On Quark Field and Nuclear Physics

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Abstract

The quark field unifies the four interactions of the Standard Model.

$SU(2)$-Nuclear Physics as an analog of $U(1)$-chemistry, is related to discrete symmetry groups, corresponding to quark flavors, and supporting Dr. Moon's Model of the nucleus. Reinterpreting Weak Force as modeling transitions of Klein geometries of baryons via Quark Lines Diagrams, in particle accelerators experiments and Nuclear Physics is attempted.

Nuclear Force is a resultant of exchange of mesons as two-ways quark "bonds" between nucleons, similar to electronic bonds in chemistry.

An effective potential has terms corresponding to Coulomb force, Gravity and Nuclear Force, with applications to Gravity Control and Cold Fusion / Biological Transmutations.

Further considerations regarding supersymmetry and the Network Model of Quantum Physics, are included.

1 Introduction

A prerequisite for this article is [1], containing a brief explanation of spin dependence of nuclear force, the main topic of this note.

The central concept, the quark field, as currently modeled by an effective potential [1], is claimed to correspond to the four interactions [1].

Additional background can be found in [22].

Another contribution of this brief note amounts to taking into account the geometry of the 3D-quark frame (Platonic geometry), to refine the mesonic model of Nuclear Force in a similar vein with the use of VSERP Theory for electronic bonds [26], valence and non-valence ones, in determining the geometry of molecules in Chemistry.

Further considerations regarding supersymmetry and the Network Model of Quantum Physics, setting the above contributions within the "Big Picture" are mentioned, since the value of a more general theory is to unify apparently disjoint areas of study in Science, even labeled as "fringe" or "paranormal".

1.1 Electronic vs. Nucleonic Shells

Schrodinger's equation models time evolution (bound states dynamics) in Wave Mechanics, akin to space transitions modeled by cobordisms in TQFTs. Although wildly used for modeling the electronic structure of atoms, for the understanding of nuclei a discrete approach, based on Platonic groups of symmetry and their geometries, is essential [12].

Nuclear Physics may be compared with Chemistry, dominated by valence electron bonds, and photon transitions between $U(1)$-states; here mesons are nuclear bonds between nucleons assuming Platonic geometries in nuclei, as pioneered by Dr. Moon's model.

Hence we transition from Wave Mechanics (or even Matrix Mechanics: harmonic oscillator, S-matrix etc.) towards a discrete, geometric description, conform with the 3rd quantization (discrete qubit space: Platonic geometries).

To understand the shell model of nucleus the VSEPR Model of electronic shells is needed: [25]. The imprint of discrete Platonic symmetries on the geometry of molecules is prominent: [26]. A similar phenomenon is exhibited by the shells of the nucleus, as pioneered by Dr. Moon [11].

[1] The Strong Force is restricted to distinct baryons interactions, since there is no need for quark confinement.

1.2 What are Quarks?

Quarks are essentially the in/out sources / sinks of the quark field, as a unified entity associated with a baryon. Probed with electrons, a proton reveals three fractional electric charges. Gell-Man postulated that these are "independent particles" within the nucleon (baryon), an idea opposed by physicists until the success of the quark model classification scheme of elementary particles took over; then the "free particles" quark model needed a Strong Force to confine quarks (see [22]).

Mathematically it can be compared with a 3-punctured Riemann sphere, a "trinion" which is a 3D version of the 3-point interaction vertex in QFT [2].

1.3 Unification via the Quark Field

The quark field unifies EM, Weak and Strong Forces and Gravity, via spin direction dependence (long range: Gravity; short range: Nuclear force) and finite number of spin axes, and meson exchange as bonds enforcing specific geometries (similar to Chemistry), with its complex system of sources / sinks corresponding to fractional charges of quarks (electric and color), viewed as one force field [3]

A comparison of nuclei with metals (solid structure of chemical substances) and molecules (liquid and gas) is helpful; the various "phases of agregation" (gas, liquid, solid, plasma) correspond to the Platonic symmetry groups and solids (T selfdual, C/O and I/D in duality).

2 On Nuclear Force

[1] describes the role of various mesons (Omega, sigma, rho) acting as bonds between nucleons. Note that a meson is a two-way quantum channel, with a particular orientation of the bond for local time direction (particle-antiparticle pair). The resultant is called Nuclear Force.

2.1 Mesons as Nuclear Bonds

These bonds are highly spin-orbit interaction dependent. The spins of quarks (3D-frame) orient the nucleon's three fractional charges as sources and sinks of the quark field, usually referred to independently as color and electric charges. Nucleons are nodes in a 2-complex with local Platonic geometry akin to the geometry of complex molecules (see [11] diagrams). The $SU(2)$ "orbits" correspond to faces of Platonic solids, similar to the electron orbits with $Z/n \to U(1)$ nodes of the 1-complex of the Bohr model of the atom. For a comparison of electronic / nucleon shell theory see [13].

The mesonic bonds "transfer" the geometry properties of 3D-quark frame configurations constituting such an "$SU(2)$-molecule"; the various spin orientations yield different couplings between say a pair of nucleons, with their 3 quark field sources / sinks (fractional charges: $\pm$, $U(1)$-related / EM+G, AND RGB-colors $SU(2)$-related / Weak/Strong Force). For example $\pi(u\bar{d}$ could be interpreted as vibrations of the T static configuration inside the dynamic cubical envelop C (Platonic solid). [4]

The study of mesonic bonds between nucleons and of the resulting Nuclear Force is a quasi-static framework for understanding particle accelerator scattering experiments, and conversely. It is somewhat analog to the study of spectroscopy ("scattering") and chemistry (bound states of an atom), at the level of EM / $U(1)$-gauge theory.

2.2 The Deuteron

A good example is the deuteron, with an electronic envelop containing the $uud \overset{\pi(d\bar{u}}{\to} udd$ coupling of the 3D-quark field of the proton/nucleon pair; the spin dependence (effective potential model) needs be detailed as 3×3-quark interaction, as sources / sinks of the quark field ($U(1) \to SU(2)$ Hopf bundle reduced to discrete symmetry groups). How such a two-body system "vibrates" (transitions) is controlled by the corresponding Klein geometry (group acting on a space).

[2]Why not a 4-point vertex, reminiscent of the 4 points of a Mobius transformation and cross-ration? Is a forth quark "neutral" from an electric point of view? The electron is considered by some authors a 4-th color (time?).

[3]The in and out lines of force from the quark fractional charges of a baryon suggests a possible connection with braiding / link approach and quantum computing.

[4]In this article we introduce some ideas in the form of statements which are rather suggestions of questions to be investigated and possible conjectures.

The spin for a deuteron, not spherically symmetric, comes from nucleons with spin aligned parallel. What does this mean and why, at the level of fractional charges of quarks, should be determined in terms of the mesonic u/d nuclear bond.

2.3 Other Models of Nuclei

There are various models for nuclei: droplet model, FCC lattice model etc. [14, 35].

These are well documented in classical textbooks, yet without reference to elementary particle interactions, which involves the quark structure of nucleons. This can be compared with chemistry vs. solid state physics models and methods.

Indeed, the magic numbers for stable isotopes has been studied in the context of discrete models of the nuclei [23].

2.4 What is Spin?

The spin in general is a macro property of a quantum system, corresponding with the behaviour under an interaction with another macro-system (usually a magnetic field) and reflecting an internal structure not necessarily acknowledged at a certain time of the development of the theory.

For electrons it was demonstrated part of the Stern-Gerlach experiment. It is not clear at this time what is the structure of such a fermionic channel (electronic), that experiences the deflection up or down under a magnetic field.

There are toroidal models of electrons, but a 2-slit experiment invites to view an "electron" as a fermionic channel, with genus one topology [5].

The spin of a nucleon corresponds at the quantum level to the orientation of the quark directions of the nucleon (RGB 3D-frame), with their fractional charges rotating in a magnetic field in order to minimize the interaction energy level. It may be also restricted to the possible symmetry axes of the Platonic solid.

2.5 Gravity and Nuclear Force

In general, the spin direction of a nucleon, relative to another, affects the central force (essentially Coulomb force), which is a global measure of the interaction, weather Gravitational or Nuclear (see effective potential below, §3).

Similar considerations apply to mesons (Q-information channels) and conjecturally to electrons (muons and taons as EM-channels, open, e.g. in 2-slit experiments or closed, as orbitals, in atoms [19]), implying the need for a new model reflecting their lack of spherical symmetry when viewed as pointwise particles [20].

2.6 Higher Mass Mesons as Modes

Higher mass mesons (C/O geometry) like $\rho(u\bar{d})$ and $\omega(u\bar{d})$, with the same quark flavor content, are involved in more massive nuclei, as higher excitations of the same 2-complex geometry, akin to 3D-cymatics modes of vibration (different Z/n edge nodes, but with the same Platonic geometry).

3 Nuclear force, EM and Gravity

Briefly, the nucleon-nucleon interaction with a potential of the form [1]:

$$V_{NN} = V_C(r) + V_{spin} + V_{flavor} + V_{spin-flavor},$$

$$V_{spin} = V_\sigma(r)\sigma_1 \cdot \sigma_2, \quad V_{flavor} = V_\tau(r)\tau_1 \cdot \tau_2, \quad V_{\sigma\tau}(r)(\sigma_1 \cdot \sigma_2)(\tau_1 \cdot \tau_2).$$

models Coulomb electric force (first term), Gravity correction force (spin dependent 2nd term) and Nuclear Force (spin-orbit coupling: 3rd term, isospin dependent for u/d flavors - the 1st generation of fermions, with T/C symmetry groups: static / dynamic).

[5]The 2-slit acts as a beam-splitter for fotons, which in fact are excitations traveling on such fermionic channels, as claimed by the fermion-boson unification theory proposed by the author. Hence the spin of a photon maybe a shadow of the corresponding electronic channel

The term Strong Force includes color confinement walls, and will be avoided, whenever possible.

Note that the Nuclear Force is a resultant of the various quark exchange processes, via mesons, with positive and negative force contributions depending on the type of mesons [1].

3.1 Cold Fusion and Bio Transmutations

Note also that this force essential in fusion and transmutations is highly dependent on spin orientation of quarks (nucleons). This supplements the heuristic arguments from [21], based on quark structure and their fractional electric charges.

Conjecturally, the manipulation of spin directions of quarks of baryons (reorienting the nucleon) is used by enzymes to achieve biological transmutations [27]. Similar to Dynamic Nuclear Orientation process for orienting the nuclear spin-frame of nucleons, which experimentally was proven to allow to control Gravity, enzymes may use spin-orbit coupling, between the electron's spin and nuclear spins, to control and "screen" the Coulomb repulsion, favoring positive mesonic bonds. This comes in addition to the well-known role of enzymes in facilitating chemical reactions.

3.2 Shells and Magic Numbers

The shell model of nucleus, using discrete symmetry groups [11], should predict the magic numbers of isotope stability. This should come from the combinatorial investigation of pairing fractional electric charges, via u/d mesons pi, omega, sigma and rho. The investigation can be performed using computer simulations.

The magic and doubly magic numbers should be correlated to completion of Platonic solids vertices and edges of shells, as in a Quark Line Diagram (Knot Theory link?) of the nucleus. As a first step, the corresponding literature should take into account the quark model of nucleons with meson bonds model for the Nuclear Force [28].

The fact that same flavor content mesons, but with different mass / energy achieve different force strengths [1] is probably due to a resonance phenomenon for the nucleon as a resonating cavity (compare with the geometry of the bucky-ball [29], at the level of chemistry, with electronic distributed bonds, using VSERP Theory).

A more technical study of magic numbers in polyhedral clusters, including Platonic geometry and refining indirectly Moon's model, can be found in the work of Teo and Sloan [33].

The parallel between electronic theory and nucleon theory is again prominent when noticing that magic numbers occur not only with nuclei, but also with clusters of Na-atoms [34].

3.3 Meson Shells and Mass

Not only the nucleus has a shell structure, in terms of poyhedral structures with nodes for nucleons and edges as mesonic bonds, but also the mesonic mass spectrum (resonance energies) exhibit a shell structure, governed most likely by the same discrete subgroups (Platonic).

Data supporting this discrete shell model can be found in the work of Palazzi, who shows that mesonic bonds exhibit shell structure [30] (quantized resonance modes). His work focuses on the concept of mass for elementary particles (internal energy modes of vibration), with applications to the shell model.

3.4 Baryon Mass from a Shell Model

This application of shell model carries over to the structure of baryons and their masses, again pointing towards discrete symmetry groups [31].

This points to the possible geometries of a baryon and its proper modes of vibration [36], providing more info into the structure of the quark field (the three sources / sinks we call quarks).

3.5 What about Gluons?

QCD is formulated with RGB color of quarks as charges and (RGB) gluons as bosons carrying the interaction.

While quarks are not independent particles, they still represent charges of the quark field, hence could be set in correspondence with RGB color as sources of QCD.

The mesons as two-way quantum channels (bonds in a nucleus) may play the role of fermionic channels through witch gluons as bosons propagate, in a similar way photons propagate on fermionic channels (localized "electrons" when probed / measured). [6]

3.6 From Electronics to Infotronics

The analogies presented, between various aspects of the theory of electronic circuits, free or constrained by conductors, and the theory of nucleons, free (particle accelerators) or constrained (nuclei), invites to a generalization: Electronics vs. Infotronics [37].

One may derive a parallel between "elements of circuits, classical or quantum. One notable element, the transistor assembled in many copies of VLSI maybe compared with the nuclei, built out of nucleons as trinions with quarks as I/O elements.

The electronic channels ($U(1)$, free (closed or open; e.g. orbitals, 2-slit experiment etc; ER-bridges: GR wormholes or EPR teleportation conduits) or constrained (conductors), correspond to mesonic channels in scattering experiments (two-way / duplex exchange of flavor and E-p) or mesonic bonds in nuclei (resonant circuits).

The parameters of these elements may be also compared (Q-factors / lifetimes, resonance masses / proper frequencies etc.).

Of course, this is at an informal, yet inviting manner to document and further study the two related theories ($U(1) \to SU(2)$).

It is an extension of the Master-Slave Duality between Classical and Quantum Computing, classical vs. quantum logic[7].

For more regarding the "Material Universe" as a simulation, see [38].

4 Conclusions

The idea that quarks form a system of sources / sinks for a unified field, called the quark field, allows to piece together many of the already accepted facts within the SM.

4.1 Unification

The accepted effective potential in nuclei, spin and flavor dependent, exhibits the terms attributed to EM, Gravity and Nuclear Force. This supports the model of a unified field, called the quark field, I/O of the three fractional charges corresponding bto quarks, which break down into electric and color components, with gravitational charge as a byproduct. The weakness of the macroscopic effective gravitational potential is due to a statistic average, yielding the equivalent mechanic inertial mass and the magnitude of the universal constant of gravity [3].

4.2 Nuclear Physics

The last of these terms is a resultant of baryon interactions via quark flavor exchanges mediated by mesons, as two-way quantum bonds (channels) in bound states of a nucleus.

The analogy with Chemistry is quite striking: from $U(1)$-QFT to $SU(2)$. It encompasses the theory of shells accordingly.

4.3 Spin Dependence

Spin dependence of Gravity and Nuclear Force is due to the dependence on the orientation of the triple system of sources represented by quarks, and leading to different strengths in the bonds (short range for Nuclear Force and long range for Gravity, as a correction term to EM).

[6] At this point one may ponder on what "odic force" of Baron Von Reichenbach is [41] and if it is not associated in fact with such fermionic channels; we know chi is EM vector potential flowing in a similar fermionic medium, e.g. aura of biological systems etc. [40].

[7] As above so below ...

The implications to cold fusion and transmutations are obvious, yet in need of a more precise modeling and computations, experiments etc.

4.4 Nuclear Physics and HEP

The Strong Force is a resultant of quark field interactions between nucleons via mesons as double bonds. The study of the nucleus together with the orbitals enveloping it, as a bound quantum system is a low energy framework for understanding Elementary Particle Physics.

The parallel between Chemistry and Nuclear Physics is quite obvious: VSERP model of the electronic shells and Moon model of nucleus. The parallel between bonds, electronic and quark-antiquark (mesonic) is again prominent.

4.5 Discrete Symmetry and 3rd Quantization

Moreover, the signature of discrete symmetry groups (Platonic / binary) shows in the presence of shells not just for electrons (VSEPR) and nuclei (Moon etc.), but also for meson masses (bonds) and baryon masses (modes of vibration and geometry flavors) [32].

4.6 Elementary Particle Physics and Applications

There are too many facts supporting that the nucleon is a complex yet irreducible unit, fundamental building block of matter (quantum gate akin with a transistor for classical electronics), to further claim quarks are particles ("free" yet confined!). The 3-sources / sinks model of a nucleon, with the other baryons its higher geometry and energetic states (vibrations/ 3D-cymatics [43]; see [36]) is established. As a consequence, the quark field unifies the "fundamental interactions".

Some consequences at the level of technology and industrial applications are: Gravity Control Propulsion via Dynamic Nuclear Polarization (Orientation) and Cold Fusion / Catalytic Biological Transmutations via enzyme manipulations.

4.7 The "Big Picture"

The unification of "fundamental" interactions goes hand in hand with unification of fermions and bosons via the Network Model[8], explaining many disparate aspects observed and documented: 2-slit experiment, quantum tunneling, entanglement, delayed choice and quantum erasure, odic force and chi-prana-life force, energetic healing, Emoto ice experiments, and Benveniste's experiments proving the quantum information memory of water [42], mind-over-matter interactions etc.

For additional related technical ideas see also [24].

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