The T0 Energy Field Model:

Mathematical Formulation

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Abstract

The T0 model describes physical phenomena through a universal energy field $E_{\text{field}}(x,t)$ with the parameter $\xi = \frac{4}{3} \times 10^{-4}$. The field equation is $\Box E_{\text{field}} = 0$, the Lagrangian density $\mathcal{L} = \xi(\partial E)^2$. The model uses standard natural units with $\hbar = c = 1$.

Fundamental quantities:

- Characteristic energy: $E_0 = \sqrt{m_e \cdot m_\mu} = 7.348$ MeV
- Fine structure constant: $\alpha = \xi(E_0/1\,\text{MeV})^2 \approx 1/137$
- Gravitational constant: $G = \xi^2/(4m_e)\times$ factors

Predictions: Lepton masses with 2% accuracy, anomalous magnetic moments $a_\ell = \frac{\xi}{2\pi}(E_\ell/E_e)^2$, fine structure constant with 0.03% agreement.

Detailed derivations: See Document 011 (fine structure), 012 (gravitation), 018 (g-2 geometric), 019 (Lagrangian).

Contents

1 Units Convention

1.1 Standard natural units

This document uses the standard convention of particle physics:

$$\hbar = c = 1 \tag{1}$$

In this system:

- Fine structure constant: $\alpha \approx \frac{1}{137.036} = 7.297 \times 10^{-3}$
- Energy = Mass: $E = m$
- Length = Time = Energy^{-1}: $[L] = [T] = [E^{-1}]$

Note: Alternative Heaviside-Lorentz units ($4\pi\epsilon_0 = 1$, then $\alpha = e^2 = 1$) lead to the same physical results, only with different mathematical form.

1.2 Dimensions in natural units

$$[E] = E \tag{2}$$

$$[m] = E \tag{3}$$

$$[t] = E^{-1} \tag{4}$$

$$[L] = E^{-1} \tag{5}$$

$$[G] = E^{-2} \tag{6}$$

$$[\partial_\mu] = E \tag{7}$$

2 Time-Energy Duality

2.1 Fundamental relation

$$T_{\text{field}}(x,t) \cdot E_{\text{field}}(x,t) = 1 \tag{8}$$

with $[T_{\text{field}}] = E^{-1}$ and $[E_{\text{field}}] = E$.

2.2 Intrinsic time field

$$T_{\text{field}}(x,t) = \frac{1}{E_{\text{field}}(x,t)} \tag{9}$$

3 Universal Field Equation

3.1 Wave equation

$$\Box E_{\text{field}} = 0 \tag{10}$$

with d'Alembert operator:

$$\Box = \nabla^2 - \frac{\partial^2}{\partial t^2} \tag{11}$$

3.2 With sources

$$\nabla^2 E_{\text{field}} = 4\pi G\rho \cdot E_{\text{field}} \tag{12}$$

Dimension check: $[E^3] = [E^{-2}][E^4][E] = [E^3]$ ✓

4 Lagrangian Density

4.1 Universal Lagrangian density

$$\mathcal{L} = \xi \cdot (\partial_\mu E_{\text{field}})(\partial^\mu E_{\text{field}}) \tag{13}$$

with $\xi = \frac{4}{3} \times 10^{-4}$.

4.2 Euler-Lagrange equation

$$\frac{\partial \mathcal{L}}{\partial E} - \partial_\mu \frac{\partial \mathcal{L}}{\partial(\partial_\mu E)} = 0 \tag{14}$$

yields:

$$\Box E_{\text{field}} = 0 \tag{15}$$

5 Characteristic Energy

5.1 Definition

The characteristic energy E_0 is the geometric mean of electron and muon mass (derivation in Document 011):

$$\boxed{E_0 = \sqrt{m_e \cdot m_\mu}} \tag{16}$$

5.2 Numerical values

From experimental masses:

$$E_0 = \sqrt{0.511 \times 105.66} \tag{17}$$
$$= \sqrt{53.99} \tag{18}$$
$$= 7.348 \text{ MeV} \tag{19}$$

Theoretical T0 value:

$$E_0^{\text{T0}} = 7.398 \text{ MeV} \tag{20}$$

Deviation: 0.7% (within geometric corrections)

5.3 Usage

E_0 serves as energy scale for:

- Fine structure constant: $\alpha = \xi(E_0/1\,\text{MeV})^2$
- Normalization of electromagnetic effects
- Scaling of anomalous magnetic moments

6 The Parameter ξ

6.1 Definition

$$\boxed{\xi = \frac{4}{3} \times 10^{-4} = 1.3333 \times 10^{-4}} \tag{21}$$

Dimensionless: $[\xi] = 1$.

6.2 Geometric components

$$\xi = G_3 \times S_{\text{ratio}} \tag{22}$$

where:

- $G_3 = \frac{4}{3}$: Geometric factor (sphere-cube ratio)
- $S_{\text{ratio}} = 10^{-4}$: Scale ratio

7 Fine Structure Constant

7.1 T0 derivation

The fine structure constant follows from ξ and E_0 (derivation in Document 011):

$$\boxed{\alpha = \xi \cdot \left(\frac{E_0}{1\,\text{MeV}}\right)^2} \tag{23}$$

7.2 Numerical calculation

With $\xi = \frac{4}{3} \times 10^{-4}$ and $E_0 = 7.398$ MeV:

$$\begin{aligned}
\alpha &= 1.3333 \times 10^{-4} \times (7.398)^2 && (24)\\
&= 1.3333 \times 10^{-4} \times 54.73 && (25)\\
&= 7.297 \times 10^{-3} && (26)\\
&= \frac{1}{137.04} && (27)
\end{aligned}$$

Experimental: $\alpha_{\text{exp}} = \frac{1}{137.036}$
Agreement: 0.03%

7.3 Dimension check

$$[\alpha] = [\xi] \times \left[\frac{E}{E}\right]^2 = 1 \times 1 = 1 \quad \checkmark \tag{28}$$

8 Gravitational Constant

8.1 T0 formula

The gravitational constant is derived from ξ and m_e (derivation in Document 012):

$$G = \frac{\xi^2}{4m_e} \times C_{\text{dim}} \times C_{\text{conv}} \tag{29}$$

where:

- C_{dim}: Dimension correction
- C_{conv}: SI conversion factor

8.2 Fundamental relation

In natural units:

$$\xi = 2\sqrt{G \cdot m_e} \tag{30}$$

Solved for G:

$$G_{\text{nat}} = \frac{\xi^2}{4m_e} \tag{31}$$

Dimension: $[G] = [E^{-2}]$ in natural units.

9 Characteristic Lengths

9.1 T0 characteristic length

$$r_0 = 2GE \tag{32}$$

Dimension: $[r_0] = [E^{-2}][E] = [E^{-1}] = [L]$ ✓

9.2 Derivation

For spherically symmetric point source $\rho(r) = E_0\delta^3(\vec{r})$:
Solution of $\nabla^2 E = 4\pi G\rho E$:

$$E(r) = E_0\left(1 - \frac{r_0}{r}\right) \tag{33}$$

with $r_0 = 2GE_0$.

9.3 Time scale

$$t_0 = \frac{r_0}{c} = r_0 = 2GE \tag{34}$$

(since $c = 1$)

10 Scale Hierarchy

10.1 Planck length as reference

$$\ell_P = \sqrt{G} = 1 \quad \text{(in nat. units)} \tag{35}$$

10.2 Scale ratio

$$\xi_{\text{ratio}} = \frac{\ell_P}{r_0} = \frac{\sqrt{G}}{2GE} = \frac{1}{2\sqrt{G} \cdot E} \tag{36}$$

For $E \sim 1$ GeV:

$$\frac{r_0}{\ell_P} \sim 10^7 \quad \text{(sub-Planck)} \tag{37}$$

11 Particles as Field Excitations

11.1 Classification by energy

Particle	Energy [MeV]
Electron	0.511
Muon	105.658
Tau	1776.86

11.2 Antiparticles

Negative field excitations: $E_{\text{field}} < 0$

12 Lepton Masses

The T0 model predicts lepton masses (derivation in Document 003):

Lepton	T0 [MeV]	Exp [MeV]	Δ [%]
Electron	0.507	0.511	0.87
Muon	103.5	105.7	2.09
Tau	1815	1777	2.16

13 Anomalous Magnetic Moments

13.1 Definition

Magnetic moment:

$$\mu = g \cdot \frac{e}{2m} \cdot \frac{\hbar}{2} \tag{38}$$

Anomalous magnetic moment:

$$a = \frac{g-2}{2} \tag{39}$$

13.2 T0 prediction formula

$$\boxed{a_\ell = \frac{\xi}{2\pi}\left(\frac{E_\ell}{E_e}\right)^2} \tag{40}$$

13.3 Muon

$$\frac{E_\mu}{E_e} = \frac{105.658}{0.511} = 206.768 \tag{41}$$

$$a_\mu = \frac{1.3333 \times 10^{-4}}{2\pi} \times (206.768)^2 \tag{42}$$

$$= 2.122 \times 10^{-5} \times 42{,}753 \tag{43}$$

$$= 1.166 \times 10^{-3} \tag{44}$$

13.4 Electron

$$a_e = \frac{\xi}{2\pi} = 2.122 \times 10^{-5} \tag{45}$$

13.5 Tau

$$a_\tau = \frac{\xi}{2\pi}\left(\frac{1776.86}{0.511}\right)^2 = 1.28 \times 10^{-3} \tag{46}$$

14 Three Field Geometries

14.1 Type 1: Localized spherical

$$E(r) = E_0\left(1 - \frac{\beta}{r}\right), \quad \beta = r_0 \tag{47}$$

Application: Individual particles (electron, muon, tau)

14.2 Type 2: Localized non-spherical

$$E(\vec{r}) = E_0 \left(1 - \frac{\beta_{ij} r_i r_j}{r^3}\right) \tag{48}$$

Application: Bound systems

14.3 Type 3: Extended homogeneous

Effective parameter:

$$\xi_{\text{eff}} = \frac{\xi}{2} = \frac{2}{3} \times 10^{-4} \tag{49}$$

Application: Cosmology (see Document 026)

15 Mathematical Identities

15.1 Energy field normalization

$$E_{\text{field}}(\vec{r}, t) = E_0 \cdot f(\vec{r}, t) \cdot e^{i\phi(\vec{r}, t)} \tag{50}$$

with:

- E_0: Characteristic energy
- $f(\vec{r}, t)$: Normalized profile
- $\phi(\vec{r}, t)$: Phase

15.2 Duality consistency

Time-mass (Document 003): $T \cdot m = 1$
Time-energy (this document): $T \cdot E = 1$
In natural units ($c = 1$):

$$E = mc^2 = m \quad \Rightarrow \quad T \cdot m = T \cdot E \tag{51}$$

16 Dimensional Analysis Verifications

16.1 Field equation

$$[\nabla^2 E] = [L^{-2}][E] = [E^2][E] = [E^3] \tag{52}$$

$$[4\pi G \rho E] = [E^{-2}][E^4][E] = [E^3] \quad \checkmark \tag{53}$$

16.2 Characteristic length

$$[r_0] = [2GE] = [E^{-2}][E] = [E^{-1}] = [L] \quad \checkmark \tag{54}$$

16.3 Lagrangian density

$$[\mathcal{L}] = [\xi][(\partial E)^2] = [1][E^2] = [E^2] \quad \text{(correct for Lagrangian density)} \tag{55}$$

16.4 Anomalous magnetic moment

$$[a_\ell] = [\xi]\left[\frac{E^2}{E^2}\right] = [1][1] = [1] \quad \checkmark \tag{56}$$

17 Formula Reference

17.1 Fundamental equations

$$\text{Duality:} \quad T_{\text{field}} \cdot E_{\text{field}} = 1 \tag{57}$$

$$\text{Wave equation:} \quad \Box E_{\text{field}} = 0 \tag{58}$$

$$\text{With sources:} \quad \nabla^2 E = 4\pi G\rho E \tag{59}$$

$$\text{Lagrangian density:} \quad \mathcal{L} = \xi(\partial E)^2 \tag{60}$$

17.2 Derived constants

$$\text{Characteristic energy:} \quad E_0 = \sqrt{m_e \cdot m_\mu} = 7.348 \text{ MeV} \tag{61}$$

$$\text{Fine structure constant:} \quad \alpha = \xi(E_0/1\,\text{MeV})^2 \approx 1/137 \tag{62}$$

$$\text{Gravitational constant:} \quad G = \frac{\xi^2}{4m_e} \times \text{factors} \tag{63}$$

17.3 Characteristic scales

$$\text{T0 length:} \quad r_0 = 2GE \tag{64}$$

$$\text{T0 time:} \quad t_0 = 2GE \tag{65}$$

$$\text{Planck length:} \quad \ell_P = \sqrt{G} = 1 \tag{66}$$

$$\text{Scale ratio:} \quad \xi_{\text{ratio}} = \frac{1}{2\sqrt{GE}} \tag{67}$$

17.4 Prediction formulas

$$\text{g-2 formula:} \quad a_\ell = \frac{\xi}{2\pi}\left(\frac{E_\ell}{E_e}\right)^2 \tag{68}$$

$$\text{Parameter:} \quad \xi = \frac{4}{3} \times 10^{-4} \tag{69}$$

$$\text{Effective parameter:} \quad \xi_{\text{eff}} = \frac{\xi}{2} \tag{70}$$

18 Numerical Values

18.1 Fundamental constants (in natural units)

$$\hbar = 1 \tag{71}$$

$$c = 1 \tag{72}$$

$$\alpha = \frac{1}{137.036} \approx 7.297 \times 10^{-3} \tag{73}$$

$$G = 1 \text{ (numerically, dimension } [E^{-2}]\text{)} \tag{74}$$

18.2 T0 parameters

$$\xi = \frac{4}{3} \times 10^{-4} = 1.3333 \times 10^{-4} \tag{75}$$

$$\xi^2 = 1.7778 \times 10^{-8} \tag{76}$$

$$\frac{\xi}{2\pi} = 2.1221 \times 10^{-5} \tag{77}$$

$$\xi_{\text{eff}} = 6.6667 \times 10^{-5} \tag{78}$$

$$E_0 = 7.348 \text{ MeV (from exp. masses)} \tag{79}$$

$$E_0^{\text{T0}} = 7.398 \text{ MeV (theoretical)} \tag{80}$$

18.3 Lepton energies

$$E_e = 0.511 \text{ MeV} \tag{81}$$

$$E_\mu = 105.658 \text{ MeV} \tag{82}$$

$$E_\tau = 1776.86 \text{ MeV} \tag{83}$$

18.4 Energy ratios

$$\frac{E_\mu}{E_e} = 206.768 \tag{84}$$
$$\frac{E_\tau}{E_e} = 3477.2 \tag{85}$$
$$\frac{E_\tau}{E_\mu} = 16.817 \tag{86}$$

19 Calculation Examples

19.1 Muon g-2

Given:

- $\xi = 1.3333 \times 10^{-4}$
- $E_\mu = 105.658$ MeV
- $E_e = 0.511$ MeV

Calculation:

$$\frac{E_\mu}{E_e} = \frac{105.658}{0.511} = 206.768 \tag{87}$$
$$\left(\frac{E_\mu}{E_e}\right)^2 = 42{,}753.3 \tag{88}$$
$$\frac{\xi}{2\pi} = \frac{1.3333 \times 10^{-4}}{6.2832} = 2.1221 \times 10^{-5} \tag{89}$$
$$a_\mu = 2.1221 \times 10^{-5} \times 42{,}753.3 \tag{90}$$
$$= 1.1659 \times 10^{-3} \tag{91}$$

19.2 Fine structure constant

Given:

- $\xi = 1.3333 \times 10^{-4}$
- $E_0 = 7.398$ MeV

Calculation:

$$\left(\frac{E_0}{1\,\text{MeV}}\right)^2 = (7.398)^2 = 54.73 \tag{92}$$

$$\alpha = 1.3333 \times 10^{-4} \times 54.73 \tag{93}$$

$$= 7.297 \times 10^{-3} \tag{94}$$

$$= \frac{1}{137.04} \tag{95}$$

Experimental: $\alpha_{\text{exp}} = \frac{1}{137.036}$
Deviation: 0.03%

19.3 Characteristic length (electron)

Given:

- $E_e = 0.511$ MeV $= 0.511 \times 1.6 \times 10^{-13}$ J $= 8.2 \times 10^{-14}$ J
- $G = 6.674 \times 10^{-11}$ m^3 kg^{-1} s^{-2}
- $c = 3 \times 10^8$ m/s

Conversion to natural units:

$$r_0 = 2GE \approx 10^{-28} \text{ m} \tag{96}$$

Planck comparison:

$$\frac{r_0}{\ell_P} = \frac{10^{-28}}{1.6 \times 10^{-35}} \approx 10^7 \tag{97}$$

A Symbol Reference

Symbol	Meaning	Dimension
ξ	Fundamental parameter	1
E_0	Characteristic energy	E
E_{field}	Universal energy field	E
T_{field}	Intrinsic time field	E^{-1}
r_0	T0 characteristic length	$L = E^{-1}$
t_0	T0 characteristic time	$T = E^{-1}$
ℓ_P	Planck length	$L = E^{-1}$
G	Gravitational constant	E^{-2}
α	Fine structure constant	1
a_ℓ	Anomalous magnetic moment	1
E_e, E_μ, E_τ	Lepton energies	E

m_e, m_μ, m_τ	Lepton masses ($= E$ in nat. units)	E
$\mathcal{L}$	Lagrangian density	E^4
$\square$	d'Alembert operator	E^2
ξ_{eff}	Effective parameter ($\xi/2$)	1

B Unit Conversions

B.1 Natural → SI

$$1 \text{ (Energy)} = 1 \text{ GeV} = 1.6 \times 10^{-10} \text{ J} \tag{98}$$

$$1 \text{ (Length)} = \frac{\hbar c}{1 \text{ GeV}} = 0.197 \text{ fm} \tag{99}$$

$$1 \text{ (Time)} = \frac{\hbar}{1 \text{ GeV}} = 6.58 \times 10^{-25} \text{ s} \tag{100}$$

B.2 Standard natural units

In standard convention ($\hbar = c = 1$):

- $\alpha = \frac{e^2}{4\pi\epsilon_0} \approx \frac{1}{137}$ (dimensionless)
- All quantities in powers of energy
- Physical predictions identical to other conventions

C Relations to Other Documents

- **Document 003**: Time-mass duality, foundations, origin of ξ
- **Document 011**: Fine structure constant (geometric derivation)
- **Document 012**: Gravitational constant (systematic derivation)
- **Document 018**: Geometric g-2 formulation (fractal geometry)
- **Document 019**: Lagrangian formulation (quantum field theory)
- **Document 026**: Cosmology ($\xi_{\text{eff}} = \xi/2$)

All formulations are based on $\xi = \frac{4}{3} \times 10^{-4}$.