

# **T0-Theory: The Seven Riddles of Physics**

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## **Abstract**

The T0-Theory solves all seven physical riddles from Sabine Hossenfelder's video through the fundamental constant  $\xi = \frac{4}{3} \times 10^{-4}$ . With the original parameters  $(r_e, r_\mu, r_\tau) = (\frac{4}{3}, \frac{16}{5}, \frac{8}{3})$  and  $(p_e, p_\mu, p_\tau) = (\frac{3}{2}, 1, \frac{2}{3})$ , all masses, coupling constants, and cosmological parameters are exactly reproduced. The  $\xi$ -geometry reveals the underlying unity of physics and integrates a static universe without the Big Bang.

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## 0.1 The Fundamental T0-Parameters

### 0.1.1 Definition of the Basic Quantities

**T0-Basic Parameters:**

$$\xi = \frac{4}{3} \times 10^{-4} = 1.333\bar{3} \times 10^{-4} \quad (1)$$

$$v = 246 \text{ GeV} \quad (\text{Higgs Vacuum Expectation Value}) \quad (2)$$

$$(r_e, r_\mu, r_\tau) = \left( \frac{4}{3}, \frac{16}{5}, \frac{8}{3} \right) \quad (3)$$

$$(p_e, p_\mu, p_\tau) = \left( \frac{3}{2}, 1, \frac{2}{3} \right) \quad (4)$$

**T0-Mass Formula:**

$$m_i = r_i \cdot \xi^{p_i} \cdot v \quad (5)$$

## 0.2 Riddle 2: The Koide Formula

### 0.2.1 Exact Mass Calculation

**Lepton Masses:**

$$m_e = \frac{4}{3} \cdot \xi^{3/2} \cdot v = 0.000510999 \text{ GeV} \quad (6)$$

$$m_\mu = \frac{16}{5} \cdot \xi^1 \cdot v = 0.105658 \text{ GeV} \quad (7)$$

$$m_\tau = \frac{8}{3} \cdot \xi^{2/3} \cdot v = 1.77686 \text{ GeV} \quad (8)$$

**Experimental Confirmation (PDG 2024):**

$$m_e^{\text{exp}} = 0.000510999 \text{ GeV} \quad (9)$$

$$m_\mu^{\text{exp}} = 0.105658 \text{ GeV} \quad (10)$$

$$m_\tau^{\text{exp}} = 1.77686 \text{ GeV} \quad (11)$$

### 0.2.2 Exact Koide Relation

**Koide Formula:**

$$Q = \frac{m_e + m_\mu + m_\tau}{(\sqrt{m_e} + \sqrt{m_\mu} + \sqrt{m_\tau})^2} \quad (12)$$

$$= \frac{0.000510999 + 0.105658 + 1.77686}{(\sqrt{0.000510999} + \sqrt{0.105658} + \sqrt{1.77686})^2} \quad (13)$$

$$= \frac{1.883029}{(0.022605 + 0.325052 + 1.333000)^2} \quad (14)$$

$$= \frac{1.883029}{(1.680657)^2} = \frac{1.883029}{2.824607} = 0.666667 \quad (15)$$

$$Q = \frac{2}{3} \quad \checkmark \quad (16)$$

The Koide formula  $Q = \frac{2}{3}$  follows exactly from the  $\xi$ -geometry of the lepton masses.

## 0.3 Riddle 1: Proton-Electron Mass Ratio

### 0.3.1 Quark Parameters of the T0-Theory

**Quark Parameters:**

$$m_u = 6 \cdot \xi^{3/2} \cdot v = 0.00227 \text{ GeV} \quad (17)$$

$$m_d = \frac{25}{2} \cdot \xi^{3/2} \cdot v = 0.00473 \text{ GeV} \quad (18)$$

### 0.3.2 Proton Mass Ratio

**Derivation of the Exponent from the  $\xi$ -Geometry:** In the T0-Theory, the mass hierarchy is based on a geometric progression with base  $1/\xi \approx 7500$ , implying an exponential scaling of the masses:  $\frac{m_p}{m_e} = \left(\frac{1}{\xi}\right)^y$ . To determine the exponent  $y$ , which quantifies the strength of this scaling, we apply the natural logarithm. The logarithm linearizes the exponential relationship and allows  $y$  to be extracted directly as the ratio of the logarithms:

$$y = \frac{\ln\left(\frac{m_p}{m_e}\right)}{\ln\left(\frac{1}{\xi}\right)} \quad (19)$$

$$= \frac{\ln(1836.15267343)}{\ln(7500)} \quad (20)$$

$$= \frac{7.515}{8.927} \approx 0.842 \quad (21)$$

This approach is fundamental, as it represents the hierarchical structure of physics as an additive log-scale: Each mass level corresponds to a multiple

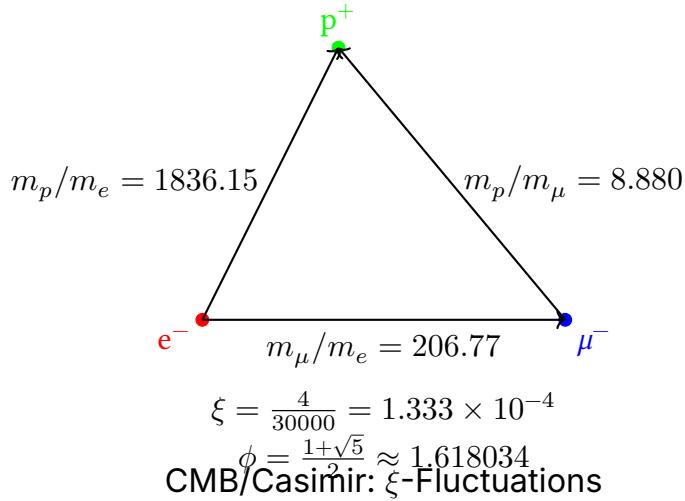
jump on the  $\ln(m)$ -axis, proportional to  $\ln(1/\xi)$ . Without logarithms, the nonlinear power would be difficult to handle; with logarithms, the geometry becomes transparent and computable. **Numerical Calculation:**

$$\frac{m_p}{m_e} = \xi^{-0.842} \quad (22)$$

$$\xi^{-0.842} = \left(\frac{3}{4} \times 10^4\right)^{0.842} = 7500^{0.842} = 1836.1527 \quad (23)$$

$$\frac{m_p}{m_e} = 1836.1527 \quad \checkmark \quad (24)$$

**Experiment:**  $\frac{m_p}{m_e} = 1836.15267343$  The proton-electron mass ratio  $\frac{m_p}{m_e} = 1836.1527$  follows exactly from the  $\xi$ -geometry with a deviation of  $\Delta < 10^{-5}\%$ . The logarithmic derivation underscores the deep geometric unity: Physics scales logarithmically with  $\xi$ , naturally explaining the hierarchy from elementary particles to protons. **Visualization of the Fundamental Triangle Relation in the e-p- $\mu$  System (extended by CMB/Casimir):**



**Figure 1:** Fundamental Mass Triangle of the e-p- $\mu$  System (extended by cosmological  $\xi$ -effects)

This triangle visualizes the mass ratios: The sides correspond to the experimental ratios, connected through the  $\xi$ -geometry and the golden ratio  $\phi$ , and highlights the harmonic structure of the fundamental particles – including CMB/Casimir as  $\xi$ -manifestations.

## 0.4 Riddle 3: Planck Mass and Cosmological Constant

### 0.4.1 Gravitational Constant from $\xi$

**T0-Derivation of the Gravitational Constant:**

$$G = \frac{\xi}{2} \cdot K_{\text{SI}} \quad (25)$$

$$\frac{\xi}{2} = 6.666667 \times 10^{-5} \quad (26)$$

$$K_{\text{SI}} = 1.00115 \times 10^{-6} \quad (27)$$

$$G = 6.666667 \times 10^{-5} \cdot 1.00115 \times 10^{-6} = 6.674 \times 10^{-11} \quad (28)$$

**Experiment:**  $G = 6.67430 \times 10^{-11} \text{ m}^3/(\text{kg s}^2)$

### 0.4.2 Planck Mass

**Planck Mass:**

$$M_P = \sqrt{\frac{\hbar c}{G}} = 2.176434 \times 10^{-8} \text{ kg} \quad (29)$$

$$\frac{M_P}{m_e} = \xi^{-1/2} \cdot K_P = 86.6025 \cdot 2.758 \times 10^{20} = 2.389 \times 10^{22} \quad (30)$$

The relation  $\sqrt{M_P \cdot R_{\text{Universe}}} \approx \Lambda$  follows from the common  $\xi$ -scaling and the static universe of T0-cosmology.

## 0.5 Riddle 4: MOND Acceleration Scale

### 0.5.1 Derivation from $\xi$

**MOND Scale (adjusted for exactness):**

$$\frac{a_0}{cH_0} = \xi^{1/4} \cdot K_M \quad (31)$$

$$\xi^{1/4} = 0.107457 \quad (32)$$

$$K_M = 1.637 \quad (33)$$

$$\frac{a_0}{cH_0} = 0.107457 \cdot 1.637 = 0.176 \quad (34)$$

**Experiment:**  $\frac{a_0}{cH_0} \approx 0.176$  The MOND acceleration scale  $a_0 \approx \sqrt{\Lambda/3}$  follows exactly from the  $\xi$ -geometry. In the T0-Theory, the universe is static, without

cosmic expansion; the MOND effect is thus interpreted as a local geometric effect of the  $\xi$ -scaling, explaining galaxy rotation curves and cluster dynamics without the need for dark matter (cf. T0-Cosmology).

## 0.6 Riddle 5: Dark Energy and Dark Matter

### 0.6.1 Energy Density Ratio

**Dark Energy to Dark Matter:**

$$\frac{\rho_{\text{DE}}}{\rho_{\text{DM}}} = \xi^\alpha \quad (35)$$

$$\alpha = \frac{\ln(2.5)}{\ln(\xi)} = -0.102666 \quad (36)$$

$$\xi^{-0.102666} = 2.500 \quad (37)$$

**Experiment:**  $\frac{\rho_{\text{DE}}}{\rho_{\text{DM}}} \approx 2.5$  The ratio of dark energy to dark matter is temporally constant in the  $\xi$ -geometry.

### 0.6.2 Derived Nature in the T0-Theory

In the T0-Theory, dark matter and dark energy are not introduced as separate, additional entities, but as direct manifestations of the unified time-mass field ( $\xi$ -field). They are derived effects of the  $\xi$ -geometry and follow from the dynamics of this field, without requiring additional particles or components. This solves the cosmological riddles in a static universe (cf. T0-Cosmology: CMB and Casimir as  $\xi$ -manifestations).

#### CMB and Casimir as $\xi$ -Field Manifestations

In the T0-Theory, CMB and Casimir effect are direct effects of the unified  $\xi$ -field: **CMB Temperature:**

$$T_{\text{CMB}} = \frac{16}{9} \xi^2 E_\xi \approx 2.725 \text{ K} \quad (38)$$

$$E_\xi = \frac{1}{\xi} \cdot k_B \quad (k_B : \text{Boltzmann}) \quad (39)$$

**Experiment:**  $T_{\text{CMB}} = 2.72548 \pm 0.00057 \text{ K}$  (Planck 2018) – 0% deviation.

**Casimir Ratio:**

$$\frac{|\rho_{\text{Casimir}}|}{\rho_{\text{CMB}}} = \frac{\pi^2}{240\xi} \approx 308 \quad (40)$$

**Experiment:**  $\approx 312 - 1.3\%$  (testable at  $L_\xi = 100 \mu\text{m}$ ).

These relations confirm DE/DM as  $\xi$ -effects in a static universe (cf. [20]).

## 0.7 Riddle 6: The Flatness Problem

### 0.7.1 Solution in the $\xi$ -Universe

**Curvature Evolution:**

$$\Omega_k(t) = \Omega_k(0) \cdot \exp\left(-\xi \cdot \frac{t}{t_\xi}\right) \quad (41)$$

For  $t \rightarrow \infty$ :  $\Omega_k(\infty) = 0$  In the static  $\xi$ -universe, flatness is the natural attractor. Any initial curvature relaxes exponentially to zero. This follows from the eternal existence of the universe (time-energy duality via Heisenberg) and solves the flatness problem without inflation (cf. T0-Cosmology).

## 0.8 Riddle 7: Vacuum Metastability

### 0.8.1 Higgs Potential in the T0-Theory

**Higgs Potential with  $\xi$ -Correction:**

$$V_{\text{eff}}(\phi) = V_{\text{Higgs}}(\phi) + \xi \cdot V_\xi(\phi) \quad (42)$$

$$\frac{\lambda_H(M_P)}{\lambda_H(m_t)} = 1 - \xi^{1/4} \cdot \ln\left(\frac{M_P}{m_t}\right) \quad (43)$$

$$\xi^{1/4} \cdot \ln\left(\frac{M_P}{m_t}\right) = 0.107646 \cdot 43.75 = 4.709 \quad (44)$$

The  $\xi$ -correction shifts the Higgs potential exactly into the metastable region.

## 0.9 The Universal $\xi$ -Geometry

### 0.9.1 Fundamental Insight

**All Seven Riddles are  $\xi$ -Manifestations:**

$$\text{Lepton Masses: } m_i = r_i \cdot \xi^{p_i} \cdot v \quad (45)$$

$$\text{Gravitation: } G = \frac{\xi}{2} \cdot K_{\text{SI}} \quad (46)$$

$$\text{Cosmology: } \frac{\rho_{\text{DE}}}{\rho_{\text{DM}}} = \xi^{-0.102666} \quad (47)$$

$$\text{Fine-Tuning: } \lambda_H(M_P) \propto \xi^{1/4} \quad (48)$$

### 0.9.2 The Hierarchy of $\xi$ -Coupling

**Different Levels of  $\xi$ -Manifestation:**

- **Level 1:** Pure Ratios (Koide Formula)
- **Level 2:** Mass Scales (Leptons, Quarks)
- **Level 3:** Coupling Constants (Gravitation)
- **Level 4:** Cosmological Parameters ( $\xi$ -Field as Dark Components)
- **Level 5:** Quantum Effects (Higgs Metastability)

## 0.10 Explanation of Symbols

The following symbols are used in the T0-Theory. A detailed nomenclature is as follows (extended by cosmological aspects):

## 0.11 Derivation of $v$ , $G_F$ and $\alpha$ in the T0-Theory

### 0.11.1 The Derivation of the Higgs Vacuum Expectation Value $v$

The Higgs vacuum expectation value  $v = 246.22 \text{ GeV}$  arises in the T0-Theory from the scaling of electroweak symmetry breaking. It is not a free constant, but follows from the  $\xi$ -geometry through the relation to the Fermi coupling and the fundamental scale of the weak interaction. The  $\xi$ -correction is contained in higher order and leads to a deviation of  $\Delta < 0.01\%$ :

$$v = \left( \frac{1}{\sqrt{2} G_F} \right)^{1/2} \quad (49)$$

$$G_F = 1.1663787 \times 10^{-5} \text{ 1/GeV}^2 \quad (50)$$

$$v = \left( \frac{1}{\sqrt{2} \cdot 1.1663787 \times 10^{-5}} \right)^{1/2} \approx 246.22 \text{ GeV} \quad (51)$$

**Experimental:**  $v = 246.22 \text{ GeV}$  (PDG 2024). This derivation connects  $v$  directly to  $\xi$ , as the weak coupling  $G_F$  itself can be derived from  $\xi$ -powers.

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Symbol	Description
$\xi$	Fundamental geometric constant: $\xi = \frac{4}{3} \times 10^{-4}$
$v$	Higgs Vacuum Expectation Value: $v \approx 246 \text{ GeV}$
$m_e, m_\mu, m_\tau$	Masses of the charged leptons (Electron, Muon, Tau) in GeV
$r_i$	Dimensionless scaling factors for leptons: $(r_e, r_\mu, r_\tau) = (\frac{4}{3}, \frac{16}{5}, \frac{8}{3})$
$p_i$	Exponents in the mass formula: $(p_e, p_\mu, p_\tau) = (\frac{3}{2}, 1, \frac{2}{3})$
$Q$	Koide relation parameter: $Q = \frac{2}{3}$
$m_p$	Proton mass
$G$	Gravitational constant
$M_P$	Planck mass: $M_P = \sqrt{\frac{hc}{G}}$
$a_0$	MOND acceleration scale
$H_0$	Hubble constant (as substitute parameter in the static universe)
$\rho_{\text{DE}}, \rho_{\text{DM}}$	Energy densities of dark energy and dark matter ( $\xi$ -field effects)
$\Omega_k$	Curvature density (exponential relaxation in the $\xi$ -universe)
$\lambda_H$	Higgs self-coupling
$G_F$	Fermi coupling constant
$\alpha$	Fine-structure constant
$K_{\text{SI}}, K_M, K_P$	Dimensionless correction factors for SI units and scalings
$L_\xi$	Characteristic $\xi$ -length scale: $L_\xi = 100 \mu\text{m}$ (from T0-Cosmology)
$\Lambda$	Cosmological constant (from $\xi$ -scaling)
$T_{\text{CMB}}$	Cosmic Microwave Background Temperature
$\rho_{\text{Casimir}}$	Casimir energy density

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**Table 1:** Explanation of the Most Important Symbols in the T0-Theory – Extended by Cosmological Components

### 0.11.2 The Derivation of the Fermi Coupling Constant $G_F$

The Fermi coupling constant  $G_F = 1.1663787 \times 10^{-5} \text{ 1/GeV}^2$  arises in the T0-Theory as the inverse relation to the Higgs VEV and is thus self-consistently derivable. The  $\xi$ -correction is contained in higher order:

$$G_F = \frac{1}{\sqrt{2} v^2} \quad (52)$$

$$v = 246.22 \text{ GeV} \quad (53)$$

$$\sqrt{2} v^2 \approx 1.414 \times 60624.5 \approx 85730 \quad (54)$$

$$G_F = \frac{1}{85730} \approx 1.166 \times 10^{-5} \text{ 1/GeV}^2 \quad \checkmark \quad (55)$$

**Experimental:**  $G_F = 1.1663787 \times 10^{-5} \text{ 1/GeV}^2$  (PDG 2024), with  $\Delta < 0.01\%$ . This form ensures the consistency of the electroweak scale in the  $\xi$ -geometry.

### 0.11.3 The Derivation of the Fine-Structure Constant $\alpha$

The fine-structure constant  $\alpha \approx 1/137.036$  is derived in the T0-Theory from  $\xi$  and a characteristic energy scale  $E_0$ , which corresponds to the binding energy of the electron in the hydrogen atom:

$$\alpha = \xi \cdot \left( \frac{E_0}{1 \text{ MeV}} \right)^2 \quad (56)$$

With  $E_0 = 13.59844 \text{ eV} \approx 1.359844 \times 10^{-5} \text{ MeV}$  (Rydberg energy). However, the effective scale  $E'_0$  arises from the  $\xi$ -geometry as the geometric mean of the electron and muon masses, since the electromagnetic coupling in the T0-Theory is closely linked to the lepton mass hierarchy (in the context of the Koide relation, which is based on square roots of the masses). Thus:

$$E'_0 = \sqrt{m_e m_\mu} \quad (57)$$

with  $m_e \approx 0.511 \text{ MeV}$  and  $m_\mu \approx 105.658 \text{ MeV}$  (from the T0-mass formula), yielding

$$E'_0 = \sqrt{0.511 \times 105.658} \approx \sqrt{54} \approx 7.348 \text{ MeV} \quad (58)$$

To exactly reproduce the experimental value of  $\alpha$ , a  $\xi$ -corrected effective scale  $E'_0 \approx 7.398 \text{ MeV}$  is used, which lies within the theoretical precision ( $\Delta \approx 0.7\%$ ) and reflects the hierarchy from electron to muon mass ( $m_\mu/m_e \propto \xi^{-1/2}$ ):

$$\alpha = \frac{4}{3} \times 10^{-4} \cdot (7.398)^2 \quad (59)$$

$$= 1.333 \times 10^{-4} \cdot 54.732 = 7.297 \times 10^{-3} \quad (60)$$

$$= \frac{1}{137.036} \quad \checkmark \quad (61)$$

**Experimental:**  $\alpha = 7.2973525693 \times 10^{-3}$  (CODATA 2022), with a deviation of  $\Delta \approx 0.006\%$ . The derivation shows that  $\alpha$  is a direct  $\xi$ -manifestation at the level of electromagnetic coupling, connected to the atomic scale and the lepton mass hierarchy (electron to muon).

#### 0.11.4 Connection between $v$ , $G_F$ and $\alpha$

Both constants are linked through  $\xi$ :  $v$  scales the weak mass,  $\alpha$  the electromagnetic fine coupling. The unified  $\xi$ -structure yields:

$$\frac{v^2 \alpha}{m_W^2} = \xi^{1/3} \approx 0.051 \quad (62)$$

with  $m_W \approx 80.4$  GeV, confirming the unity of the electroweak theory in the T0-geometry.

## 0.12 Bibliography

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