Emergence of **Space-Time Physics** from **Quantum Computing** Formalism

with Algebraic-Geometry Models in Physics and Chemistry

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Abstract

The current program of the present author is to derive the "persistent illusion" of Space-Time through *Wilsonization* of Quantum Computing, from which Gauge Theory over the Space-Time Manifold should emerge, in several big steps[1]:

1) *Hopf bundle* allows to relate qubits and gates / spinorial physics with Space-Time concepts;

2) Adding topology to the base space provides the general framework of Gauge Theory with singularities (sources; see (3) below);

3) Application of *Ramification Theory* for *Belyi pairs* of algebraic Riemann surfaces provides the framework for *Elementary Particle Physics*.

Further considerations allows to bridge Classical Physics and Quantum Physics in *both* directions! The startling conclusion is that "TIME" does not exist; the local, de Broglie vibration we call *quantum phase*, is all we need (... and memory to record how Systems transform).

[1] Work in progress ...

Contents

The presentation is structured as follows:

I) STEM News (info of some recent breakthroughs we need to know off)

II) General Considerations:

- Levels of Generality: Philosophy, Physics and Math/Comp. Science
- Separation of Sciences vs. Unification: lessons from AI
- *Space and Time emergence in Gauge Theory* from the Quantum Computing perspective on spinors, via "Wilsonification".

III) The *Kahler Package* Structure and Riemann Surfaces / Beyi pairs

- We need "Space"; "Time" is a convenience parameter (DNE; all is change of structure: "Panta Rei")
- Local relativistic time from the quantum phase (Putting together ideas from Einstein / Feynman / de Broglie).

IV) Conclusions: we have the theoretical pieces of the puzzle; applications: Nuclear Research and Elementary Particles.

Part I: General Considerations

- STEM News
- General Principles: Galois, Klein, Lie
- Bridging *Classical* and *Quantum*

Quick update on Quantum Physics

Many breakthroughs occurred in the past 40 years or so, NOT reported by the media:

1) *Platonic groups* explain Standard Model fermion generations, quark flavors etc. (F. Potter, L. M. Ionescu);

2) Gravitational force is a nuclear spin polarization effect (F. Alzofon, L. M. Ionescu), resulting from the *Qubit/Quark Model*;

3) *Understanding* the relation "Classical - Quantum": a) Hilbertization; b) Hodgification; c) Wilsonization;

4) Algebraic-Geometric Tools for Physicists: Kahler triangle, Riemann-Belyi Theorems and applications to Elementary Particle Physics ("Beauty and the Beast").

Regarding (1) and (2) see vixra.org/L. M. Ionescu (see Bibliography); (3) and (4) will be reported here.

From Galois to Felix Klein and Sophus Lie

General principals have been essential in providing a deep conceptual advancement of Theory with succesful applications (see "On some programs in Math-Physics" [**?**]).
We will just mention *Galois Principle*:

To study on Object associate and study its group of symmetries.

It was used by Felix Klein to unify Geometries, by Sophus Lie (his friend and collaborator) to study Differential Equations, leading to *Theory of Lie Groups and Lie Algebras*, and further by Emmy Noether, Langlands and beyond (*"Finite groups rule the Standard Model"*).

Other general ideas are needed to have a unified understanding of Modern Physics: *Hilbertization, Hodgification, Wilsonization* and *Categorification*.

How to "Bridge" Classical and Quantum

1) Hilbertization (Classical to Quantum)...
2) Hodgification: from Riemann Surfaces as quantum configuration spaces, to spinorial $SU(2)$-Gauge Theory via complexification;
3) Wilsonization: from spinorial / QC flow in $2+2$ real dimensions, to Space-Time Physics in $3+1$ dimensions; the qubit space / Hopf Bundle paradigm.

In essence Einstein-Cartan Theory (towards "Quantum Gravity" in a classical way), introduces *entanglement* of Reference Frames (space directions and clocks), missing only the 2:1 aspects of Weyl's Gauge Theory of $SU(2)$ and $SL(2,C)$ of modern Quantum Physics (spinors, CFT etc.).

What is the Quantum Order Parameter?

The role of Quantum Phase ($U(1)$-Gauge Theory) is that of a local cyclic order parameter interpreted as an *Einstein-Feynman Relativistic Time* (see Fynmann QED).

• Linear Time is NOT a physical dimension / observable; even more, Lorentz Frames are a *linear approximation* as in Special Relativity. The "correct" interpretation: universal covering map idea for a $U(1)$-clock with "number of revolutions" recorded by the Lab Observer (memory aspect of "time").

• Similarly regarding "Space": local frames are defined by nucleon field principal directions we call "quarks" (fields of EM-type in a spinorial formulation; not just "electron" $U(1)$-gauge theory).

Part II: AG-Models for Physics and Chemistry

- Riemann surfaces and Belyi Maps
- Dessins d'Enfant and Einstein-Feynman Graphs
- Rethinking "Particle Physics"

All we need is a Riemann Surface

... and holomorphic and anti-holomorphic sectors (chirality). This leads to a doubling $2 \to 2+2$, mathematically achieved via *Hodge structure* ("Hodge-ification").

To model a quantum process, e.g. scattering experiment, resonant atom/molecule, cell etc. we need a Quantum Network structure, Elements of Circuit and a model relating them in a coherent manner: *Algebraic Curves over a Number Field*.

• The role of the Kahler Triangle J, ω, g: our Quantum Space-Time Model with finite group of symmetry (Hurewitz Riemann Surfaces with Dessins d'Enfants);

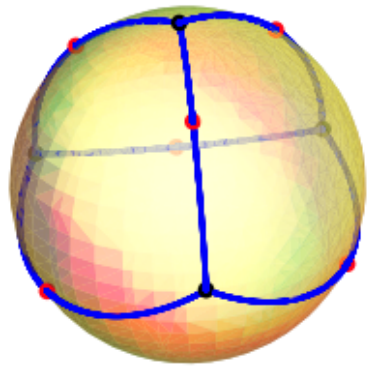
• A 1-form flow A ("vector potential") has a "Network Skeleton" consisting of its divisor (nodes) and cuts (links). It is an "upgrade" of a *fat Feynman graph*, by enriching it with a local *Einstein-Feynman Quantum Time* (complex structure: C^*-action; linear R^*-action comes for free).

Belyi Maps - an example

From "Beauty and the Beast" (The Standard Model and The Monster / Modular group quotients, including Platonic solids etc): L.I. presentation and "AG-Tools for Elementary Particle Physics" (see vixra.org and [2]).

A *Belyi map* $\beta(z) : RS \to S^2$, is a covering map of an algebraic RS over a number field, ramified over at most three points over of the *Belyi-Block sphere* (that is $(S^2, div(S), Fix(S))$ with antipodal map $S(z) = 1/z$: residue kernel). The Belyi map for the tetrahedron is [2]:

$$\beta(z) = \frac{c_4(\tau_1,\tau_0)^3 - c_6(\tau_1,\tau_0)^2}{c_4(\tau_1,\tau_0)^3} = \frac{64(z^3-1)^3}{z^3(z^3+8)^3} \quad \text{where} \quad z = \frac{\tau_1}{\tau_0}$$



Dessins d'Enfants

The *Network Skeleton* of the RS, is a *Dessin d'Enfant* (DdE), which results as the pull-back of the "cut" $[0, 1]$ of the Belyi-Block sphere (name "Block sphere" is added to suggest the connection with QC: qubits and quantum gates).

• DdE were introduced by Grothendieck, after Belyi Th. opened a new R&D research in AG (related to NF and absolute Galois group: Alg. NT; also with Connes-Kreimer work on renormalization, Theory of Periods etc.)

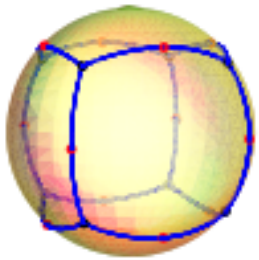
• We add the Physics interpretation of quantum phase as "quantum time" to the local data for DdE, which enriches the concept of Feynman Diagram with the concept of Einstein-Feynman Quantum Time (complex structure and finite cyclicality at nodes: towards a "de Broglie pilot wave" connection).

N.B. The theory of *fat Feynman Graphs* is well developed, with its applications to QFT and String Theory; addition: Q-phase / Q-Time.

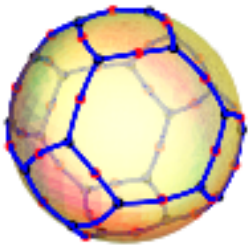
Other examples - Types of Baryons: flavor mix and spin?

- Belyi maps with symmetry group $O = S^4$ [2]:

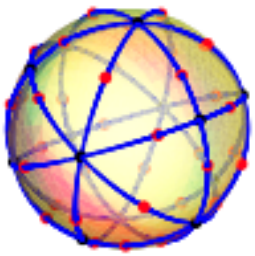
Solids As Dessins: Rotation Group S_4



- Cube
- Platonic Solid
- $\beta(z) = \frac{(1+14z^4+z^8)^3}{108z^4(-1+z^4)^4}$



- Truncated Octahedron
- Archimedean Solid
- $\beta(z) = \frac{(1-390z^4+2319z^8+236z^{12}+2319z^{16}-390z^{20}+z^{24})^3}{2916z^4(-1+z^4)^4(1+14z^4+z^8)^6}$



- Tetrakis Hexahedron
- Catalan Solid
- $\beta(z) = \frac{2916z^4(-1+z^4)^4(1+14z^4+z^8)^6}{(1-390z^4+2319z^8+236z^{12}+2319z^{16}-390z^{20}+z^{24})^3}$

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Comparing with Lepton Masses

Pros

• The normalization coefficients include 108. The masses of course are not absolute, and both 108 and 1728 should be compared with the mass ratios of the leptons ($m_e \approx 1$?).

• Plotting both the coefficients $1, 108, 1728$ and the experimental data $0.511, 103.5, 1771$ gives a reasonable match (electron mass is small - exceptional?).

• Fun fact: $1729 = 1 + 1728$ is Ramanujan's taxi number [2], with many interesting properties (see Wiki: sum of cubes, Carmichael number, Loeschian norm of four 1st quadrant Eisenstein integers etc.)

... and **Cons**

• But why 1 is not there, 1/64 occurs for the tetrahedron and 2916 for truncated octahedron? Also dual geometries, which in this author's opinion correspond to the same weak isospin (u/d-type per generation), have inverse rational functions, hence also coefficients!?

[2] Thank you Sunil!

Tessellated Riemann Surfaces and Hurwitz Surfaces

Dessins d'Enfant define triangulations (faces correspond to preimage of infinity on S^2). An instance of such triangulations are *tessellations of RS*. Their groups of symmetry are maximal for higher genus on the so called *Hurwitz Surfaces*

Hurwitz Automorphisms Theorem 1893

$$|Aut(RS(g))| \leq 7 \cdot 4! \ [-\chi(RS(g))] = 84(g-1).$$

which constrains also the possible *Poincare-Hopf Flows*.

N.B. More info in this direction is provided by *Beyi Theorem* and the theory of *Modular Curves*, which correspond to quotients of *The Modular Group* $SL(2, Z)$, the "quantum kernel" of Mobius transformations ... this all ties in with Belyi Th. and author's program of *Algebraization of Quantum Physics* (see "Natural Units, Pi-groups and Period Laws" [4]).

... and Poincare-Hopf Theorem

Think of genus / EP-map as characterizing the relations between "highways" connecting the "cities", or cuts / principal directions relating the sources of the field - apply to quark model and quark fields / EM-sources etc..

Poincare-Hopf Index Theorem

Total index of a Vector Field=EP-characteristic.

• See [3] for details and interpretation (resolution of DOFs and possible flows); applied to *Gauge Theory with Sources*, i.e. including *Ramification Theory* (AG-Tools for PP), allows to quantize EM-sources (div and curl).

• There are more types of EM-charges (types of sources of field) then the "traditional" Coulomb-type ± 1! (e.g. nucleons with their quark structure we "reduce" to magnetic spin, loosing the opportunity to model Gravity as a polarization effect).

N.B. A stronger version in this direction is *Riemann-Roch Thereom* ...

Rethinking "Particles and Fields": The Network Model

Lessons from Molecular Physics (Chemistry): atoms and bonds, together with the Hopf fibration model (Wilsonization: fundamental representation of $SU(2)$ to adjoint representation) unifying *Theory of Quarks* and *Theory of Electron* as 3+1 generators (Beyond EW and QCD of SM), lead to the following viewpoint regarding "elementary particles".

• There are *3+1 quarks*: three S-like quarks of RGB-colors (defining Q-Space) and one T-quark, the electron (defining Q-Time);

• *Elementary Particles*: baryons (matter nodes) and lepto-mesons (matter bonds), e.g. atomic bonds are *leptonic bonds* (pair of opposite spin T-quarks), while nuclear bonds between baryons are *mesonic bonds*: pair of S-quarks ("opposite isospin": $q\bar{q}$);

- *Baryons*: nucleons with various Platonic-Johnston Klein Geometries;

- *Lepto-Mesons*: results from unification of quarks and electronic orbital structure (3+1 generators of the $U(2)$-Gauge Theory).

AG-Model for Quantum Networks Interactions: Category of Belyi Maps and Morphisms

From the "ambient Space-Time Physics of Quantum Systems", weather Feynman Diagrams, Quark Line Diagrams or String Theory's RS embedded in a "landscape", we model transitions (changes) of Quantum Systems as morphisms of a category of adequate objects (AG-Model): the category of Belyi maps and morphisms of Belyi maps.

• *Quantum Systems* are modeled by *Belyi maps* $\beta : RS/k \to S^2$, which are AG-morphisms of an algebraic curve over a number field RS/k (epi), ramified over at most three points.

• Transitions, reactions and *Transformations of Quantum Systems* (e.g. I/O in a scattering experiment of HEP; molecular reaction in Chemistry etc.) are modeled as *morphisms of Belyi maps*.

N.B.: While developing the theory, one needs to relate this framework with the already established models: FD (QFT/GT), QLD (Standard Model), ST; Valence Shell Electron Pair Repulsion Theory etc..

Part III: Applications

- Table of Elementary Particles
- Nuclear Research and Energy

On Varlamov's Work - Table of Elementary Particles

We are at the point were we have a *Table of Elementary Particles* [5], yet we don't have a complete structure to justify how it works; this is similar to the History of Mendeleev's Table, appearing before Bohr's model of the atom.

• 14-th Ginzburg's Problem: Classify "Elementary Particles" [5].

• Recall: *baryons are "elementary"* (irreducible geometries of RS/modular curves), while *lepto-mesons are bonds*, hence derived by the "Theory of S/T-quark Bonds" (compare with Chemistry: atoms vs. molecules), i.e. a reformulation of SM / Quark Line Diagrams and theory of quark flavors. The true role of $SU(3)$ will be explained later on.

• Using AG-Models for Quantum Systems suggests using finite groups of symmetry to characterize "elementary particles": modular group quotients $SL(2,Z)/\Gamma$ as maximal symmetry groups of automorphisms of Hurwitz surfaces, as modular curves.

Look-up Table for Quark Flavor Mixes

Recall that $SU(3)$-QCD of SM is a 70's theory ignoring the theoretical progress realized in the past 50 years.

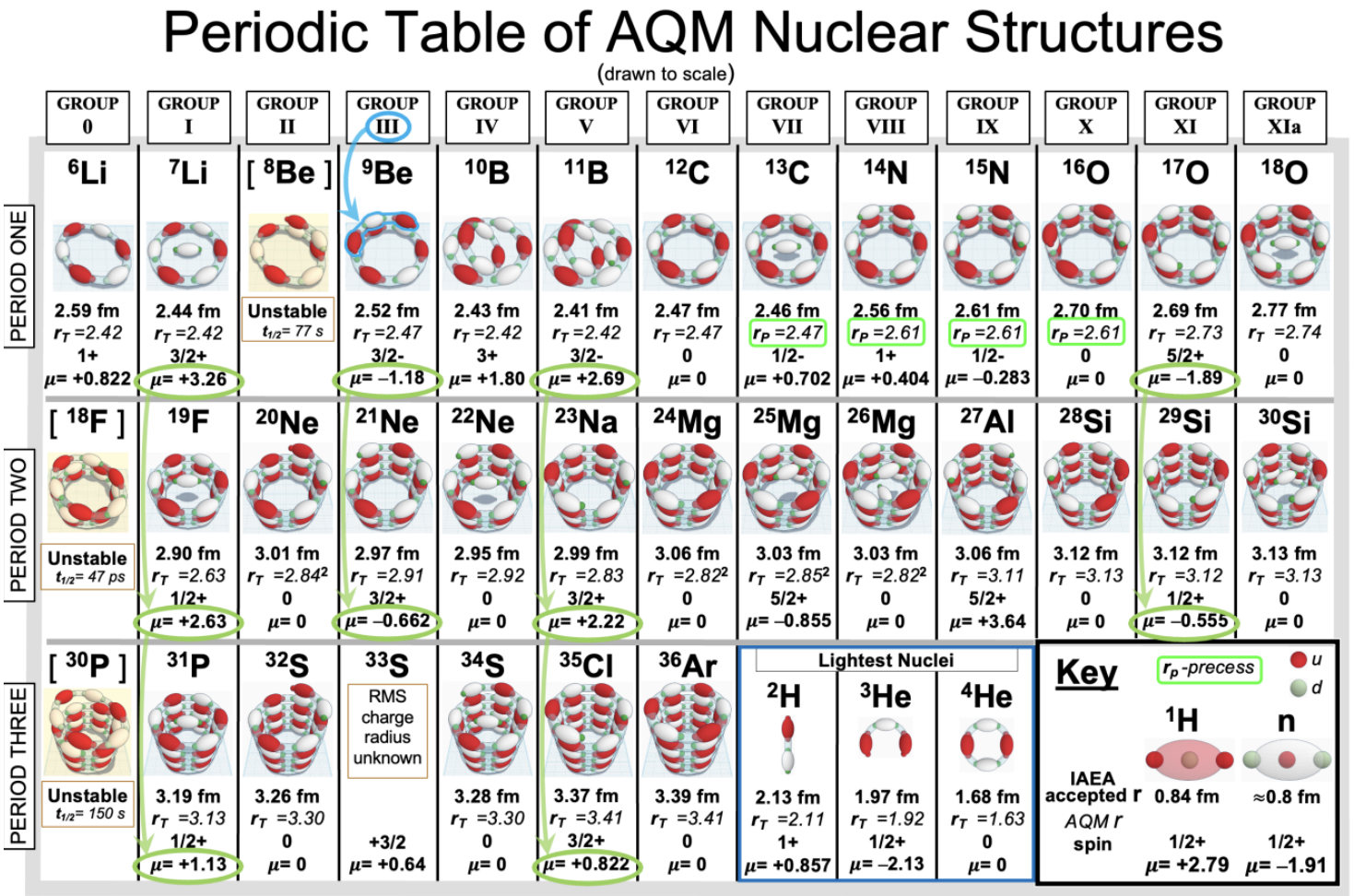
• *$SU(3)$ is the group of symmetries of quark frames*, derived from $SU(2)$ fundamental representation as the adjoint representation (Wilsonization: $2+2 \to 3+1$).

Also the three *fermion generations correspond to Platonic groups of symmetry* [2, 1]. Hence the various combinations of quark content, e.g. *ucs*, should match some generators and relations presentation of a $SL(2,Z)/\Gamma$, corresponding to a *Johnson solid as Klein geometry* (relates to: modular curves, Hurewitz surfaces, Belyi maps, RAM-T).

• Now we need to identify a look-up table between quark flavor composition and such groups: [5] is a good source for this task. The main point is to use that the representation theory of $SU(3)$ needs "factored" via adjoint representation of $SU(2)$ etc.

Structure of Nuclei and Quark Fields

Another source of information regarding the *structure of the quark fields* of proton/neutron, hence of baryons, comes from the work of R. Walsh [3]: *Average Quark Model*, see [4]



Applications to Nuclear Research and Elementary Particles

The present advancements in the *Structure of Nuclei* and of *Elementary Particles* (baryons and lepto-mesonic bonds) have obvious applications towards the understanding of *special proprieties of meta-materials*, especially *2D-latered materials* like graphene etc. - see L.I. ROCAM 2024 presentation [4], *Nanotechnologies* and *Attosecond Physics*; further presentations are available in authors ISU research web site [2].

These theoretical and experimental advancements are of general interest for *Nuclear Research and Energy* and *Elementary Particles* research (*ATTN: http://theo.inrne.bas.bg/*).

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- Ray Walsh, Nuclear structure from Average Quark Position, https://chemrxiv.org/engage/chemrxiv/article-details/6408e493cc600523a3dfef8b; see also further work on the Average Quark Model.
- L. M. Ionescu, On Gravity and Gravity Anisotropic Metamaterials, invited oral presentation at the 10th International Conference on Advanced Materials, ROCAM 2024, July 15-18, 2024, Bucharest, Romania; see link at https://about.illinoisstate.edu/lmiones/research/

Feedback and discussions are welcome anytime!
Collaborations, formal as well as informal are needed for the development of a large project ...

Thank you!

... and special thanks to the organizers!