GRAVITY AS AN EMERGENT AVERAGE FORCE FROM QUARK FIELDS INTERACTIONS

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Abstract. Gravitational force is established as an average force resulting from quark field interactions, specifically functioning as a nuclear spin-spin interaction. This perspective is consistent with the Standard Model quark model of nucleons and the Nuclear Force Lagrangian. It was experimentally verified by Frederick Alzofon and theoretically predicted by a general framework based on the Standard Model. At present, a multitude of researchers have documented, based on experiment, the dependence of the Gravitational constant on the type of material, specifically on the nucleon content of the material's nuclei. There is a critical need to extend the Standard Model formalism with the appropriate interpretation of Nuclear Force resulting from a quark-to-quark tensorial interaction. By deriving the Gravitational constant as the electric permittivity for nucleon spin-to-nuclear spin polarization effects, we can reformulate the current Quantum Chromodynamics (QCD) framework. This reformulation avoids pointwise premises regarding quarks, operating instead in the spirit of Einstein-Cartan connections with torsion for the Differential Geometry of the frame bundle (as in Einstein-Cartan-Sciama-Kibble Theory), which corresponds directly with Yang-Mills Gauge Theory based solely on the $SU(2)$ gauge group.

Contents

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1. Introduction

The Scientific Method—reliant upon observation, theoretical modeling, and rigorous laboratory verification—has historically driven our greatest leaps in understanding the cosmos, exemplified by the sequence of Brahe, Kepler, Newton, and Einstein. A recent, vital analog to this tradition is unfolding through the works of Alzofon [2], the present author [1, 3], and several contemporary researchers. Notably, figures such as Patrick Bruskiewich [7], Ephraim Fischbach [8], Dimitrios Germanis, and Konstantinos Kaloyerou provide compelling arguments and proofs regarding the variability of the Gravitational Constant, G.

While these researchers advance diverse theoretical models, it is crucial to highlight the direct derivation by Sky Darmos [9, 10], who demonstrated a proportionality of G to the *number of nucleons*. This is entirely consistent with the author's model of the fractional electric charge of quarks within nucleons acting as the quantum-level source of gravity. Furthermore, a plethora of experimental studies report anomalies in the measurement of G that fall well outside expected margins of error, challenging the classical static value assumed in Newtonian and Einsteinian gravity.

This essay synthesizes the core ideas emerging from the past forty years of established experiments and mainstream science-based research. We aim to demonstrate that gravity is not an isolated phenomenon requiring an exotic quantum carrier, but rather a natural, emergent property of known interactions.

2. The Standard Model Framework and the Geometric Bridge to Einstein-Cartan Theory

The Quark Model of the Standard Model already contains the mathematical architecture necessary to predict a nuclear spin-spin interaction. Traditionally, the effective nucleon-nucleon interaction relies on a potential of the following form [3, 6]:

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

Where the constituent terms are defined as:

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

This formulation elegantly models a Coulomb electric force (the first term), a residual spin-dependent force (the second term), and the Strong Nuclear Force (the spin-orbit coupling in the third and fourth terms, which are isospin dependent for up and down quark flavors).

While standard Quantum Chromodynamics (QCD) treats these interactions purely as internal nuclear mechanics, their macroscopic implications become profound when viewed through the lens of differential geometry. General Relativity, in its classical formulation, models spacetime as a pseudo-Riemannian manifold defined strictly by curvature. However, it operates on the assumption of a symmetric, torsion-free connection, effectively ignoring the intrinsic angular momentum (spin) of fermionic matter at the macroscopic scale.

To bridge the quantum interactions of the Standard Model with the geometry of gravity, we must reformulate our geometric premises in the spirit of Einstein-Cartan-Sciama-Kibble (ECSK) theory. Einstein-Cartan theory naturally extends General Relativity by relaxing the constraint of a symmetric affine connection, thereby introducing spacetime *torsion*. Crucially, within the ECSK framework, this torsion tensor couples directly and naturally to the intrinsic spin density of matter.

The mathematical correspondence between these two theoretical frameworks is striking. The Yang-Mills gauge theory of the Standard Model—specifically the $SU(2)$

gauge group governing the internal dynamics of quarks—operates structurally in the exact same manner as the connections within the principal frame bundle of Einstein-Cartan geometry. The gauge potential A_μ of the quark interactions serves as the precise quantum analog to the spin connection ω_μ^{ab} in differential geometry.

Therefore, the V_{spin} term originating from the Standard Model Lagrangian is not merely a localized, negligible nuclear phenomenon; it is the quantum mechanical source of spacetime torsion. When we analyze bulk matter in equilibrium conditions—meaning it is not subjected to external, dynamic nuclear spin polarization—the macroscopic, statistical average of this massive network of nuclear spin-spin interactions yields a weak, universally attractive force [4].

The localized $SU(2)$ gauge interactions of the quark fields aggregate to define the emergent metric and torsional properties of spacetime. In this framework, gravity does not require the introduction of a novel, unobserved "graviton." Instead, it emerges logically and mathematically as the residual, averaged spin-spin interaction of quark fields, seamlessly unifying the nuclear Lagrangian of the Standard Model with the extended geometric reality of Einstein-Cartan theory.

3. Alzofon Experiments and Follow-up Reproductions

Frederick Alzofon's pioneering experimental work serves as the critical empirical anchor for the emergent gravity hypothesis. Working outside the rigid geometric constraints of classical General Relativity, Alzofon operated on the profound intuition that gravity is an "effective theory." He proposed that the gravitational field is not an isolated curvature of empty space, but rather a macroscopic phenomenon arising from the statistical thermodynamics of subatomic particles—specifically rooted in vacuum fluctuations and particle-antiparticle polarization effects.

In the context of the Standard Model quark framework outlined above, Alzofon's intuition aligns perfectly with the concept of randomized nuclear spin-spin interactions settling into a macroscopic, universally attractive equilibrium. He hypothesized that if gravity is indeed an emergent property of these chaotic subatomic spin alignments, then artificially organizing or "polarizing" these spins should directly perturb the macroscopic gravitational manifestation.

To test this, Alzofon designed an experiment that elegantly bypassed the need for astronomical masses or exotic energies [2]. Utilizing principles analogous to Dynamic Nuclear Polarization (DNP), he applied precisely pulsed microwave radiation to a material sample—such as aluminum—suspended within a constant, static magnetic field. The objective was to induce a state of coherent nuclear spin alignment, temporarily organizing the internal orientations of the sample's atomic nuclei.

By forcing this alignment, the experiment effectively "cooled" the randomized microscopic interactions that normally produce the baseline gravitational force. The results were highly significant: the dynamic orientation of the nuclear spins disrupted the equilibrium average of the tensorial quark-to-quark interactions, leading to a measurable modification of the gravitational force acting upon the material. The sample exhibited altered weight characteristics that could not be explained by classical electrodynamics or Newtonian mechanics.

Importantly, these findings are not isolated historical anomalies. In recent years, the core principles of Alzofon's work have been reproduced, rigorously analyzed, and theoretically formalized. Advanced research and recent presentations within the aerospace and advanced propulsion communities have securely grounded these empirical findings within the Standard Model. Free-fall experiments and subsequent spin-polarization data confirm that by altering the nuclear spin state of a material, we are not simply “shielding” it from a background gravitational field; rather, we are directly manipulating the quantum mechanical source of gravity itself.

4. EXPERIMENTS DEMONSTRATING GRAVITATIONAL CONSTANT IS MATERIAL DEPENDENT

The classical formulations of gravity, from Newton to Einstein, rest upon the foundational assumption that the gravitational constant, G, is a universal and invariable scalar. However, a growing body of experimental data and theoretical re-evaluations strongly suggests that G is not a constant, but rather depends on the type of material being measured. Specifically, the gravitational coupling appears to be intrinsically linked to the nucleon content and chemical composition of the interacting masses.

The historical precedent for this paradigm shift can be traced to Ephraim Fischbach’s 1986 reanalysis of the classical Eötvös experiment [8]. Fischbach’s work uncovered the tantalizing possibility of a composition-dependent force, originally termed a “fifth force,” which scaled proportionately with the baryon number of the test materials. While initially controversial, this conceptual opening paved the way for modern researchers to investigate gravity not as a fundamental constant, but as an emergent, material-dependent phenomenon.

Building upon this, Patrick Bruskiewich has advanced the hypothesis that gravity is a residual quantum effect arising from the tangential electrostatic forces between constituent charged particles within hadronic matter [7]. Bruskiewich points out that laboratory measurements of G are typically conducted using heavy elements (like lead or tungsten), which contain a specific mix of protons and neutrons. He postulates that the measured gravitational constant is actually a weighted average of proton-proton, neutron-neutron, and proton-neutron interactions. Consequently, a purely protonic mass would yield a different measured value for G than a mass composed of complex nuclei, offering a tangible mechanism for galactic rotational anomalies without resorting to dark matter.

This material dependence is further corroborated by the extensive empirical analyses of Sky Darmos [9, 10]. Darmos has aggregated decades of data from Cavendish-style torsion balance experiments to demonstrate strong statistical evidence that G varies based on chemical composition. Darmos mathematically formalizes this variance by showing that gravitational strength is directly proportional to the quark count, or the total number of nucleons, within the interacting bodies. His findings challenge the strict classical interpretation of the Equivalence Principle, suggesting that the density variations in the quantum vacuum manifest differently depending on the specific baryon numbers involved.

Crucially, it must be emphasized that these material-dependent variations in G are not inexplicable anomalies; they ensue naturally from a tensorial quark-quark interaction. As outlined in previous sections, this interaction is already mathematically contained within the Lagrangian of the Standard Model. Because different elements possess distinct internal nuclear geometries and quark orbital distributions, the averaged tensor interactions differ slightly from one material to another. This renders G not as a rigid constant of spacetime curvature, but as an emergent macroscopic coefficient—akin to electric permittivity—that depends inherently on the nucleon spin-to-nuclear spin polarization of the specific materials interacting.

5. Consistency of Experimental Data with the Quark Model

The empirical variations in the gravitational constant find a rigorous mathematical foundation when we examine the internal $SU(2)$ gauge structure of nucleons. The

Standard Model does not treat the neutron as a fundamental, neutral point particle, but rather as a composite state of three quarks. It is the internal geometry of this composite state that serves as the quantum engine for emergent gravity.

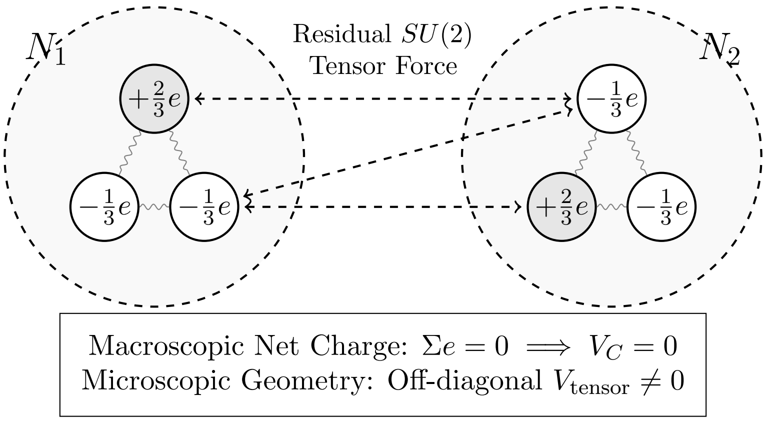

FIGURE 1. Conceptual representation of the spatial distribution of fractional electric charges ($SU(2)$ eigenvalues) within two interacting neutrons. While the macroscopic Coulomb potential vanishes, the localized geometry of the fractional charges results in a non-vanishing, off-diagonal tensor force.

In the language of gauge theory, the quark fields are coupled to the $SU(2)$ gauge connection A_μ. We can extract the localized electric component of this interaction by analyzing the divergent part of the $SU(2)$-quark field. Mathematically, the fractional electric charges of the quarks emerge natively as the eigenvalues of the corresponding state eigenvectors within this representation space. If we let a quark state be represented by a spinor ψ, the charge operator acting upon these states yields the characteristic $+2/3e$ and $-1/3e$ eigenvalues.

When two macroscopically neutral neutrons interact, their baseline Coulomb potential vanishes because the sum of their internal eigenvalues is strictly zero. However, the complete quantum mechanical interaction is governed by the tensor product of their respective many-body quark states: $\Psi_{N_1} \otimes \Psi_{N_2}$.

Because the fractional charges possess a distinct spatial and spin distribution within the nucleon cavity, the interaction Hamiltonian retains non-vanishing, off-diagonal tensorial terms. This means the localized fractional charge distributions interact via a residual, spin-dependent tensor force. The neutrons are electrically neutral as a whole, but their internal $SU(2)$ field divergences interact much like complex, higher-order multipoles.

It is this precise, unshielded tensorial interaction—the residual dynamic of the spatially distributed fractional charges—that scales up. When averaged over the 10^{23} nucleon interactions present in macroscopic bodies, this minute quantum tensor force manifests as the continuous, attractive equilibrium force we classically quantify as gravity. Therefore, gravity's dependence on the specific nucleon architecture of different materials is not an anomaly, but a direct, mathematical consequence of the $SU(2)$ quark field.

6. Conclusions: Gravity is Not a Fundamental Force

The pursuit of a unified theory of physics has long been stalled by the assumption that gravity is a fundamental force of nature requiring its own unique quantum carrier—the elusive graviton. However, when we synthesize the theoretical architecture of the Standard Model with the empirical realities of modern experimentation, a far more elegant reality emerges: gravity is not a fundamental force, but an emergent macroscopic phenomenon.

Specifically, gravitational attraction is the statistical, macroscopic average of quantum-level nuclear spin-spin interactions. The Standard Model already mathematically describes a tensorial quark-quark interaction within the V_{spin} term of the strong nuclear force. By recognizing that the localized $SU(2)$ gauge interactions of these quark fields mathematically correspond to the spacetime torsion described in Einstein-Cartan-Sciama-Kibble theory, we establish a direct geometric bridge between quantum mechanics and General Relativity.

This theoretical framework does not exist in a vacuum; it is rigorously supported by experimental data. Frederick Alzofon's experiments demonstrated that by dynamically organizing nuclear spins through pulsed radiation, the macroscopic gravitational force acting upon a material can be measurably altered. Furthermore, the extensive aggregation of Cavendish-style torsion balance data confirms that the Gravitational constant, G, is not a universal scalar, but a material-dependent variable directly proportional to the nucleon architecture of the interacting masses.

Gravity is, essentially, a nuclear spin polarization effect.

By shifting our perspective to view gravity as an emergent average force resulting from quark field interactions, we eliminate the need for exotic new particles or mathematical abstractions that detach from empirical observation. The tools for unification are already in our hands, embedded within the Standard Model. The next great leap in physics will not come from inventing new fundamental forces, but from understanding the profound, emergent geometry of the forces we already know.

AppendixComparison with Quantum Gravity theories

Usually referred to as *Quantum Gravity Theories* are theories aiming to quantize General Relativity, usually not taking into account spin-spin interaction terms. They also aim to "quantize space-time" itself.

However, the current *Quantum Computing Revolution* suggests focusing the efforts in developing the Standard Model, consistent with the epistemology of *Modern Quantum Computing*, which, paraphrasing Feynman, *is Modern Quantum Computing.* One important argument supporting such a shift of perspective, and hence direction in

R&D, is the experimental confirmation that *Space and Time are emergent concepts* [5]. Notably the use of *Quantum Echo* techniques used in Quantum Computing, like Google's Willow Processor, practically demonstrate that the concept of "linear time" is outdated. If spacetime itself is emergent, attempting to quantize it as a fundamental structure is a misdirection; we must instead look to the interactive fields (quarks and spin) from which spacetime and gravity collaboratively emerge.

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