$$

or even more math structure as in *TQFTs from subfactors*.

A.3.2 Particle Physics "Time"

The experiments with particle accelerators are not exactly like shooting with a riffle; is each event "triggered" under a tight timeline control?

End the theory is based on the statistics of the events (Monte Carlo simulations etc.).

Hence our macro-perception of quantum events is rather random, not the processes themselves.

A.3.3 ... and Schrodinger's Cat

The trigger of the poison is activated by the decay, which is (according to the above considerations) externally causated. Hence the two "classically separated" systems (not correlated / entangled), the trigger and the Cat, cannot be modeled correctly, without taking into account the external interaction via a neutrino ...

And then it's like getting a virus, get seek and die ... it can be described as a quantum process, but the contamination as an input data is crucial to make sense of the output and the model.

A.4 On Perturbation Theory and Renormalization

Scattering experiments with leptons $U(1)$-gauge group and baryons $SU(2)$-gauge group obey common principles.

The measured cross-section probability is an average over processes with finite number of nodes and loops, either viewed as Feynman diagrams or Quark Line Diagrams. The modes of a scattering experiment (creation and decays) correspond to the level of energy-momentum used as "input", which limits the possible loops created (particle-antiparticle pairs). Invoking Heisenberg Uncertainty Principle is conceptually wrong, since such a loop has a definite vector potential circulation which is a physical process with a real momentum and energy.

Although some parts of the scattering Network may not be visible if the particles are detected in some way (e.g. Wilson chamber etc.), the real network can be inferred from the measured data.

The finiteness of each scattering process is clearly seen when considering decays: there are a finite number of modes of decay. Similarly, there are a finite number of modes of creation (excitation), for each level of energy used to generate them.

A.4.1 The Partition Function

Hence the so called *partition function* is a formal generating function (coefficients are amplitudes of probability, usually computed using Feynman Diagrams) and need not have a finite L1-norm (if probabilities) or L2-norm [7]

A.5 What is a mechanical analogy in Particle Physics?

A quantum process or system, e.g. orbital of the H-atom, maybe analyzed via an analygy, e.g. mechanical, electrical or hydrodinamical.

The idea is to interpret the Hamiltonian formalism accordingly, in terms of position and moment (mechanical analogy), e.g. the "speed of the electron" in orbit, Bohr radius etc and $\alpha = v_e/c$; or in terms of charge and magnetic flux (Quantum Electric Circuit analogy, in terms of LC lump elements of the quantum circuit), with $\alpha c = Z_0$, as above.

Alternatively the flow of a vector field may be interpreted as a fluid flow and α related to the stress tensor, in connection with μ_0 [3].

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