Elimination of Mass as a Dimensional Placeholder in the T0 Model: Towards Truly Parameter-Free Physics

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Abstract

This paper demonstrates that the mass parameter m, which appears in the formulations of the T0 model, serves exclusively as a dimensional placeholder and can be systematically eliminated from all equations. Through rigorous dimensional analysis and mathematical reformulation, we show that the apparent dependence on specific particle masses is an artifact of conventional notation and not fundamental physics. The elimination of m reveals the T0 model as a truly parameter-free theory, based solely on the Planck scale and providing universal scaling laws while systematically eliminating distortions due to empirical mass determinations. This work establishes the mathematical foundation for a complete ab-initio formulation of the T0 model, which requires no external experimental inputs beyond the fundamental constants $\hbar$, c, G, and k_B.

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0.1 Introduction

0.1.1 The Problem of Mass Parameters

The T0 model appears, as formulated in previous works, to critically depend on specific particle masses such as the electron mass m_e, proton mass m_p, and Higgs boson mass m_h. This apparent dependence has raised concerns about the predictive power of the model and its reliance on empirical inputs that may themselves be contaminated by Standard Model assumptions.

A careful analysis reveals, however, that the mass parameter m fulfills a purely **dimensional function** in the T0 equations. This paper shows that m can be systematically eliminated from all formulations and unveils the T0 model as a fundamentally parameter-free theory based exclusively on Planck-scale physics.

0.1.2 Dimensional Analysis Approach

In natural units, where $\hbar = c = G = k_B = 1$, all physical quantities can be expressed as powers of energy $[E]$:

$$\text{Length:} \quad [L] = [E^{-1}] \tag{1}$$
$$\text{Time:} \quad [T] = [E^{-1}] \tag{2}$$
$$\text{Mass:} \quad [M] = [E] \tag{3}$$
$$\text{Temperature:} \quad [\Theta] = [E] \tag{4}$$

This dimensional structure suggests that mass parameters could be replaced by energy scales, leading to more fundamental formulations.

0.2 Systematic Mass Elimination

0.2.1 The Intrinsic Time Field

Original Formulation

The intrinsic time field is traditionally defined as:

$$T(\vec{x},t) = \frac{1}{\max(m(\vec{x},t),\omega)} \tag{5}$$

Dimensional Analysis:

- $[T(\vec{x},t)] = [E^{-1}]$ (time field dimension)
- $[m] = [E]$ (mass as energy)
- $[\omega] = [E]$ (frequency as energy)
- $[1/\max(m,\omega)] = [E^{-1}]$ ✓

Mass-Free Reformulation

The fundamental insight is that only the **ratio** between characteristic energy and frequency is physically relevant. We reformulate as:

$$\boxed{T(\vec{x},t) = t_{\text{P}} \cdot g(E_{\text{norm}}(\vec{x},t),\omega_{\text{norm}})} \tag{6}$$

where:

$$t_{\text{P}} = \sqrt{\frac{\hbar G}{c^5}} \quad \text{(Planck time)} \tag{7}$$

$$E_{\text{norm}} = \frac{E(\vec{x},t)}{E_{\text{P}}} \quad \text{(normalized energy)} \tag{8}$$

$$\omega_{\text{norm}} = \frac{\omega}{E_{\text{P}}} \quad \text{(normalized frequency)} \tag{9}$$

$$g(E_{\text{norm}},\omega_{\text{norm}}) = \frac{1}{\max(E_{\text{norm}},\omega_{\text{norm}})} \tag{10}$$

Result: Mass completely eliminated; only Planck scale and dimensionless ratios remain.

0.2.2 Field Equation Reformulation

Original Field Equation

$$\nabla^2 T(x,t) = -4\pi G\rho(\vec{x})T(x,t)^2 \tag{11}$$

with mass density $\rho(\vec{x}) = m \cdot \delta^3(\vec{x})$ for a point source.

Energy-Based Formulation

Replacement of mass density by energy density:

$$\boxed{\nabla^2 T(x,t) = -4\pi G\frac{E(\vec{x})}{E_{\mathrm{P}}}\delta^3(\vec{x})\frac{T(x,t)^2}{t_{\mathrm{P}}^2}} \tag{12}$$

Dimensional Verification:

$$[\nabla^2 T(x,t)] = [E^{-1}\cdot E^2] = [E] \tag{13}$$

$$[4\pi G E_{\mathrm{norm}}\delta^3(\vec{x})T(x,t)^2/t_{\mathrm{P}}^2] = [E^{-2}][1][E^6][E^{-2}]/[E^{-2}] = [E] \quad \checkmark \tag{14}$$

0.2.3 Point Source Solution: Parameter Separation

The Mass Redundancy Problem

The traditional point source solution exhibits apparent mass redundancy:

$$T(x,t)(r) = \frac{1}{m}\left(1 - \frac{r_0}{r}\right) \tag{15}$$

with $r_0 = 2Gm$. Substitution:

$$T(x,t)(r) = \frac{1}{m}\left(1 - \frac{2Gm}{r}\right) = \frac{1}{m} - \frac{2G}{r} \tag{16}$$

Critical Observation: Mass m appears in **two different roles**:

1. As a normalization factor $(1/m)$
2. As a source parameter $(2Gm)$

This suggests that m **masks two independent physical scales**.

Parameter Separation Solution

We reformulate with independent parameters:

$$\boxed{T(x,t)(r) = T_0\left(1 - \frac{L_0}{r}\right)} \tag{17}$$

where:

- T_0: Characteristic time scale $[E^{-1}]$
- L_0: Characteristic length scale $[E^{-1}]$

Physical Interpretation:

- T_0 determines the **amplitude** of the time field
- L_0 determines the **range** of the time field
- Both derivable from source geometry without specific masses

0.2.4 The ξ-Parameter: Universal Scaling

Traditional Mass-Dependent Definition

$$\xi = 2\sqrt{G} \cdot m \tag{18}$$

Problem: Requires specific particle masses as input.

Universal Energy-Based Definition

$$\boxed{\xi = 2\sqrt{\frac{E_{\text{characteristic}}}{E_{\text{P}}}}} \tag{19}$$

Universal Scaling for Different Energy Scales:

$$\text{Planck Energy } (E = E_{\text{P}}): \quad \xi = 2 \tag{20}$$

$$\text{Electroweak Scale } (E \sim 100 \text{ GeV}): \quad \xi \sim 10^{-8} \tag{21}$$

$$\text{QCD Scale } (E \sim 1 \text{ GeV}): \quad \xi \sim 10^{-9} \tag{22}$$

$$\text{Atomic Scale } (E \sim 1 \text{ eV}): \quad \xi \sim 10^{-28} \tag{23}$$

No specific particle masses required!

0.3 Complete Mass-Free T0 Formulation

0.3.1 Fundamental Equations

The complete mass-free T0 system:

Mass-Free T0 Model

$$\text{Time Field:} \quad T(\vec{x},t) = t_{\mathrm{P}} \cdot f(E_{\mathrm{norm}}(\vec{x},t), \omega_{\mathrm{norm}}) \tag{24}$$

$$\text{Field Equation:} \quad \nabla^2 T(x,t) = -4\pi G \frac{E_{\mathrm{norm}}}{\ell_{\mathrm{P}}^2} \delta^3(\vec{x}) T(x,t)^2 \tag{25}$$

$$\text{Point Sources:} \quad T(x,t)(r) = T_0 \left(1 - \frac{L_0}{r}\right) \tag{26}$$

$$\text{Coupling Parameter:} \quad \xi = 2\sqrt{\frac{E}{E_{\mathrm{P}}}} \tag{27}$$

0.3.2 Parameter Count Analysis

Formulation	Before Mass Elimination	After Mass Elimination
Fundamental Constants	$\hbar, c, G, k_B$	$\hbar, c, G, k_B$
Particle-Specific Masses	$m_e, m_\mu, m_p, m_h, \ldots$	None
Dimensionless Ratios	No explicit	E/E_{P}, L/ℓ_{P}, T/t_{P}
Free Parameters	∞ (one per particle)	0
Empirical Inputs Required	Yes (masses)	No

0.3.3 Dimensional Consistency Verification

Equation	Left Side	Right Side	Status
Time Field	$[T(\vec{x},t)] = [E^{-1}]$	$[t_{\mathrm{P}} \cdot f(\cdot)] = [E^{-1}]$	✓
Field Equation	$[\nabla^2 T(x,t)] = [E]$	$[G E_{\mathrm{norm}} \delta^3 T(x,t)^2 / \ell_{\mathrm{P}}^2] = [E]$	✓
Point Source	$[T(x,t)(r)] = [E^{-1}]$	$[T_0(1 - L_0/r)] = [E^{-1}]$	✓
ξ-Parameter	$[\xi] = [1]$	$[\sqrt{E/E_{\mathrm{P}}}] = [1]$	✓

Table 1: Dimensional Consistency of Mass-Free Formulations

0.4 Experimental Implications

0.4.1 Universal Predictions

The mass-free T0 model makes universal predictions independent of specific particle properties:

Scaling Laws

$$\xi(E) = 2\sqrt{\frac{E}{E_{\text{P}}}} \tag{28}$$

This relation must hold for **all** energy scales and provides a stringent test of the theory.

QED Anomalies

The anomalous magnetic moment of the electron becomes:

$$a_e^{(\text{T0})} = \frac{\alpha}{2\pi} \cdot C_{\text{T0}} \cdot \left(\frac{E_e}{E_{\text{P}}}\right) \tag{29}$$

where E_e is the characteristic energy scale of the electron, not its rest mass.

Gravitational Effects

$$\Phi(r) = -\frac{GE_{\text{source}}}{E_{\text{P}}} \cdot \frac{\ell_{\text{P}}}{r} \tag{30}$$

Universal scaling for all gravitational sources.

0.4.2 Elimination of Systematic Biases

Problems with Mass-Dependent Formulations

Traditional approaches suffer from:

- **Circular Dependencies**: Using experimentally determined masses to predict the same experiments
- **Standard Model Contamination**: All mass measurements presuppose SM physics
- **Precision Illusions**: High apparent precision masks systematic theoretical errors

Advantages of the Mass-Free Approach

- **Model Independence**: No dependence on potentially biased mass determinations
- **Universal Tests**: The same scaling laws apply across all energy scales
- **Theoretical Purity**: Ab-initio predictions solely from the Planck scale

0.4.3 Proposed Experimental Tests

Multi-Scale Consistency

Test of the universal scaling relation:

$$\frac{\xi(E_1)}{\xi(E_2)} = \sqrt{\frac{E_1}{E_2}} \tag{31}$$

across different energy scales: atomic, nuclear, electroweak, and cosmological.

Energy-Dependent Anomalies

Measurement of anomalous magnetic moments as functions of energy scale rather than particle identity:

$$a(E) = a_{\text{SM}}(E) + a^{(\text{T0})}(E/E_{\text{P}}) \tag{32}$$

Geometric Independence

Verification that T_0 and L_0 can be determined independently from source geometry without specific mass values.

0.5 Geometric Parameter Determination

0.5.1 Source Geometry Analysis

Spherically Symmetric Sources

For a spherically symmetric energy distribution $E(r)$:

$$T_0 = t_{\text{P}} \cdot f\left(\frac{\int E(r) d^3 r}{E_{\text{P}}}\right) \tag{33}$$

$$L_0 = \ell_{\text{P}} \cdot g\left(\frac{R_{\text{characteristic}}}{\ell_{\text{P}}}\right) \tag{34}$$

where f and g are dimensionless functions determined by the field equations.

Non-Spherical Sources

For general geometries, the parameters become tensorial:

$$T_0^{ij} = t_\mathsf{P} \cdot f_{ij}\left(\frac{I^{ij}}{E_\mathsf{P}\ell_\mathsf{P}^2}\right) \tag{35}$$

$$L_0^{ij} = \ell_\mathsf{P} \cdot g_{ij}\left(\frac{I^{ij}}{\ell_\mathsf{P}^2}\right) \tag{36}$$

where I^{ij} is the energy-momentum tensor of the source.

0.5.2 Universal Geometric Relations

The mass-free formulation reveals universal relations between geometric and energetic properties:

$$\frac{L_0}{\ell_\mathsf{P}} = h\left(\frac{T_0}{t_\mathsf{P}}, \text{shape parameters}\right) \tag{37}$$

These relations are **independent of specific mass values** and depend only on:

- Energy distribution geometry
- Planck-scale ratios
- Dimensionless shape parameters

0.6 Connection to Fundamental Physics

0.6.1 Emergent Mass Concept

Mass as an Effective Parameter

In the mass-free formulation, what we traditionally call mass emerges as:

$$m_{\text{effective}} = E_{\text{characteristic}} \cdot f(\text{geometry}, \text{couplings}) \tag{38}$$

Different Masses for Different Contexts:

- **Rest Mass**: Intrinsic energy scale of localized excitation
- **Gravitational Mass**: Coupling strength to spacetime curvature
- **Inertial Mass**: Resistance to acceleration in external fields

All reducible to **energy scales and geometric factors**.

Resolution of Mass Hierarchies

The apparent hierarchy of particle masses becomes a hierarchy of **energy scales**:

$$\frac{m_t}{m_e} \to \frac{E_{\text{top}}}{E_{\text{electron}}} \tag{39}$$
$$\frac{m_W}{m_e} \to \frac{E_{\text{electroweak}}}{E_{\text{electron}}} \tag{40}$$
$$\frac{m_P}{m_e} \to \frac{E_{\text{P}}}{E_{\text{electron}}} \tag{41}$$

No fundamental mass parameters, only energy scale ratios.

0.6.2 Unification with Planck-Scale Physics

Natural Scale Emergence

All physics organizes itself naturally around the Planck scale:

$$\text{Microscopic Physics:} \quad E \ll E_{\text{P}}, \quad L \gg \ell_{\text{P}} \tag{42}$$
$$\text{Macroscopic Physics:} \quad E \ll E_{\text{P}}, \quad L \gg \ell_{\text{P}} \tag{43}$$
$$\text{Quantum Gravity:} \quad E \sim E_{\text{P}}, \quad L \sim \ell_{\text{P}} \tag{44}$$

Scale-Dependent Effective Theories

Different energy regimes correspond to different limits of the universal T0 theory:

$$E \ll E_{\text{P}}: \quad \text{Standard Model Limit} \tag{45}$$
$$E \sim \text{TeV}: \quad \text{Electroweak Unification} \tag{46}$$
$$E \sim E_{\text{P}}: \quad \text{Quantum Gravity Unification} \tag{47}$$

0.7 Philosophical Implications

0.7.1 Reductionism to the Planck Scale

The elimination of mass parameters shows that **all physics** is reducible to the **Planck scale**:

- No fundamental mass parameters exist
- Only energy and length ratios are important
- Universal dimensionless couplings emerge naturally
- Truly parameter-free physics achieved

0.7.2 Ontological Implications

Mass as a Human Construct

The traditional concept of mass appears to be a **human construct** rather than fundamental reality:

- Useful for practical calculations
- Not present at the deepest level of the theory
- Emergent from more fundamental energy relations

Universal Energy Monism

The mass-free T0 model supports a form of **energy monism**:

- Energy as the only fundamental quantity
- All other quantities as energy relations
- Space and time as energy-derived concepts
- Matter as structured energy patterns