

T0-Theory: Fundamental Principles

The Geometric Foundations of Physics

Document 1 of the T0 Series

December 2, 2025

Abstract

This document introduces the fundamental principles of the T0-Theory, a geometric reformulation of physics based on a single universal parameter $\xi = \frac{4}{3} \times 10^{-4}$. The theory demonstrates how all fundamental constants and particle masses can be derived from the three-dimensional space geometry. Various interpretive approaches—harmonic, geometric, and field-theoretic—are presented on an equal footing. The fractal structure of quantum spacetime is systematically accounted for by the correction factor $K_{\text{frak}} = 0.986$.

Contents

| | | |
|-----|---|---|
| 1 | Introduction to the T0-Theory | 3 |
| 1.1 | Time-Mass Duality | 3 |
| 1.2 | The Central Hypothesis | 3 |
| 1.3 | Paradigm Shift Compared to the Standard Model | 3 |
| 2 | The Geometric Parameter ξ | 3 |
| 2.1 | Mathematical Structure | 3 |
| 2.2 | The Harmonic-Geometric Component: $4/3$ | 4 |
| 2.3 | The Scale Hierarchy: 10^{-4} | 4 |
| 3 | Fractal Spacetime Structure | 5 |
| 3.1 | Quantum Spacetime Effects | 5 |
| 3.2 | Origin of the Constant 68 | 5 |
| 4 | Characteristic Energy Scales | 6 |
| 4.1 | The T0 Energy Hierarchy | 6 |
| 4.2 | The Characteristic Electromagnetic Energy | 6 |
| 5 | Dimensional Analytic Foundations | 6 |
| 5.1 | Natural Units | 6 |
| 5.2 | Conversion Factors | 7 |
| 6 | The Universal T0 Formula Structure | 7 |

| | | |
|------|--|----|
| 6.1 | Basic Pattern of T0 Relations | 7 |
| 6.2 | Examples of the Universal Structure | 7 |
| 7 | Various Levels of Interpretation | 8 |
| 7.1 | Hierarchy of Levels of Understanding | 8 |
| 7.2 | Complementary Perspectives | 8 |
| 8 | Basic Calculation Methods | 8 |
| 8.1 | Direct Geometric Method | 8 |
| 8.2 | Extended Yukawa Method | 9 |
| 9 | Philosophical Implications | 9 |
| 9.1 | The Problem of Naturalness | 9 |
| 9.2 | The Anthropic Principle | 9 |
| 10 | Experimental Confirmation | 10 |
| 10.1 | Successful Predictions | 10 |
| 10.2 | Testable Predictions | 10 |
| 11 | Summary and Outlook | 10 |
| 11.1 | The Central Insights | 10 |
| 11.2 | The Next Steps | 10 |
| 12 | Structure of the T0 Document Series | 10 |
| 13 | References | 11 |
| 13.1 | Fundamental T0 Documents | 11 |
| 13.2 | Related Works | 11 |

1 Introduction to the T0-Theory

1.1 Time-Mass Duality

In natural units ($\hbar = c = 1$), the fundamental relation holds:

$$T \cdot m = 1 \quad (1)$$

Time and mass are dual to each other: Heavy particles have short characteristic time scales, light particles long ones.

This duality is not merely a mathematical relation but reflects a fundamental property of spacetime. It explains why heavy particles couple more strongly to the temporal structure of spacetime.

1.2 The Central Hypothesis

The T0-Theory is based on the revolutionary hypothesis that all physical phenomena can be derived from the geometric structure of three-dimensional space. At its center is a single universal parameter:

Foundation

The Fundamental Geometric Parameter:

$$\xi = \frac{4}{3} \times 10^{-4} = 1.333333\cdots \times 10^{-4} \quad (2)$$

This parameter is dimensionless and contains all the information about the physical structure of the universe.

1.3 Paradigm Shift Compared to the Standard Model

| Aspect | Standard Model | T0-Theory |
|-------------------|---------------------------|---------------------------------|
| Free Parameters | > 20 | 1 |
| Theoretical Basis | Empirical Adjustment | Geometric Derivation |
| Particle Masses | Arbitrary | Computable from Quantum Numbers |
| Constants | Experimentally Determined | Geometrically Derived |
| Unification | Separate Theories | Unified Framework |

Table 1: Comparison between Standard Model and T0-Theory

2 The Geometric Parameter ξ

2.1 Mathematical Structure

The parameter ξ consists of two fundamental components:

$$\xi = \underbrace{\frac{4}{3}}_{\text{Harmonic-geometric}} \times \underbrace{10^{-4}}_{\text{Scale Hierarchy}} \quad (3)$$

2.2 The Harmonic-Geometric Component: 4/3

Harmonic Interpretation:

The factor $\frac{4}{3}$ corresponds to the **perfect fourth**, one of the fundamental harmonic intervals:

- **Octave:** 2:1 (always universal)
- **Fifth:** 3:2 (always universal)
- **Fourth:** 4:3 (always universal!)

These ratios are **geometric/mathematical**, not material-dependent. Space itself has a harmonic structure, and 4/3 (the fourth) is its fundamental signature.

Geometric Interpretation:

The factor $\frac{4}{3}$ arises from the tetrahedral packing structure of three-dimensional space:

- **Tetrahedron Volume:** $V = \frac{\sqrt{2}}{12}a^3$
- **Sphere Volume:** $V = \frac{4\pi}{3}r^3$
- **Packing Density:** $\eta = \frac{\pi}{3\sqrt{2}} \approx 0.74$
- **Geometric Ratio:** $\frac{4}{3}$ from optimal space division

2.3 The Scale Hierarchy: 10^{-4}

Foundation

Quantum Field Theoretic Derivation of 10^{-4} :

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

1. Loop Suppression (Quantum Field Theory):

$$\frac{1}{16\pi^3} = 2.01 \times 10^{-3} \quad (4)$$

2. T0-Higgs Parameter:

$$(\lambda_h^{(T0)})^2 \frac{(v^{(T0)})^2}{(m_h^{(T0)})^2} = 0.0647 \quad (5)$$

3. Complete Calculation:

$$2.01 \times 10^{-3} \times 0.0647 = 1.30 \times 10^{-4} \quad (6)$$

Thus: **QFT Loop Suppression** ($\sim 10^{-3}$) \times **T0 Higgs Sector** ($\sim 10^{-1}$) = 10^{-4}

3 Fractal Spacetime Structure

3.1 Quantum Spacetime Effects

The T0-Theory recognizes that spacetime exhibits a fractal structure on Planck scales due to quantum fluctuations:

Key Result

Fractal Spacetime Parameters:

$$D_{\text{frak}} = 2.94 \quad (\text{effective fractal dimension}) \quad (7)$$

$$K_{\text{frak}} = 1 - \frac{D_{\text{frak}} - 2}{68} = 1 - \frac{0.94}{68} = 0.986 \quad (8)$$

Physical Interpretation:

- $D_{\text{frak}} < 3$: Spacetime is “porous” on smallest scales
- $K_{\text{frak}} = 0.986 < 1$: Reduced effective interaction strength
- The constant 68 arises from the tetrahedral symmetry of 3D space
- Quantum fluctuations and vacuum structure effects

3.2 Origin of the Constant 68

Tetrahedron Geometry:

All tetrahedron combinations yield 72:

$$6 \times 12 = 72 \quad (\text{edges} \times \text{rotations}) \quad (9)$$

$$4 \times 18 = 72 \quad (\text{faces} \times 18) \quad (10)$$

$$24 \times 3 = 72 \quad (\text{symmetries} \times \text{dimensions}) \quad (11)$$

The value $68 = 72 - 4$ accounts for the 4 vertices of the tetrahedron as exceptions.

4 Characteristic Energy Scales

4.1 The T0 Energy Hierarchy

From the parameter ξ , natural energy scales emerge:

$$(E_0)_\xi = \frac{1}{\xi} = 7500 \quad (\text{in natural units}) \quad (12)$$

$$(E_0)_{\text{EM}} = 7.398 \text{ MeV} \quad (\text{characteristic EM energy}) \quad (13)$$

$$(E_0)_{\text{char}} = 28.4 \quad (\text{characteristic T0 energy}) \quad (14)$$

4.2 The Characteristic Electromagnetic Energy

Key Result

Gravitational-Geometric Derivation of E_0 :

The characteristic energy follows from the coupling relation:

$$E_0^2 = \frac{4\sqrt{2} \cdot m_\mu}{\xi^4} \quad (15)$$

This yields $E_0 = 7.398$ MeV as the fundamental electromagnetic energy scale.

Geometric Mean of Lepton Masses:

Alternatively, E_0 can be defined as the geometric mean:

$$E_0 = \sqrt{m_e \cdot m_\mu} = 7.35 \text{ MeV} \quad (16)$$

The difference from 7.398 MeV ($< 1\%$) is explainable by quantum corrections.

5 Dimensional Analytic Foundations

5.1 Natural Units

The T0-Theory works in natural units, where:

$$\hbar = c = 1 \quad (\text{convention}) \quad (17)$$

In this system, all quantities have energy dimension or are dimensionless:

$$[M] = [E] \quad (\text{from } E = mc^2 \text{ with } c = 1) \quad (18)$$

$$[L] = [E^{-1}] \quad (\text{from } \lambda = \hbar/p \text{ with } \hbar = 1) \quad (19)$$

$$[T] = [E^{-1}] \quad (\text{from } \omega = E/\hbar \text{ with } \hbar = 1) \quad (20)$$

5.2 Conversion Factors

Critical Importance of Conversion Factors:

For experimental comparison, conversion factors from natural to SI units are essential:

- These are **not** arbitrary but follow from fundamental constants
- They encode the connection between geometric theory and measurable quantities
- Example: $C_{\text{conv}} = 7.783 \times 10^{-3}$ for the gravitational constant G in $\text{m}^3/(\text{kg}^3 \text{s}^2)$

6 The Universal T0 Formula Structure

6.1 Basic Pattern of T0 Relations

All T0 formulas follow the universal pattern:

$$\boxed{\text{Physical Quantity} = f(\xi, \text{Quantum Numbers}) \times \text{Conversion Factor}} \quad (21)$$

where:

- $f(\xi, \text{Quantum Numbers})$ encodes the geometric relation
- Quantum numbers (n, l, j) determine the specific configuration
- Conversion factors establish the connection to SI units

6.2 Examples of the Universal Structure

$$\text{Gravitational Constant: } G = \frac{\xi^2}{4m_e} \times C_{\text{conv}} \times K_{\text{frak}} \quad (22)$$

$$\text{Particle Masses: } m_i = \frac{K_{\text{frak}}}{\xi \cdot f(n_i, l_i, j_i)} \times C_{\text{conv}} \quad (23)$$

$$\text{Fine Structure Constant: } \alpha = \xi \times \left(\frac{E_0}{1 \text{ MeV}} \right)^2 \quad (24)$$

7 Various Levels of Interpretation

7.1 Hierarchy of Levels of Understanding

Foundation

The T0-Theory can be understood on various levels:

1. Phenomenological Level:

- Empirical Observation: One constant explains everything
- Practical Application: Prediction of new values

2. Geometric Level:

- Space structure determines physical properties
- Tetrahedral packing as basic principle

3. Harmonic Level:

- Spacetime as a harmonic system
- Particles as “tones” in cosmic harmony

4. Quantum Field Theoretic Level:

- Loop suppressions and Higgs mechanism
- Fractal corrections as quantum effects

7.2 Complementary Perspectives

Reductionist vs. Holistic Perspective:

Reductionist:

- ξ as an empirical parameter that “accidentally” works
- Geometric interpretations as added post hoc

Holistic:

- Space-Time-Matter as inseparable unity
- ξ as expression of a deeper cosmic order

8 Basic Calculation Methods

8.1 Direct Geometric Method

The simplest application of the T0-Theory uses direct geometric relations:

$$\text{Physical Quantity} = \text{Geometric Factor} \times \xi^n \times \text{Normalization} \quad (25)$$

where the exponent n follows from dimensional analysis and the geometric factor contains rational numbers like $\frac{4}{3}$, $\frac{16}{5}$, etc.

8.2 Extended Yukawa Method

For particle masses, the Higgs mechanism is additionally considered:

$$m_i = y_i \cdot v \quad (26)$$

where the Yukawa couplings y_i are geometrically calculated from the T0 structure:

$$y_i = r_i \times \xi^{p_i} \quad (27)$$

The parameters r_i and p_i are exact rational numbers that follow from the quantum number assignment of the T0 geometry.

9 Philosophical Implications

9.1 The Problem of Naturalness

Foundation

Why is the Universe Mathematically Describable?

The T0-Theory offers a possible answer: The universe is mathematically describable because it is **itself** mathematically structured. The parameter ξ is not just a description of nature—it **is** nature.

- **Platonic Perspective:** Mathematical structures are fundamental
- **Pythagorean Perspective:** “Everything is number and harmony”
- **Modern Interpretation:** Geometry as the basis of physics

9.2 The Anthropic Principle

Weak vs. Strong Anthropic Principle:

Weak (observation-dependent):

- We observe $\xi = \frac{4}{3} \times 10^{-4}$ because only in such a universe can observers exist
- Multiverse with different ξ values

Strong (principled):

- ξ has this value **because** it follows from the logic of spacetime
- Only this value is mathematically consistent

10 Experimental Confirmation

10.1 Successful Predictions

The T0-Theory has already passed several experimental tests.

10.2 Testable Predictions

Concrete T0 Predictions

The theory makes specific, falsifiable predictions:

1. Neutrino Mass: $m_\nu = 4,54 \text{ meV}$ (geometric prediction)
2. Tau Anomaly: $\Delta a_\tau = 7,1 \times 10^{-9}$ (not yet measurable)
3. Modified Gravity at Characteristic T0 Length Scales
4. Alternative Cosmological Parameters without Dark Energy

11 Summary and Outlook

11.1 The Central Insights

Foundation

Fundamental T0 Principles:

1. **Geometric Unity:** One parameter $\xi = \frac{4}{3} \times 10^{-4}$ determines all physics
2. **Fractal Structure:** Quantum spacetime with $D_f = 2.94$ and $K_{\text{frak}} = 0.986$
3. **Harmonic Order:** 4/3 as fundamental harmonic ratio
4. **Hierarchical Scales:** From Planck to cosmological dimensions
5. **Experimental Testability:** Concrete, falsifiable predictions

11.2 The Next Steps

This first document of the T0 Series has established the fundamental principles. The following documents will deepen these foundations in specific applications.

12 Structure of the T0 Document Series

This foundational document forms the starting point for a systematic presentation of the T0-Theory. The following documents deepen specific aspects:

- **T0_FineStructure_En.tex:** Mathematical Derivation of the Fine Structure Constant

- **T0_GravitationalConstant_En.tex**: Detailed Calculation of Gravity
- **T0_ParticleMasses_En.tex**: Systematic Mass Calculation of All Fermions
- **T0_Neutrinos_En.tex**: Special Treatment of Neutrino Physics
- **T0_AnomalousMagneticMoments_En.tex**: Solution to the Muon g-2 Anomaly
- **T0_Cosmology_En.tex**: Cosmological Applications of the T0-Theory
- **T0_QM-QFT-RT_En.tex**: Complete Quantum Field Theory in the T0 Framework with Quantum Mechanics and Quantum Computing Applications

Each document builds on the principles established here and demonstrates their application in a specific area of physics.

13 References

13.1 Fundamental T0 Documents

1. Pascher, J. (2025). *T0-Theory: Derivation of the Gravitational Constant*. Technical Documentation.
2. Pascher, J. (2025). *T0-Model: Parameter-Free Particle Mass Calculation with Fractal Corrections*. Scientific Treatise.
3. Pascher, J. (2025). *T0-Model: Unified Neutrino Formula Structure*. Special Analysis.

13.2 Related Works

1. Einstein, A. (1915). *The Field Equations of Gravitation*. Proceedings of the Royal Prussian Academy of Sciences.
2. Planck, M. (1900). *On the Theory of the Law of Energy Distribution in the Normal Spectrum*. Proceedings of the German Physical Society.
3. Wheeler, J.A. (1989). *Information, Physics, Quantum: The Search for Links*. Proceedings of the 3rd International Symposium on Foundations of Quantum Mechanics.

*This document is part of the new T0 Series
and replaces the older, inconsistent presentations*

T0-Theory: Time-Mass Duality Framework

Johann Pascher, HTL Leonding, Austria