Parameter System-Dependency in T0-Model:

SI vs. Natural Units and the Danger
of Direct Transfer of Formula Symbols Johann Pascher
Department of Communications Engineering,
Höhere Technische Bundeslehranstalt (HTL), Leonding, Austria
johann.pascher@gmail.com December 23, 2025

Abstract

This paper systematically analyzes the parameter dependency between SI units and T0-model natural units, revealing that fundamental parameters like ξ, α_{EM}, β_{T}, and Yukawa couplings have dramatically different numerical values in different unit systems. Through detailed calculations, we demonstrate that direct transfer of parameter values between systems leads to errors spanning multiple orders of magnitude. The analysis extends beyond specific parameters to establish universal transformation rules and provides critical warnings against naive parameter transfer. This work establishes that the apparent inconsistencies in T0-model parameters are actually systematic unit-system dependencies that require careful transformation protocols for experimental verification.

Contents

0.1   Introduction

0.1.1   The Parameter Transfer Problem

The T0 model, formulated in natural units where $\hbar = c = G = k_B = \alpha_{\mathrm{EM}} = \alpha_{\mathrm{W}} = \beta_{\mathrm{T}} = 1$, presents a fundamental challenge when compared with experimental data expressed in SI units. This paper demonstrates that the apparent inconsistencies between T0-model predictions and experimental observations are not physical contradictions but systematic unit-system dependencies.

The core insight is that parameters such as ξ, α_{EM}, and β_{T} represent fundamentally different quantities when expressed in different unit systems:

$$\xi_{\mathrm{SI}} \neq \xi_{\mathrm{nat}}, \quad \alpha_{\mathrm{EM,SI}} \neq \alpha_{\mathrm{EM,nat}}, \quad \beta_{T,\mathrm{SI}} \neq \beta_{T,\mathrm{nat}}$$

0.1.2   Scope and Methodology

This analysis covers:

- Systematic calculation of parameter ratios between SI and T0-natural units

- Demonstration of transformation invariance for dimensionless ratios

- Extension to variable parameters like ξ and Yukawa couplings

- Universal warnings against direct parameter transfer

- Guidelines for correct experimental comparison protocols

0.2   The ξ Parameter: Variable Across Mass Scales

0.3   The Universal ξ-Field Framework

The cornerstone of the T0-model is the universal geometric constant that serves as the fundamental parameter for all physical calculations.

The universal geometric constant:

$$\xi = \frac{4}{3} \times 10^{-4} = 1.3333... \times 10^{-4} \tag{1}$$

This dimensionless constant is used throughout T0 theory to connect quantum mechanical and gravitational phenomena. It establishes the characteristic strength of field interactions and provides the foundation for unified field descriptions.

For the detailed derivation and physical justification of this parameter, see the document "Parameter Derivation" (available at: https://github.com/jpascher/T0-Time-Mass-Duality/2/pdf/parameterherleitung_En.pdf).

This geometric constant determines a characteristic energy scale for the ξ-field:

$$E_\xi = \frac{1}{\xi} = \frac{3}{4 \times 10^{-4}} = 7500 \text{ (natural units)} \tag{2}$$

0.3.1 Definition and Physical Meaning

The parameter ξ is also the ratio of the Schwarzschild radius to the Planck length:

$$\xi = \frac{r_0}{\ell_{\mathrm{P}}} = \frac{2Gm}{\ell_{\mathrm{P}}} \tag{3}$$

Crucial: The parameter ξ scales with the mass of the object under consideration according to $\xi(m) = 2Gm/\ell_{\mathrm{P}}$. The Higgs mass defines the fundamental reference scale $\xi_0 = 1.33 \times 10^{-4}$, to which all other masses are normalized in the T0 model.

0.3.2 Connection to Higgs Physics

The T0 model establishes a fundamental connection between ξ and Higgs sector physics through the relationship derived in the complete field-theoretic framework

$$\xi = \frac{\lambda_h^2 v^2}{16\pi^3 m_h^2} \approx 1.33 \times 10^{-4} \tag{4}$$

where:

- $\lambda_h \approx 0.13$ (Higgs self-coupling)

- $v \approx 246$ GeV (Higgs VEV)

- $m_h \approx 125$ GeV (Higgs mass)

This represents the universal scale parameter that emerges from fundamental Standard Model physics, while the mass-dependent form $\xi = 2Gm/\ell_{\mathrm{P}}$ applies to specific objects.

0.3.3 ξ Values in the SI System

Using SI constants:

$$G = 6.674 \times 10^{-11} \text{ m}^3/(\text{kg} \cdot \text{s}^2) \tag{5}$$
$$\ell_{\mathrm{P}} = 1.616 \times 10^{-35} \text{ m} \tag{6}$$

We calculate ξ_{SI} for various objects:
The parameter ξ varies over 46 orders of magnitude!

Object	Mass	ξ_{SI}
Electron	9.109×10^{-31} kg	7.52×10^{-7}
Proton	1.673×10^{-27} kg	1.38×10^{-3}
Human (70 kg)	7.0×10^{1} kg	6.4×10^{6}
Earth	5.972×10^{24} kg	4.1×10^{28}
Sun	1.989×10^{30} kg	1.8×10^{38}
Planck mass	2.176×10^{-8} kg	2.0

Table 1: ξ values for different objects in SI units

0.3.4 ξ Transformation to T0-Natural Units

Based on the comprehensive transformation analysis, the conversion factor between systems is approximately:

$$\frac{\xi_{\text{nat}}}{\xi_{\text{SI}}} \approx 4100$$

This gives T0-natural unit values:

Object	ξ_{SI}	ξ_{nat}
Electron	7.52×10^{-7}	3.1×10^{-3}
Proton	1.38×10^{-3}	5.7
Human (70 kg)	6.4×10^{6}	2.6×10^{10}
Sun	1.8×10^{38}	7.4×10^{41}

Table 2: ξ transformation between unit systems

0.3.5 Invariance of Ratios

Critical verification: The ratios between different objects remain identical in both systems:

$$\frac{\xi_{\text{Sun,SI}}}{\xi_{\text{e,SI}}} = \frac{1.8 \times 10^{38}}{7.52 \times 10^{-7}} = 2.4 \times 10^{44} \tag{7}$$

$$\frac{\xi_{\text{Sun,nat}}}{\xi_{\text{e,nat}}} = \frac{7.4 \times 10^{41}}{3.1 \times 10^{-3}} = 2.4 \times 10^{44} \tag{8}$$

Ratios are invariant under system transformation!

0.4 The Fine-Structure Constant α_{EM}

0.4.1 The Mystification of 1/137

The fine-structure constant $\alpha_{\text{EM}} \approx 1/137$ has been declared one of the greatest mysteries of physics by prominent physicists:

- **Richard Feynman**: "It is one of the greatest damn mysteries of physics: a magic number that comes to us with no understanding whatsoever."

- **Wolfgang Pauli**: "When I die, I will ask God two questions: Why relativity? And why 137? I believe he will have an answer for the first one."

- **Max Born**: "If α were larger, molecules could not exist, and there would be no life."

0.4.2   Electromagnetic Duality as the Key

What all these statements overlook: The fine-structure constant possesses two mathematically equivalent representations that reveal its true nature:

$$\alpha_{\text{EM}} = \frac{e^2}{4\pi\varepsilon_0\hbar c} \quad \text{(Standard form)} \tag{9}$$

$$\alpha_{\text{EM}} = \frac{e^2\mu_0 c}{4\pi\hbar} \quad \text{(Dual form)} \tag{10}$$

This equivalence is based on the Maxwell relation $c^2 = \frac{1}{\varepsilon_0\mu_0}$ and reveals a fundamental electromagnetic duality:

$$\frac{1}{\varepsilon_0 c} = \mu_0 c \tag{11}$$

0.4.3   The Dual Nature of α: System-Dependent yet Invariant

The fine-structure constant possesses a remarkable dual nature:

As an Invariant Ratio of Physical Quantities

Regardless of the chosen system of units, α remains constant as a **ratio** of fundamental lengths:

$$\alpha_{\text{EM}} = \frac{r_e}{\lambda_C} = \frac{\text{Classical electron radius}}{\text{Compton wavelength}} \tag{12}$$

Similarly, the inverse ratio:

$$\alpha_{\text{EM}}^{-1} = \frac{a_0}{\lambda_C/2\pi} = \frac{\text{Bohr radius}}{\text{Reduced Compton wavelength}} = 137.036... \tag{13}$$

These ratios are **system-of-units invariant** – they have the same numerical value in any consistent system of units, as the units cancel out in the ratio.

As a System-Dependent Numerical Value

Simultaneously, the numerical value of α depends on the choice of fundamental units:

- **SI system**: $\alpha = \frac{e^2}{4\pi\varepsilon_0\hbar c} \approx 1/137$

- **Natural units**: $\alpha = 1$ (by suitable choice)

- **Gaussian units**: $\alpha = \frac{e^2}{\hbar c} \approx 1/137$

0.4.4   The System Dependency of α

The numerical value $\alpha_{\text{EM}} = 1/137$ is **valid exclusively in the SI system**:

$$\text{SI system:} \quad \alpha_{\text{EM}}^{\text{SI}} = \frac{e^2}{4\pi\varepsilon_0\hbar c} \approx \frac{1}{137.036} \tag{14}$$

$$\text{Natural system of units:} \quad \alpha_{\text{EM}}^{\text{nat}} = 1 \text{ (by suitable choice of units)} \tag{15}$$

Transformation factor:

$$\frac{\alpha_{\text{EM}}^{\text{nat}}}{\alpha_{\text{EM}}^{\text{SI}}} = 137.036 \tag{16}$$

0.4.5   The Natural System of Units with $\alpha = 1$

In a natural system of units that respects electromagnetic duality, we obtain:

- $\hbar_{\text{nat}} = 1$ (quantum mechanical scale)

- $c_{\text{nat}} = 1$ (relativistic scale)

- $\varepsilon_{0,\text{nat}} = 1$ (electric constant)

- $\mu_{0,\text{nat}} = 1$ (magnetic constant)

- $e_{\text{nat}}^2 = 4\pi$ (elementary charge)

With these values, $\alpha = 1$ is verified in both the standard form and the dual form:

$$\alpha = \frac{4\pi}{4\pi \cdot 1 \cdot 1 \cdot 1} = 1 \tag{17}$$

0.4.6   The Resolution of the "Mystery"

The apparent mystification of $1/137$ arises from:

1. **Confusion of two aspects**: The invariance of the ratios is conflated with the system-dependency of the numerical representation.

2. **Treatment of the SI system as absolute**: The historically evolved SI units (meter, second, kilogram, ampere) force electromagnetic constants to take "unnatural" values.

3. **Forgetting the construction of unit systems**: All unit systems are human constructs. Nature knows no preferred units.

4. **Search for deeper meaning in conversion factors**: The number 137 has no deeper cosmic significance than, say, the factor 1609.344 between miles and meters.

0.4.7   The Anthropic Fallacy

Typical anthropic arguments claim:

- "If $\alpha_{\text{EM}} = 1/200 \to$ no atoms $\to$ no life"

- "If $\alpha_{\text{EM}} = 1/80 \to$ no stars $\to$ no life"

- "Therefore, $\alpha_{\text{EM}} = 1/137$ is 'fine-tuned' for life"

The problem: These arguments presuppose the SI system as absolute!

In natural units: $\alpha_{\text{EM}} = 1$ is perfectly natural and requires no fine-tuning whatsoever. The electromagnetic interaction has unit strength in the natural system of units, which respects the fundamental structure of quantum mechanics and relativity.

0.4.8   Sommerfeld's Harmonic Imprinting

An often overlooked historical aspect: In 1916, Arnold Sommerfeld actively searched for **harmonic ratios** in atomic spectra, guided by the philosophical conviction that nature follows musical principles.

His methodological approach:

1. **Expectation** of musical ratios in quantum transitions

2. **Calibration** of measurement systems to produce harmonic values

3. **Definition** of α_{EM} based on harmonic spectroscopic adjustments

4. **Attribution** of the resulting ratio to fundamental physics

The apparent "harmony" in $\alpha_{\text{EM}}^{-1} = 137 \approx (6/5)^{27}$ is therefore not a cosmic discovery, but the result of Sommerfeld's harmonic expectations embedded into the definition of the unit system.

0.4.9   Physical Interpretation

In natural units, $\alpha = 1$ represents the perfect balance between:

- **Electric field coupling** (via ε_0 with c^{-1})

- **Magnetic field coupling** (via μ_0 with c^{+1})

- **Quantum mechanical scale** (via $\hbar$)

- **Relativistic scale** (via c)

The electromagnetic duality $\frac{1}{\varepsilon_0 c} = \mu_0 c$ ensures this perfect balance.

0.4.10 Summary: The True Lesson

The fine-structure constant teaches us a profound lesson about the nature of physical laws:

The fundamental relationships of the universe are elegant and simple when expressed in their natural language.

The apparent complexity and mystery of "1/137" are merely artifacts of our historical decision to measure electromagnetic phenomena with units originally defined for mechanical quantities.

The "fine-tuning problem" completely dissolves once we recognize:

- $\alpha = 1/137$ is not a fundamental number, but a unit conversion factor

- $\alpha = 1$ represents the natural strength of the electromagnetic coupling

- The apparent "mystery" arises from treating arbitrary SI units as absolute

- The fundamental relationships of nature are simple in their natural language

0.4.11 Historical Warning: The Eddington Saga

Arthur Eddington (1882-1944) attempted to "prove" $\alpha_{\text{EM}} = 1/137$ from first principles and developed elaborate numerological theories. The result was entirely speculative and wrong – a warning against mystifying system-dependent numbers.

However, modern analysis shows that the fine-structure constant is indeed derivable from fundamental electromagnetic vacuum constants and that $\alpha_{\text{EM}} = 1$ in natural units is not only possible but reveals the arbitrary nature of our choice of unit system.

0.5 The β_{T} Parameter

0.5.1 Empirical vs. Theoretical Values

The β_{T} parameter shows the same system dependency:

$$\beta_{T,\text{SI}} \approx 0.008 \text{ (from astrophysical observations)} \tag{18}$$
$$\beta_{T,\text{nat}} = 1 \text{ (in T0-natural units)} \tag{19}$$

Transformation factor:

$$\frac{\beta_{T,\text{nat}}}{\beta_{T,\text{SI}}} = \frac{1}{0.008} = 125$$

0.5.2 Theoretical Foundation from Field Theory

The T0 model establishes $\beta_{\text{T}} = 1$ through the fundamental field-theoretic relationship [**?**]:

$$\beta_{\text{T}} = \frac{\lambda_h^2 v^2}{16\pi^3 m_h^2 \xi} = 1 \tag{20}$$

This relationship, combined with the Higgs-derived value of ξ, uniquely determines $\beta_{\text{T}} = 1$ in natural units, eliminating any free parameters from the theory.

0.5.3   Circularity in SI Determination

The SI value $\beta_{T,\text{SI}}$ is determined through:

$$z(\lambda) = z_0 \left(1 + \beta_\text{T} \ln \frac{\lambda}{\lambda_0} \right)$$

But this involves:

- Hubble constant $H_0 \rightarrow$ distance measurements

- Distance ladder $\rightarrow$ standard candles

- Photometry $\rightarrow$ Planck radiation law $\rightarrow$ fundamental constants

The determination is circular through cosmological parameters!

0.6   The Wien Constant α_W

0.6.1   Mathematical vs. Conventional Values

Wien's displacement law gives:

$$\text{SI system:} \quad \alpha_W^\text{SI} = 2.8977719... \tag{21}$$
$$\text{T0 system:} \quad \alpha_W^\text{nat} = 1 \tag{22}$$

Transformation factor:
$$\frac{\alpha_W^\text{SI}}{\alpha_W^\text{nat}} = 2.898$$

0.7   Parameter Comparison Table

Parameter	SI Value	T0-nat Value	Ratio	Factor
ξ (electron)	7.5×10^{-6}	3.1×10^{-2}	4100	$10^{3.6}$
α_EM	7.3×10^{-3}	1	137	$10^{2.1}$
β_T	0.008	1	125	$10^{2.1}$
α_W	2.898	1	2.9	$10^{0.5}$

Table 3: Systematic parameter differences between unit systems

All parameters show 0.5-4 orders of magnitude difference between systems!

0.8   Yukawa Parameters: Variable and System-Dependent

0.8.1   The Hierarchy of Yukawa Couplings

In the Standard Model, Yukawa couplings vary dramatically:

Particle	y_i (SI system)
Electron	2.94×10^{-6}
Muon	6.09×10^{-4}
Tau	1.03×10^{-2}
Up quark	1.27×10^{-5}
Top quark	1.00
Bottom quark	2.25×10^{-2}

Table 4: Yukawa coupling hierarchy (5 orders of magnitude variation)

0.8.2 Transformation Uncertainty

The transformation of Yukawa parameters between systems requires careful consideration of the Higgs mechanism. The general form would be:

$$y_{i,\text{nat}} = y_{i,\text{SI}} \times T_{\text{Yukawa}}$$

where T_{Yukawa} depends on the transformation of Higgs vacuum expectation value and particle masses.

0.8.3 Consistency Requirements

The Higgs mechanism requires:

$$m_h^2 = \frac{\lambda_h v^2}{2}$$

For transformation consistency:

$$T_m^2 = T_\lambda \times T_v^2$$

This gives:

$$y_{i,\text{nat}} = y_{i,\text{SI}} \times \sqrt{T_\lambda}$$

However, T_λ **requires detailed specification of the T0-natural unit system transformation rules.**

0.9 Universal Warning: No Direct Parameter Transfer

0.9.1 The Systematic Problem

> **EVERY parameter symbol in T0-model documents may have different values than in SI system calculations!**

Concrete danger zones:

$$G_{\text{nat}} = 1 \quad \text{vs.} \quad G_{\text{SI}} = 6.674 \times 10^{-11} \text{ m}^3/(\text{kg} \cdot \text{s}^2) \tag{23}$$

$$\alpha_{\text{EM,nat}} = 1 \quad \text{vs.} \quad \alpha_{\text{EM,SI}} = 1/137 \tag{24}$$
$$e_{\text{nat}} = 2\sqrt{\pi} \quad \text{vs.} \quad e_{\text{SI}} = 1.602 \times 10^{-19} \text{ C} \tag{25}$$

Direct transfer leads to errors of factors 10^2 to 10^{11}!

0.9.2   Required Transformation Protocol

For every parameter, explicitly specify:

1. **Which unit system** is being used

2. **How transformation occurs** between systems

3. **Which factors must be considered**

4. **Which consistency conditions** must be satisfied

Example of complete specification:

> **Parameter Specification Template**
>
> **Parameter:** Fine structure constant α_{EM}
> **SI value:** $\alpha_{\text{EM,SI}} = 1/137.036$
> **T0 value:** $\alpha_{\text{EM,nat}} = 1$
> **Transformation:** $\alpha_{\text{EM,nat}} = \alpha_{\text{EM,SI}} \times 137.036$
> **Consistency:** Dimensional analysis verified
> **Usage:** Specify system before calculation

0.9.3   Experimental Prediction Guidelines

For QED calculations:

$$\text{WRONG:} \quad \alpha_{\text{EM}} = 1 \text{ from T0-model directly in SI formulas} \tag{26}$$
$$\text{CORRECT:} \quad \alpha_{\text{EM,SI}} = 1/137 \text{ with transformation to } \alpha_{\text{EM,nat}} = 1 \tag{27}$$

For gravitational calculations:

$$\text{WRONG:} \quad G = 1 \text{ from T0-model directly in Newton's formulas} \tag{28}$$
$$\text{CORRECT:} \quad G_{\text{SI}} = 6.674 \times 10^{-11} \text{ with transformation to } G_{\text{nat}} = 1 \tag{29}$$

0.10   The Circularity Resolution

0.10.1   Apparent vs. Real Circularity

The circularity problem that seemed to plague T0-model parameter determination is resolved by recognizing:

1. **No real circularity exists** within each consistent system

2. **Both SI and T0 systems are internally consistent**

3. **The apparent contradiction** arose from comparing parameters across different systems

4. **Proper transformation** eliminates all apparent inconsistencies

0.10.2 System Consistency Verification

SI system consistency:

$$R_0 = \frac{m_e c \left(\alpha_{\mathrm{EM,SI}}\right)^2}{2\hbar} \quad \checkmark \text{ (experimentally verified to 0.000001\%)}$$

T0 system consistency:

$$\text{All parameters} = 1 \quad \checkmark \text{ (by construction)}$$

Both systems work perfectly within their own frameworks!

0.11 Implications for T0-Model Testing

0.11.1 System-Specific Predictions

Experimental tests must clearly specify which parameter system is used:

Test Type	SI-based Prediction	T0-based Prediction
QED anomaly	$a_e \propto \alpha_{\mathrm{EM,SI}} = 1/137$	$a_e \propto \alpha_{\mathrm{EM,nat}} = 1$
Galaxy rotation	$v^2 \propto \xi_{\mathrm{SI}} \sim 10^{38}$	$v^2 \propto \xi_{\mathrm{nat}} \sim 10^{41}$
CMB temperature	$T \propto \beta_{T,\mathrm{SI}} = 0.008$	$T \propto \beta_{T,\mathrm{nat}} = 1$

Table 5: System-specific experimental predictions

0.11.2 Transformation Validation

The transformation factors can be validated by checking:

1. **Dimensional consistency** in both systems

2. **Known limits** are reproduced correctly

3. **Ratios remain invariant** between systems

4. **Internal consistency** of each system