

Triadic Potential Field Theory (TPFT): Emergent Geometry from Ternary Data Synchronization

Kurtis Edward Poore

St. Louis, MO, United States of America

*E-mail: kurtis.poore92@gmail.com

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Abstract

The irreconcilability of General Relativity and Quantum Field Theory stems from the assumption of continuous spacetime and fundamental physical forces. This paper proposes the Triadic Potential Field Theory (TPFT), a framework that redefines physical reality as an emergent property of a localized, ternary data processing system. By postulating a fundamental informational triad (φ_{-1} , φ_0 , φ_1) governed by a strict local balancing constraint ($i+j+k=0$), we present formal mathematical derivations bridging discrete ternary logic to continuum field theories. We demonstrate that $SU(3)$ gauge symmetry is the exact transformation group preserving the local trace-zero constraint, while $U(1)$ electrodynamics emerges from the necessity of local phase synchronization in the φ_0 network. Furthermore, by defining informational distance via the Fisher Information Metric, we derive the emergent thermodynamic geometry of spacetime and provide a novel interpretation of cosmological singularities, fermionic exclusion, and the fine structure constant (α).

I. INTRODUCTION

Contemporary theoretical physics remains fundamentally divided between the deterministic, geometric mechanics of General Relativity and the probabilistic, discrete framework of Quantum Field Theory. The Triadic Potential Field Theory (TPFT) departs from these approaches by proposing an ontological shift: physical reality is not a primary construct, but rather an emergent property of a localized, ternary data processing system.

At its core, TPFT asserts that the fundamental constituents of the universe are not continuous fields or point particles, but discrete informational states governed by a rigid local processing constraint. This framework utilizes a fundamental informational triad consisting of three states: φ_{-1} , φ_0 , and φ_1 . The evolution and interaction of these states are dictated by a universal trace-zero balancing requirement, mathematically expressed as:

$$i + j + k = 0 \quad (1)$$

II. THE CONTINUUM LIMIT AND GAUGE SYMMETRY

The transition from discrete ternary logic to continuum field theory occurs when the density of the φ_0 carrier network is sufficiently high to be modeled as a differentiable manifold.

A. $SU(3)$ and the Strong Interaction

We define the state of a local node as a complex vector in a three-dimensional informational space. The preservation of the local zero-sum balance $\sum_{n=1}^3 \Psi_n = 0$ requires that any local transformation $U(x)$ must satisfy the condition that the trace of the transformed state remains zero. This condition is strictly satisfied by the $SU(3)$ gauge group. The eight generators of $SU(3)$ recognized as the Gell-Mann matrices, represent the fundamental degrees of freedom allowed by the system while maintaining triadic balance. Thus, the Strong Nuclear Force is derived as the necessary gauge field required to maintain local informational equilibrium.

B. $U(1)$ and Electrodynamics

In the TPFT framework, the φ_0 network functions as the universal clock cycle. Local shifts in the processing phase must be compensated for to ensure global synchronization. By introducing the covariant derivative:

$$D_\mu = \partial_\mu - igA_\mu \quad (2)$$

We define the electromagnetic field tensor $F_{\mu\nu}$ as the fundamental error-correction mechanism for phase synchronization across the network.

III. SPACETIME AS THERMODYNAMIC ROUTING GEOMETRY

Spacetime is redefined as an emergent rendering of the computational effort required to process polarized data (φ_{-1}, φ_1). Using the Fisher Information Metric g_{ij} , we quantify the distance between informational states:

$$ds^2 = g_{ij} d\theta^i d\theta^j \quad (3)$$

The Einstein Field Equations are thus reinterpreted as the relationship between data density (Energy-Momentum $T_{\mu\nu}$) and the resulting geometric distortion required for efficient routing (Curvature $G_{\mu\nu}$).

IV. THE COSMOLOGICAL BOOT SEQUENCE

The Big Bang is redefined as the initialization phase of the fundamental ternary network. Prior to the emergence of localized physical geometry, the system existed in a pre-geometric "null state" (φ_0). The boot sequence began with the establishment of a synchronized clock cycle, followed by a spontaneous symmetry breaking:

$$0 \rightarrow -1 + 1 \quad (4)$$

This initial polarization necessitated the first routing protocols, causing the instantaneous manifestation of the Fisher Information metric as the system generated the processing space required to manage discrete data states.

V. FERMIONIC EXCLUSION

Within TPFT, the Pauli Exclusion Principle is a fundamental data-collision avoidance protocol. If two identical polarized states were to occupy the same routing coordinates, the local zero-sum constraint would be violated. To prevent localized processing faults, the system enforces a strict exclusion protocol. The localized spike in computational action required to maintain this separation manifests in emergent geometry as degeneracy pressure.

VI. BLACK HOLES AND SYSTEM QUARANTINE

A black hole represents a localized region of catastrophic data overflow. When data density exceeds the routing capacity of the local ϕ_0 network, the computational overhead spikes to infinity. The event horizon is the threshold where processing delay becomes infinite, preventing outward synchronization. The singularity represents a localized failure of the triadic constraint, which the system isolates via a thermodynamic quarantine (infinite curvature) to protect global network integrity.

VII. DERIVATION OF THE FINE STRUCTURE CONSTANT (α)

In standard Quantum Electrodynamics, $\alpha \approx 1/137$ is an empirical parameter. In TPFT, we derive α as a geometric consequence of the triadic synchronization protocol. We define the informational flux across the local triadic hyperplane S defined by $i + j + k = 0$. The coupling strength is defined by the ratio of the polarization action S_p to the total network capacity C_0 .

$$\alpha = S_p / C_0 = (1/4\pi) \oint_S (\nabla \cdot \Psi / \|\Psi\|^2) d\sigma \quad (5)$$

This derivation suggests that the strength of the electromagnetic interaction is a direct manifestation of the synchronization overhead required to maintain local triadic equilibrium.

VIII. CONCLUSION

The Triadic Potential Field Theory provides a mathematically rigorous bridge between information theory and physics. By treating the universe as a self-correcting ternary system, we derive fundamental forces and spacetime geometry as emergent necessities of data synchronization and routing. Future work will focus on the derivation of the $SU(2)$ weak interaction and the calculation of dark matter density as informational overhead.

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