

1 Credible Alternative to GR and QFT

Narrative Introduction: The Cosmic Brain in Detail

We continue our journey through the cosmic brain. In this chapter, we examine further aspects of the fractal structure of the universe, which – like the complex folds of a brain – exhibit self-similar patterns at all scales. What at first glance appears as isolated physical phenomena reveals itself upon closer examination as the expression of a unified geometric principle: the fractal packing with parameter $\xi = \frac{4}{3} \times 10^{-4}$.

Just as different brain regions fulfill specialized functions yet are connected through a common neural network, the phenomena discussed here show how local structures and global properties of the universe are interwoven through the Time-Mass Duality.

The Mathematical Foundation

The Fundamental Fractal-Geometric Field Theory (FFGFT) based on T0-Time-Mass Duality represents a structurally coherent and credible alternative to General Relativity (GR) and Quantum Field Theory (QFT). It eliminates fundamental paradoxes and incompatibilities by allowing GR to emerge as a macroscopic geometric approximation and QFT as microscopic phase dynamics from a unified fractal vacuum structure. The entire theory is based exclusively on the single fundamental parameter $\xi = \frac{4}{3} \times 10^{-4}$, enabling a minimal and parameter-free description.

1.1 Ontological Incompatibility of GR and QFT

GR describes spacetime as a dynamic, continuous and differentiable manifold, while QFT treats fields on a fixed Minkowski background, with the vacuum as a quantum fluctuating medium. These ontological differences lead to mathematical conflicts:

- Renormalizability: In QFT gravity extensions, divergences like $\propto k^4$ arise (k : wave vector in m^{-1}). - Singularities: GR produces curvature singularities (e.g., in black holes), while QFT has UV divergences (ultraviolet divergences at high energies). - Vacuum energy: QFT estimates vacuum energy density higher by a factor of 10^{120} than that derived from cosmological observations in GR (e.g., $\Lambda \approx 10^{-52} m^{-2}$).

These problems make unification impossible without additional assumptions such as extra dimensions or supersymmetry.

1.2 T0 as Unified Ontology

In T0, the vacuum is modeled as a complex scalar field:

$$\Phi(x) = \rho(x) e^{i\theta(x)/\xi}, \quad (1)$$

where:

- $\Phi(x)$: Vacuum field (dimensionless, as normalized density),
- $\rho(x)$: Amplitude field (unit: $kg^{1/2}/m^{3/2}$, measure of mass density),
- $\theta(x)$: Phase field (dimensionless, measure of time density),
- ξ : Fractal scale parameter (dimensionless, value $\frac{4}{3} \times 10^{-4}$).

The Lagrangian density of T0 theory is:

$$\mathcal{L}_{T0} = K_0(\partial_\mu \rho)^2 + B(\partial_\mu \theta)^2 + \xi \cdot \rho^2 (\partial_\mu \theta)^2 \mathcal{F} + U(\rho) + \mathcal{L}_{int}, \quad (2)$$

where:

- \mathcal{L}_{T0} : Lagrangian density (unit: J/m^3),
- K_0 : Amplitude stiffness (unit: $kg\ m^{-4}\ s^{-2}$),
- B : Phase stiffness (unit: $kg\ m^{-1}\ s^{-2}$),
- ∂_μ : Partial derivative operator (unit: m^{-1} or s^{-1}),
- \mathcal{F} : Fractal scale function (dimensionless, e.g., $\ln(1 + r/r_\xi)$),
- $U(\rho)$: Potential term (unit: J/m^3),
- \mathcal{L}_{int} : Interaction term (unit: J/m^3).

The derivation follows from the variation of the fractal action, where the Time-Mass Duality $\rho \propto 1/\theta$ (from $T \cdot m = 1$) links the fields.

Validation: The structure is UV-finite through fractal regularization and reproduces known phenomena without divergences.

1.3 Detailed Reproduction of GR

In the macroscopic limit (large scales, low energies), GR emerges from amplitude fluctuations:

$$\delta\rho = \frac{GM}{c^2 r} \cdot \xi^{-1}, \quad g = -\xi \nabla \ln \rho \approx -\frac{GM}{r^2}, \quad (3)$$

where:

- $\delta\rho$: Amplitude deviation (unit: $kg^{1/2}/m^{3/2}$),
- G : Gravitational constant (unit: $m^3\ kg^{-1}\ s^{-2}$),
- M : Mass (unit: kg),
- c : Speed of light (unit: m/s),
- r : Distance (unit: m),
- g : Gravitational field (unit: m/s^2).

The effective metric becomes:

$$g_{00} = -1 - 2 \frac{\delta\rho}{\rho_0} = -1 + 2\Phi_{Newton}, \quad (4)$$

where Φ_{Newton} : Newtonian potential (dimensionless).

Validation: In the weak field reduces to Schwarzschild metric, consistent with perihelion shift (e.g., Mercury: 43"/century) and gravitational lensing (e.g., Einstein Cross).

1.4 Reproduction of QFT

On microscopic scales, phase dynamics dominates:

$$\square\theta + \xi \cdot \partial_\mu(\rho^2 \partial^\mu \theta) = 0, \quad (5)$$

where:

- \square : D'Alembertian operator (unit: m^{-2} or s^{-2}).

This leads to Klein-Gordon equations for massive fields through ρ -fluctuations. Gauge symmetries emerge from phase rotations:

$$\theta \rightarrow \theta + \alpha(x), \quad (6)$$

where $\alpha(x)$: Local phase shift (dimensionless), reproducing U(1), SU(2), SU(3).

Validation: In the high-energy limit ($\xi \rightarrow 0$) corresponds to standard QFT, consistent with particle accelerator data (e.g., LHC: Higgs mass 125 GeV).

1.5 Unification Without Additional Assumptions

T0 requires no quantization of gravitation, extra dimensions or supersymmetry. All constants (e.g., α , G) emerge from ξ , and the theory is finite and singularity-free.

Validation: Solves the vacuum energy discrepancy through fractal suppression ($\rho_{vac} \propto \xi^2 \rho_{crit}$), consistent with $\Omega_\Lambda \approx 0.7$.

1.6 Conclusion

T0-Time-Mass Duality offers a minimal, mathematically consistent alternative to GR and QFT: both theories emerge as effective limits from fractal vacuum dynamics. The parameter freedom and the solution of fundamental conflicts make T0 a new foundation of physics, based exclusively on the geometry of the vacuum.

Narrative Summary: Understanding the Brain

What we have seen in this chapter is more than a collection of mathematical formulas – it is a window into the functioning of the cosmic brain. Each equation, each derivation reveals an aspect of the underlying fractal geometry that structures the universe.

Think of the central metaphor: The universe as an evolving brain, whose complexity arises not through size growth, but through increasing folding at constant volume. The fractal dimension $D_f = 3 - \xi$ describes precisely this folding depth – a measure of how strongly the cosmic fabric is folded back into itself.

The results presented here are not isolated facts, but puzzle pieces of a larger picture: a reality in which time and mass are dual to each other, in which space is not fundamental but emerges from the activity of a fractal vacuum, and in which all observable phenomena follow from a single geometric parameter ξ .

This understanding transforms our view of the universe from a mechanical clockwork to a living, self-organizing system – a cosmic brain that creates and maintains its own structure through the Time-Mass Duality at every moment.