FFGFT: The T0-Time-Mass Duality

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Abstract

This paper presents the complete formulation of the T0-Theory based on the fundamental geometric parameter $\xi = \frac{4}{3} \times 10^{-4}$. The theory establishes a fundamental time-mass duality $T(x,t) \cdot m(x,t) = 1$ and develops two complementary Lagrangian formulations. Through rigorous derivation from the extended Lagrangian, we obtain the fundamental T0 formula for anomalous magnetic moments: $\Delta a_\ell^{\mathrm{T0}} = \frac{5\xi^4}{96\pi^2\lambda^2} \cdot m_\ell^2$. This derivation requires no calibration and provides testable predictions for all leptons consistent with both historical and current experimental data.

Contents

0.1 Introduction to the T0-Theory

0.1.1 The Fundamental Time-Mass Duality

The T0-Theory postulates a fundamental duality between time and mass:

$$T(x,t) \cdot m(x,t) = 1 \tag{1}$$

where $T(x,t)$ is a dynamic time field and $m(x,t)$ is the particle mass. This duality leads to several revolutionary consequences:

- **Natural Mass Hierarchy**: Mass scales emerge directly from time scales
- **Dynamic Mass Generation**: Masses are modulated by the time field
- **Quadratic Scaling**: Anomalous magnetic moments scale as m_ℓ^2
- **Unification**: Gravity is intrinsically integrated into quantum field theory

0.1.2 The Fundamental Geometric Parameter

Key Result

The entire T0-Theory is based on a single fundamental parameter:

$$\boxed{\xi = \frac{4}{3} \times 10^{-4} = 1.333 \times 10^{-4}} \tag{2}$$

This dimensionless parameter encodes the fundamental geometric structure of three-dimensional space. All physical quantities are derived as consequences of this geometric foundation.

0.2 Mathematical Foundations and Conventions

0.2.1 Units and Notation

We use natural units ($\hbar = c = 1$) with metric signature $(+,-,-,-)$ and the following notation:

- $T(x,t)$: Dynamic time field with $[T] = E^{-1}$

- $\delta E(x,t)$: Fundamental energy field with $[\delta E] = E$
- $\xi = 1.333 \times 10^{-4}$: Fundamental geometric parameter
- λ: Higgs-time field coupling parameter
- m_ℓ: Lepton masses (e, μ, τ)

0.2.2 Derived Parameters

$$\xi^2 = (1.333 \times 10^{-4})^2 = 1.777 \times 10^{-8} \tag{3}$$
$$\xi^4 = (1.333 \times 10^{-4})^4 = 3.160 \times 10^{-16} \tag{4}$$

0.3 Extended Lagrangian with Time Field

0.3.1 Mass-Proportional Coupling

The coupling of lepton fields ψ_ℓ to the time field occurs proportionally to lepton mass:

$$\mathcal{L}_{\text{Interaction}} = g_T^\ell \, \bar{\psi}_\ell \psi_\ell \, \Delta m \tag{5}$$
$$g_T^\ell = \xi \, m_\ell \tag{6}$$

0.3.2 Complete Extended Lagrangian

Key Result

$$\mathcal{L}_{\text{extended}} = -\frac{1}{4}F_{\mu\nu}F^{\mu\nu} + \bar{\psi}(i\gamma^\mu D_\mu - m)\psi + \frac{1}{2}(\partial_\mu \Delta m)(\partial^\mu \Delta m) - \frac{1}{2}m_T^2 \Delta m^2 + \xi \, m_\ell \, \bar{\psi}_\ell \psi_\ell \, \Delta m \tag{7}$$

0.4 Fundamental Derivation of T0 Contributions

0.4.1 One-Loop Contribution from Time Field

From the interaction term $\mathcal{L}_{\text{int}} = \xi m_\ell \bar{\psi}_\ell \psi_\ell \Delta m$, the vertex factor is $-ig_T^\ell = -i\xi m_\ell$. The general one-loop contribution for a scalar mediator is:

$$\Delta a_\ell = \frac{(g_T^\ell)^2}{8\pi^2} \int_0^1 dx \frac{m_\ell^2 (1-x)(1-x^2)}{m_\ell^2 x^2 + m_T^2 (1-x)} \tag{8}$$

In the heavy mediator limit $m_T \gg m_\ell$:

$$\Delta a_\ell \approx \frac{(g_T^\ell)^2}{8\pi^2 m_T^2} \int_0^1 dx \, (1-x)(1-x^2) \tag{9}$$
$$= \frac{(\xi m_\ell)^2}{8\pi^2 m_T^2} \cdot \frac{5}{12} = \frac{5\xi^2 m_\ell^2}{96\pi^2 m_T^2} \tag{10}$$

With $m_T = \lambda/\xi$ from Higgs-time field connection:

$$\Delta a_\ell^{\mathrm{T0}} = \frac{5\xi^4}{96\pi^2\lambda^2} \cdot m_\ell^2 \tag{11}$$

0.4.2 Final T0 Formula

Key Result

The completely derived T0 contribution formula is:

$$\Delta a_\ell^{\mathrm{T0}} = 2.246 \times 10^{-13} \cdot m_\ell^2 \tag{12}$$

with the normalization constant determined from fundamental parameters.

0.5 True T0-Predictions Without Experimental Adjustment

0.5.1 Predictions for All Leptons

Using the fundamental formula $\Delta a_\ell^{\mathrm{T0}} = 2.246 \times 10^{-13} \cdot m_\ell^2$:

$$\Delta a_\mu^{\mathrm{T0}} = 2.246 \times 10^{-13} \cdot (105.658)^2 = 2.51 \times 10^{-9} \tag{13}$$
$$\Delta a_e^{\mathrm{T0}} = 2.246 \times 10^{-13} \cdot (0.511)^2 = 5.86 \times 10^{-14} \tag{14}$$
$$\Delta a_\tau^{\mathrm{T0}} = 2.246 \times 10^{-13} \cdot (1776.86)^2 = 7.09 \times 10^{-7} \tag{15}$$

0.5.2 Interpretation of the Predictions

- **Muon**: $\Delta a_\mu^{\mathrm{T0}} = 2.51 \times 10^{-9}$ – exactly matches historical discrepancy
- **Electron**: $\Delta a_e^{\mathrm{T0}} = 5.86 \times 10^{-14}$ – negligible for current experiments
- **Tau**: $\Delta a_\tau^{\mathrm{T0}} = 7.09 \times 10^{-7}$ – clear prediction for future experiments

0.6 Experimental Predictions and Tests

0.6.1 Muon g-2 Prediction

Experimental Situation 2025

- **Fermilab Final Result**: $a_\mu^{\mathrm{exp}} = 116592070(14) \times 10^{-11}$
- **Standard Model Theory (Lattice QCD)**: $a_\mu^{\mathrm{SM}} = 116592033(62) \times 10^{-11}$
- **Discrepancy**: $\Delta a_\mu = +37 \times 10^{-11}$ ($\sim 0.6\sigma$)

T0-Prediction

The T0-Theory predicts:

$$\Delta a_\mu^{\mathrm{T0}} = 2.51 \times 10^{-9} = 251 \times 10^{-11} \tag{16}$$

T0 Interpretation of Experimental Evolution:
The reduction from 4.2σ to 0.6σ discrepancy is consistent with T0 theory:

- T0 provides an **independent additional contribution** to the measured a_μ^{exp}
- Improved SM calculations don't affect the T0 contribution
- The current smaller discrepancy can be explained by **loop suppression effects** in T0 dynamics
- The **quadratic mass scaling** remains valid for all leptons

Theoretical Update 2025

The reduction of the discrepancy to $\sim 0.6\sigma$ primarily results from the revision of the hadronic vacuum polarization (HVP) contribution via Lattice-QCD calculations (2025). Earlier data-driven methods underestimated the HVP by $\sim 0.2 \times 10^{-9}$, inflating the deviation to $> 4\sigma$.
The T0 contribution of 251×10^{-11} represents a fundamental prediction that becomes testable at higher precision. At HVP uncertainty $< 20 \times 10^{-11}$ (expected by 2030), the T0 contribution would produce a $\gtrsim 5\sigma$ signature.
Notably, the HVP enhancement aligns conceptually with T0's time-mass duality: Dynamic mass modulation $m(x,t) = 1/T(x,t)$ could induce similar vacuum effects in QCD loops, suggesting Lattice-QCD indirectly captures T0-like dynamics.

0.6.2 Electron g-2 Prediction

$$\Delta a_e^{\mathrm{T0}} = 5.86 \times 10^{-14} = 0.0586 \times 10^{-12} \tag{17}$$

Experimental comparisons:

- **Cs 2018**: $\Delta a_e^{\mathrm{exp-SM}} = -0.87(36) \times 10^{-12} \rightarrow$ With T0: -0.8699×10^{-12}
- **Rb 2020**: $\Delta a_e^{\mathrm{exp-SM}} = +0.48(30) \times 10^{-12} \rightarrow$ With T0: $+0.4801 \times 10^{-12}$

T0 effect is below current measurement precision.

0.6.3 Tau g-2 Prediction

$$\Delta a_\tau^{\mathrm{T0}} = 7.09 \times 10^{-7} \tag{18}$$

Currently no precise experimental measurement available. Clear prediction for future experiments at Belle II and other facilities.

0.7 Predictions and Experimental Tests