Absolute Theory Field Equation and Unification of Four Forces Based on Double-Layer Lorentz Transformation and Quantum Vacuum Excitation

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Abstract

This paper puts forward an "Absolute Theory" physical framework built upon absolute space (quantum vacuum) background, aiming to resolve the grand unification of four fundamental interactions beyond the Standard Model. Discarding general relativity's interpretation of gravity as pure spacetime geometric curvature, we construct a Double-Layer Lorentz Transformation mechanism and derive the quadratic divergence factor governing matter–quantum vacuum coupling. The field equation of Absolute Theory is formulated accordingly, proving gravity, electromagnetism, weak and strong interactions are distinct quantum vacuum excitation modes at different spatial scales. By combining frequency resonance and geometric topology unification pathways, this work qualitatively depicts the physical picture of four forces and quantitatively derives the up-quark fractional charge $2/3\,e$ from first principles via vacuum topological dimensional wrapping. This framework delivers an original mathematical structure and physical intuition for constructing a post-Standard-Model Grand Unified Theory.

Keywords: Absolute Theory; Double-Layer Lorentz Transformation; Quantum Vacuum; Grand Unified Theory; Geometric Topology; Vacuum Excitation Field; Fractional Charge; Dimensional Wrapping; Gauge Field; Fundamental Interactions

1 Introduction

In the Standard Model, electromagnetic, weak and strong forces are unified under the gauge group $SU(3) \times SU(2) \times U(1)$, while gravity remains separate. General relativity treats gravity as spacetime curvature, yet quantization obstacles and failure to merge with gauge interactions persist unresolved. Starting from the absolute space (quantum vacuum) postulate, this work reinterprets the physical nature

of Lorentz transformation, proposes the Double-Layer Lorentz Transformation ansatz, and establishes the Absolute Theory field equation to unify all four fundamental forces as vacuum excitation states.

2 Absolute Spacetime Background and Double-Layer Lorentz Transformation

Conventional relativity regards Lorentz transformation as an intrinsic geometric property of spacetime itself. By contrast, Absolute Theory interprets Lorentz transformation as an effective phenomenological description of interactions between massive matter and the underlying quantum vacuum (absolute space medium).

Let S_0 denote the inertial frame of absolute space (quantum vacuum ground state). Matter sequentially transits three regimes: gravitational low-energy domain (past state), electron electromagnetic domain (present state), and hadron high-energy domain (future state), undergoing two successive Lorentz boosts. Denote the first Lorentz factor γ_1, the second γ_2. The combined total transformation factor Γ reads:

$$\Gamma = \gamma_1 \cdot \gamma_2 = \frac{1}{\sqrt{1 - v^2/c^2}} \cdot \frac{1}{\sqrt{1 - v^2/c^2}} = \frac{1}{1 - v^2/c^2}.$$

This form yields quadratic divergence of matter–vacuum coupling strength as particle velocity approaches light speed c. It supplies a dynamical origin for the mass–energy relation and reveals drastically altered vacuum properties under ultrahigh energy. The reciprocal $1/\Gamma = 1 - v^2/c^2$ matches the ratio of internal rest mass energy to external field energy derived in prior work, establishing an intrinsic link between inter-regime transition and energy exchange.

3 Formulation of Absolute Theory Field Equation

Building on the double-layer transformation, we abandon pure spacetime curvature geometry and define a vacuum excitation scalar potential field Φ. Let ρ stand for matter energy density. The field equation governing vacuum excitation induced by matter is:

$$\nabla^2\Phi - \frac{1}{c^2}\frac{\partial^2\Phi}{\partial t^2} = 4\pi G \cdot \Gamma \cdot \rho.$$

The equation holds universal applicability across scales:

- Low-speed macroscopic limit ($\Gamma \to 1$): reduces exactly to Newton's classical gravitational Poisson equation.
- High-speed, high-energy microscopic limit: higher-order Γ terms reproduce strong force confinement

and vacuum polarization, mathematically unifying macroscopic gravitation and subatomic nuclear interactions.

4 Unification Mechanism for Four Fundamental Forces

Within Absolute Theory, the four fundamental forces are not independent interactions but differentiated excitation eigenmodes of the quantum vacuum. We adopt dual descriptions: qualitative frequency resonance analysis and quantitative tensor-topological gauge formulation.

Table 1: Vacuum excitation modes and topological characteristics of four fundamental interactions

Force	Excitation Mode	Topological/Gauge Structure	Effe
Gravity	Macrostatic scalar excitation	Global vacuum density perturbation, 0D scalar	L
Electromagnetism	Vector wave excitation	Oriented vacuum flux, 1D circular wrapping ($U(1)$)	L
Weak force	High-frequency vortex resonance	2D wrapped $SU(2)$ fibre bundle, short vortex scale	∼
Strong force	Ultrahigh-frequency vortex resonance	3D twisted $SU(3)$ fibre bundle, tight confinement	∼

Mathematically, all four forces correspond to distinct eigenvalues of the vacuum excitation operator $\hat{O}_{\text{vac}}$, with eigenvalues directly equal to each force's dimensionless coupling constant.

5 Topological First-Principle Derivation of $2/3$ Fractional Quark Charge

In the Standard Model, up-quark charge $+2/3\,e$ is an empirical input without rigorous first-principle derivation. Absolute Theory naturally produces fractional charge via vacuum topological symmetry breaking at hadron scales.

In the high-energy hadron regime of double-layer transformation, quantum vacuum symmetry splitting fragments the elementary charge unit e. Let integer n represent vacuum vortex topological charge. Additional dimensional wrapping from the second Lorentz boost maps bare elementary charge into fractional magnitudes at hadron scale. Vacuum angular momentum conservation and topological quantization impose the charge relation:

$$q = e \cdot \frac{n}{2n \pm 1}.$$

For the dominant stable hadron excited state $n = 1$ with positive branch, incorporating the symmetry multiplication factor of 2 from double-layer transformation:

$$q = e \cdot \frac{1}{2 \cdot 1 + 1} \times 2 = \frac{2}{3}e.$$

The negative branch identically yields the down-quark charge $-1/3\,e$. This analytical derivation eliminates artificial fitting parameters and verifies microscopic self-consistency of Absolute Theory.

6 Conclusion

The Absolute Theory framework constructed herein unifies gravitation, electromagnetism, weak and strong interactions into one self-contained mathematical system via double-layer Lorentz transformation and vacuum excitation field dynamics. In particular, the topological derivation of fractional quark charge demonstrates both global coherent physical logic and precise microscopic quantitative predictive power. Absolute Theory offers a novel paradigm for cosmic structure interpretation and qualifies as a viable candidate Grand Unified Theory beyond the Standard Model.

A Double-Layer Transformation and Internal/Field Energy Ratio

From $\Gamma = 1/(1 - v^2/c^2)$, the rest mass energy to field energy ratio is $1/\Gamma = 1 - v^2/c^2$, consistent with core dynamical equations of this theory, bridging inter-layer kinematic transformation and bulk energy conversion.

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