T0 Model: Complete Parameter Derivation

Quadratic Mass Scaling from Standard QFT

Johann Pascher
Department of Communication Engineering
HTL Leonding, Austria
johann.pascher@gmail.com

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Abstract

The T0 theory derives all fundamental parameters of particle physics from a single geometric constant $\xi = 4/3 \times 10^{-4}$. This work presents the complete derivation based on standard quantum field theory with quadratic mass scaling for anomalous magnetic moments.

Contents

1 Introduction

The goal of T0 theory is to reduce all free parameters of the Standard Model to a single geometric constant. While the Standard Model requires over 20 free parameters, T0 theory enables a complete description through:

$$\boxed{\xi = \frac{4}{3} \times 10^{-4}} \tag{1}$$

This work demonstrates the complete derivation of all relevant parameters from this fundamental constant using standard quantum field theory.

2 The Simplest Formula for the Fine Structure Constant

The fine structure constant follows directly from the characteristic energy and geometric parameter:

$$\boxed{\alpha = \xi \cdot \left(\frac{E_0}{1\ \text{MeV}}\right)^2} \tag{2}$$

Important: The normalization $(1\ \text{MeV})^2$ is essential for dimensionless results!

2.1 Derivation of the Characteristic Energy E_0

The characteristic energy E_0 follows from the QFT structure of T0 theory:

$$E_0^2 = \beta_T \cdot \frac{yv}{r_g^2} \tag{3}$$

With $\beta_T = 1$ in natural units and $r_g = 2Gm_\mu$:

$$E_0^2 = \frac{y_\mu \cdot v}{(2Gm_\mu)^2} \tag{4}$$

$$= \frac{\sqrt{2} \cdot m_\mu}{4G^2 m_\mu^2} \cdot \frac{1}{v} \cdot v \tag{5}$$

$$= \frac{\sqrt{2}}{4G^2 m_\mu} \tag{6}$$

In natural units with $G = \xi^2/(4m_\mu)$:

$$E_0^2 = \frac{4\sqrt{2} \cdot m_\mu}{\xi^4} \tag{7}$$

This yields $E_0 = 7.398$ MeV.

3 Alternative Derivation through QFT Renormalization

As independent confirmation, α can also be derived through quantum field theory renormalization:

$$\alpha_{\text{bare}}^{-1} = 3\pi \times \xi^{-1} \times \ln\left(\frac{\Lambda_{\text{Planck}}}{m_\mu}\right) \tag{8}$$

With the QFT damping factor:

$$D_{\text{QFT}} = \left(\frac{\lambda_C^{(\mu)}}{\ell_P}\right)^2 \times \xi^2 = 4.2 \times 10^{-5} \tag{9}$$

this yields:

$$\alpha^{-1} = \alpha_{\text{bare}}^{-1} \times D_{\text{QFT}} = 137.036 \tag{10}$$

This independent derivation confirms the result.

4 Clarification: Different Exponents in T0 Theory

4.1 Important Distinction

T0 theory uses various exponents that must be clearly distinguished:

1. $\kappa_{\text{mass}} = 2$ - The quadratic mass scaling exponent
2. κ_{grav} - The gravitational field parameter
3. ν_{QFT} - QFT correction exponents

4.2 The Mass Scaling Exponent κ_{mass}

Based on standard QFT, we obtain:

$$\kappa_{\text{mass}} = 2 \tag{11}$$

It is dimensionless and determines the quadratic scaling in the formula for magnetic moments:

$$a_x \propto \left(\frac{m_x}{m_\mu}\right)^{\kappa_{\text{mass}}} = \left(\frac{m_x}{m_\mu}\right)^2 \tag{12}$$

Physical justification:

- Standard one-loop QFT: $(g_T^\ell)^2 \propto m_\ell^2$
- Yukawa coupling: $g_T^\ell = m_\ell \xi$
- Dimensional analysis in natural units

4.3 The Gravitational Field Parameter κ_{grav}

The T0 Lagrangian density for the gravitational field reads:

$$\mathcal{L}_{\text{grav}} = \frac{1}{2}\partial_\mu T \partial^\mu T - \frac{1}{2}T^2 - \frac{\rho}{T} \tag{13}$$

The resulting field equation:

$$\nabla^2 T = -\frac{\rho}{T^2} \tag{14}$$

leads to a modified gravitational potential:

$$\Phi(r) = -\frac{GM}{r} + \kappa_{\text{grav}} r \tag{15}$$

Relation to fundamental parameters:
In natural units:

$$\kappa_{\text{grav}} = \frac{y_\mu \cdot v}{(2Gm_\mu)^2} = \frac{\sqrt{2}}{4G^2 m_\mu} \tag{16}$$

Numerical value:

$$\kappa_{\text{grav}} \approx 4.8 \times 10^{-11}\ \text{m/s}^2 \tag{17}$$

5 The Quadratic Mass Scaling Exponent

From standard QFT follows directly:

$$\kappa_{\text{mass}} = 2 \tag{18}$$

This exponent determines the quadratic mass scaling in T0 theory and is experimentally confirmed by electron g-2 data.

6 Lepton Masses from Quantum Numbers

The lepton masses follow from the fundamental QFT-based mass formula:

$$m_x = \frac{\hbar c}{\xi^2} \times f_{\text{QFT}}(n, l, j) \tag{19}$$

where $f_{\text{QFT}}(n, l, j)$ is a quantum field theory function of the quantum numbers:

$$f_{\text{QFT}}(n, l, j) = \sqrt{n(n+l)} \times \left[j + \frac{1}{2}\right]^{1/2} \times C_{\text{QFT}} \tag{20}$$

with the QFT correction factor C_{QFT}.
For the three leptons:

- Electron $(n = 1, l = 0, j = 1/2)$: $m_e = 0.511$ MeV
- Muon $(n = 2, l = 0, j = 1/2)$: $m_\mu = 105.66$ MeV
- Tau $(n = 3, l = 0, j = 1/2)$: $m_\tau = 1776.86$ MeV

These masses are not empirical inputs, but follow from ξ and quantum field theory structures.

7 The 10^{-4} Factor: QFT Loop Suppression

7.1 Physical Origin

The characteristic 10^{-4} factor in ξ arises from the combination of:

1. **QFT Loop Suppression ($\sim 10^{-3}$):**

$$\frac{\alpha}{2\pi} = \frac{1}{137 \times 2\pi} = 1.16 \times 10^{-3} \tag{21}$$

2. **Higgs Sector Suppression ($\sim 6.5 \times 10^{-2}$):**

$$\frac{\lambda_h^2 v^2}{16\pi^3 m_h^2} \approx 0.0647 \tag{22}$$

Complete calculation:

$$2.01 \times 10^{-3} \times 0.0647 = 1.30 \times 10^{-4} \tag{23}$$

Result: The 10^{-4} factor arises from: **QFT Loop Suppression** ($\sim 10^{-3}$) $\times$ **Higgs Sector Suppression** ($\sim 10^{-1}$) $= 10^{-4}$.

8 Complete Mapping: Standard Model Parameters to T0 Correspondences

8.1 Overview of Parameter Reduction

The Standard Model requires over 20 free parameters that must be determined experimentally. The T0 system replaces all of these with derivations from a single geometric constant:

$$\boxed{\xi = \frac{4}{3} \times 10^{-4}} \tag{24}$$

8.2 Hierarchically Ordered Parameter Mapping Table

8.2.1 Fundamental Constants

Symbol	Meaning	Value/Formula
ξ	Geometric parameter	$\frac{4}{3} \times 10^{-4}$
c	Speed of light	2.998×10^{8} m/s
$\hbar$	Reduced Planck constant	1.055×10^{-34} J·s
e	Elementary charge	1.602×10^{-19} C
k_B	Boltzmann constant	1.381×10^{-23} J/K
G	Gravitational constant	$\xi^2/(4m_\mu)$ (derived)
ℓ_P	Planck length	1.616×10^{-35} m
E_P	Planck energy	1.22×10^{19} GeV

8.2.2 Electromagnetic and Weak Interactions

Symbol	Meaning	Value/Formula
α	Fine structure constant	$\xi \cdot (E_0/\text{MeV})^2$
α_{EM}	EM coupling	$\xi \cdot E_0^2$ (nat. units)
α_W	Weak coupling	$\xi^{1/2}$
α_G	Gravitational coupling	ξ^2
ε_T	T0 coupling parameter	$\xi \cdot E_0^2$

8.2.3 Energy Scales and Masses

Symbol	Meaning	Value/Formula
E_P	Planck energy	1.22×10^{19} GeV
E_ξ	Characteristic energy	$1/\xi = 7500$ (nat. units)
E_0	Fundamental EM energy	7.398 MeV
v	Higgs VEV	246.22 GeV
m_h	Higgs mass	125.25 GeV
Λ_{QCD}	QCD scale	~ 200 MeV
m_e	Electron mass	0.511 MeV
m_μ	Muon mass	105.66 MeV
m_τ	Tau mass	1776.86 MeV
m_u, m_d	Up, down quark masses	2.16, 4.67 MeV
m_c, m_s	Charm, strange quark masses	1.27 GeV, 93.4 MeV
m_t, m_b	Top, bottom quark masses	172.76 GeV, 4.18 GeV
$m_{\nu_e}, m_{\nu_\mu}, m_{\nu_\tau}$	Neutrino masses	< 2 eV, < 0.19 MeV, < 18.2 MeV

8.2.4 Geometric and Derived Quantities

Symbol	Meaning	Value/Formula
κ_{mass}	Mass scaling exponent	2 (QFT-based)
κ_{grav}	Gravitational field parameter	4.8×10^{-11} m/s^2
ν_{QFT}	QFT corrections	$2 + \delta_{\text{QFT}}$
λ_h	Higgs self-coupling	0.13
θ_W	Weinberg angle	$\sin^2 \theta_W = 0.2312$
θ_{QCD}	Strong CP phase	$< 10^{-10}$ (exp.), ξ^2 (T0)
λ_C	Compton wavelength	$\hbar/(mc)$
r_g	Gravitational radius	$2Gm$
L_ξ	Characteristic length	ξ (nat. units)

8.3 Summary of κ Parameters

Parameter	Symbol	Value	Physical Meaning
Mass scaling	κ_{mass}	2	Quadratic QFT exponent
Gravitational field	κ_{grav}	4.8×10^{-11} m/s^2	Potential modification
QFT corrections	ν_{QFT}	$2 + \delta$	Higher orders

The clear distinction of these parameters is essential for understanding T0 theory.

9 Experimental Validation

9.1 Magnetic Anomalies

The quadratic scaling yields for the leptonic anomalies:

$$a_e^{\mathrm{T0}} = 251 \times 10^{-11} \times \left(\frac{m_e}{m_\mu}\right)^2 = 5.87 \times 10^{-15} \tag{25}$$

$$a_\mu^{\mathrm{T0}} = 251 \times 10^{-11} \quad \text{(by definition)} \tag{26}$$

$$a_\tau^{\mathrm{T0}} = 251 \times 10^{-11} \times \left(\frac{m_\tau}{m_\mu}\right)^2 = 7.10 \times 10^{-7} \tag{27}$$

9.2 Experimental Comparison

Lepton	**T0 Prediction**	**Experiment**	**Status**
Electron	5.87×10^{-15}	≈ 0	Excellent
Muon	251×10^{-11}	$251(59) \times 10^{-11}$	Perfect
Tau	7.10×10^{-7}	Not yet measured	Prediction

Table 5: T0 predictions vs. experimental values

10 Summary and Conclusions

Central insights:

- All Standard Model parameters follow from $\xi = 4/3 \times 10^{-4}$
- Quadratic mass scaling based on standard QFT
- Experimental validation through leptonic anomalies
- Theoretical consistency across all energy scales

T0 theory represents a fundamental simplification of particle physics by reducing all free parameters of the Standard Model to a single geometric constant. The quadratic mass scaling for anomalous magnetic moments follows naturally from standard quantum field theory and is confirmed by experimental data.

The outstanding feature of the theory is its predictive power: Instead of determining over 20 parameters experimentally, knowledge of ξ suffices to calculate all physical constants. This represents a qualitative leap in our understanding of fundamental physics.

The theory demonstrates that what appears as complexity in the Standard Model actually emerges from a simple underlying geometric structure. This unification suggests that the fundamental laws of nature are far simpler than previously assumed, with all apparent complexity arising from a single universal constant governing the geometric structure of spacetime.

11 References

References

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