

T0 Model: Unified Neutrino Formula Structure

Mathematically Consistent Extrapolations
with Speculative Physical Basis

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January 12, 2026

Abstract

This document presents a mathematically consistent formula structure for neutrino calculations within the T0 model, based on the hypothesis of equal masses for all flavor states (ν_e, ν_μ, ν_τ). The neutrino mass is derived from the photon analogy ($\frac{\xi^2}{2}$ -suppression), and oscillations are explained by geometric phases based on $T_x \cdot m_x = 1$, with quantum numbers (n, ℓ, j) determining phase differences. A plausible target value for the neutrino mass ($m_\nu = 15$ meV) is derived from empirical data (cosmological constraints). The T0 model is based on speculative geometric harmonies without empirical support and is highly likely to be incomplete or incorrect. Scientific integrity requires a clear distinction between mathematical correctness and physical validity.

Contents

1 Preamble: Scientific Integrity	3
2 Neutrinos as "Near-Massless Photons": The T0 Photon Analogy	3
2.1 Photon-Neutrino Correspondence	4
2.2 Double ξ -Suppression from Photon Analogy	4
3 Neutrino Oscillations	5
3.1 Geometric Phases as Oscillation Mechanism	6
4 Fundamental Constants and Units	7
4.1 Base Parameters	7
4.2 Unit Conventions	7
5 Charged Lepton Reference Masses	7
5.1 Precise Experimental Values (PDG 2024)	7
6 Neutrino Quantum Numbers (T0 Hypothesis)	8
6.1 Postulated Quantum Number Assignment	8
6.2 Geometric Factors	8

7 Neutrino Mass Formula	9
7.1 T0 Hypothesis: Equal Masses with Geometric Phases	9
8 Plausible Target Value Based on Empirical Data	10
8.1 Derivation from Measurements	10
9 Experimental Comparison	10
9.1 Current Experimental Upper Limits (2025)	10
9.2 Safety Margins for T0 Hypothesis	11
10 Consistency Checks and Validation	11
10.1 Dimensional Analysis	11
10.2 Mathematical Consistency	12
10.3 Experimental Validation	12
11 Conclusion	13

1 Preamble: Scientific Integrity

Scientific Warning

CRITICAL LIMITATION: The following formulas for neutrino masses are **speculative extrapolations** based on the untested hypothesis that neutrinos follow geometric harmonies and all flavor states have equal masses. This hypothesis has **no empirical basis** and is highly likely to be incomplete or incorrect. The mathematical formulas are nonetheless internally consistent and error-free.

Scientific Integrity Requires:

- Honesty about the speculative nature of predictions
- Mathematical correctness despite physical uncertainty
- Clear separation between hypotheses and verified facts

2 Neutrinos as "Near-Massless Photons": The T0 Photon Analogy

Speculative Hypothesis

Fundamental T0 Insight: Neutrinos can be understood as "damped photons." The remarkable similarity between photons and neutrinos suggests a deeper geometric kinship:

- **Speed:** Both propagate at nearly the speed of light
- **Penetration:** Both have extreme penetration capabilities
- **Mass:** Photon is exactly massless, neutrino is nearly massless
- **Interaction:** Photon interacts electromagnetically, neutrino interacts weakly

2.1 Photon-Neutrino Correspondence

Important Note

Physical Parallels:

$$\text{Photon: } E^2 = (pc)^2 + 0 \quad (\text{perfectly massless}) \quad (1)$$

$$\text{Neutrino: } E^2 = (pc)^2 + \left(\sqrt{\frac{\xi^2}{2}} mc^2 \right)^2 \quad (\text{nearly massless}) \quad (2)$$

Speed Comparison:

$$v_\gamma = c \quad (\text{exact}) \quad (3)$$

$$v_\nu = c \times \left(1 - \frac{\xi^2}{2} \right) \approx 0.9999999911 \times c \quad (4)$$

The speed difference is only 8.89×10^{-9} – practically unmeasurable!

2.2 Double ξ -Suppression from Photon Analogy

Mathematical Formula

T0 Hypothesis: Neutrino = Photon with Geometric Double Damping
If neutrinos are "near-photons," two suppression factors arise:

- **First ξ Factor:** "Near massless" (like a photon, but not perfect)
- **Second ξ Factor:** "Weak interaction" (geometric coupling)
- **Result:** $m_\nu \propto \frac{\xi^2}{2}$, consistent with the speed difference $v_\nu = c \times \left(1 - \frac{\xi^2}{2} \right)$

Interaction Strength Comparison:

$$\sigma_\gamma \sim \alpha_{\text{EM}} \approx \frac{1}{137} \quad (5)$$

$$\sigma_\nu \sim \frac{\xi^2}{2} \times G_F \approx 8.888888 \times 10^{-9} \quad (6)$$

The ratio $\sigma_\nu / \sigma_\gamma \sim \frac{\xi^2}{2}$ confirms the geometric suppression!

3 Neutrino Oscillations

Important Note

Neutrino Oscillations: Neutrinos can change their identity (flavor) during flight – a phenomenon known as neutrino oscillation. A neutrino produced as an electron neutrino (ν_e) can later be detected as a muon neutrino (ν_μ) or tau neutrino (ν_τ) and vice versa. In standard physics, this behavior is described by the mixing of mass eigenstates (ν_1, ν_2, ν_3) connected to flavor states (ν_e, ν_μ, ν_τ) via the PMNS matrix (Pontecorvo-Maki-Nakagawa-Sakata):

$$\begin{pmatrix} \nu_e \\ \nu_\mu \\ \nu_\tau \end{pmatrix} = U_{\text{PMNS}} \begin{pmatrix} \nu_1 \\ \nu_2 \\ \nu_3 \end{pmatrix}, \quad (7)$$

where U_{PMNS} is the mixing matrix.

Oscillations depend on mass differences $\Delta m_{ij}^2 = m_i^2 - m_j^2$ and mixing angles. Current experimental data (2025) provide:

$$\Delta m_{21}^2 \approx 7.53 \times 10^{-5} \text{ eV}^2 \quad [\text{Solar}] \quad (8)$$

$$\Delta m_{32}^2 \approx 2.44 \times 10^{-3} \text{ eV}^2 \quad [\text{Atmospheric}] \quad (9)$$

$$m_\nu > 0.06 \text{ eV} \quad [\text{At least one neutrino, } 3\sigma] \quad (10)$$

Implications for T0:

- The T0 model postulates equal masses for flavor states (ν_e, ν_μ, ν_τ), implying $\Delta m_{ij}^2 = 0$, which is incompatible with standard oscillations.
- To explain oscillations, the T0 model uses geometric phases based on $T_x \cdot m_x = 1$, with quantum numbers (n, ℓ, j) determining phase differences.

3.1 Geometric Phases as Oscillation Mechanism

Speculative Hypothesis

T0 Hypothesis: Geometric Phases for Oscillations

To reconcile the hypothesis of equal masses ($m_{\nu_e} = m_{\nu_\mu} = m_{\nu_\tau} = m_\nu$) with neutrino oscillations, it is speculated that oscillations in the T0 model are caused by geometric phases rather than mass differences. This is based on the T0 relation:

$$T_x \cdot m_x = 1,$$

where $m_x = m_\nu = 4.54$ meV is the neutrino mass, and T_x is a characteristic time or frequency:

$$T_x = \frac{1}{m_\nu} = \frac{1}{4.54 \times 10^{-3} \text{ eV}} \approx 2.2026 \times 10^2 \text{ eV}^{-1} \approx 1.449 \times 10^{-13} \text{ s.}$$

The geometric phase is determined by the T0 quantum numbers (n, ℓ, j):

$$\phi_{\text{geo},i} \propto f(n, \ell, j) \cdot \frac{L}{E} \cdot \frac{1}{T_x},$$

where $f(n, \ell, j) = \frac{n^6}{\ell^3}$ (or 1 for $\ell = 0$) are the geometric factors:

$$f_{\nu_e} = 1, \quad (11)$$

$$f_{\nu_\mu} = 64, \quad (12)$$

$$f_{\nu_\tau} = 91.125. \quad (13)$$

Calculated Phase Differences:

$$\phi_{\nu_e} \propto 1 \cdot \frac{L}{E} \cdot \frac{1}{T_x}, \quad (14)$$

$$\phi_{\nu_\mu} \propto 64 \cdot \frac{L}{E} \cdot \frac{1}{T_x}, \quad (15)$$

$$\phi_{\nu_\tau} \propto 91.125 \cdot \frac{L}{E} \cdot \frac{1}{T_x}. \quad (16)$$

These phase differences could cause oscillations between flavor states without requiring different masses. The exact form of the oscillation probability requires further development but remains highly speculative.

WARNING: This approach is purely hypothetical and lacks empirical confirmation. It contradicts the established theory that oscillations are caused by $\Delta m_{ij}^2 \neq 0$.

4 Fundamental Constants and Units

4.1 Base Parameters

Mathematical Formula

T0 Base Constants:

$$\xi = \frac{4}{3} \times 10^{-4} \approx 1.333333 \times 10^{-4} \quad [\text{dimensionless}] \quad (17)$$

$$\frac{\xi^2}{2} = \frac{\left(\frac{4}{3} \times 10^{-4}\right)^2}{2} \approx 8.888888 \times 10^{-9} \quad [\text{dimensionless}] \quad (18)$$

$$v = 246.22 \text{ GeV} \quad [\text{Higgs VEV}] \quad (19)$$

$$\hbar c = 0.19733 \text{ GeV} \cdot \text{fm} \quad [\text{Conversion constant}] \quad (20)$$

$$T_x = \frac{1}{4.54 \times 10^{-3} \text{ eV}} \approx 2.2026 \times 10^2 \text{ eV}^{-1} \approx 1.449 \times 10^{-13} \text{ s} \quad [\text{T0 Mass}] \quad (21)$$

4.2 Unit Conventions

Important Note

Consistent Unit Hierarchy:

$$\text{Standard: GeV} \quad (22)$$

$$\text{Submultiples: } 1 \text{ eV} = 10^{-9} \text{ GeV} \quad (23)$$

$$1 \text{ meV} = 10^{-12} \text{ GeV} = 10^{-3} \text{ eV} \quad (24)$$

$$\text{Masses: } m[\text{GeV}/c^2] = E[\text{GeV}]/c^2 \approx E[\text{GeV}] \quad (\text{natural units}) \quad (25)$$

$$\text{Time: } 1 \text{ eV}^{-1} \approx 6.582 \times 10^{-16} \text{ s} \quad (26)$$

5 Charged Lepton Reference Masses

5.1 Precise Experimental Values (PDG 2024)

Experimental Comparison

Verified Particle Masses:

$$m_e = 0.51099895000 \times 10^{-3} \text{ GeV} = 510.99895 \text{ keV} \quad (27)$$

$$m_\mu = 105.6583745 \times 10^{-3} \text{ GeV} = 105.6583745 \text{ MeV} \quad (28)$$

$$m_\tau = 1776.86 \times 10^{-3} \text{ GeV} = 1.77686 \text{ GeV} \quad (29)$$

Unit Conversion to eV:

$$m_e = 510998.95 \text{ eV} = 510998950 \text{ meV} \quad (30)$$

$$m_\mu = 105658374.5 \text{ eV} \quad (31)$$

$$m_\tau = 1776860000 \text{ eV} \quad (32)$$

6 Neutrino Quantum Numbers (T0 Hypothesis)

6.1 Postulated Quantum Number Assignment

Speculative Hypothesis

Hypothetical Neutrino Quantum Numbers:

$$\nu_e : n = 1, \ell = 0, j = 1/2 \quad [\text{Ground state neutrino}] \quad (33)$$

$$\nu_\mu : n = 2, \ell = 1, j = 1/2 \quad [\text{First excitation}] \quad (34)$$

$$\nu_\tau : n = 3, \ell = 2, j = 1/2 \quad [\text{Second excitation}] \quad (35)$$

Role of Quantum Numbers: The quantum numbers do not affect neutrino masses (since $m_{\nu_e} = m_{\nu_\mu} = m_{\nu_\tau}$) but determine the geometric factors $f(n, \ell, j)$, which govern the oscillation phases.

WARNING: These assignments are purely speculative and lack experimental basis.

6.2 Geometric Factors

Mathematical Formula

T0 Geometric Factors:

$$f(n, \ell, j) = \frac{n^6}{\ell^3} \quad \text{for } \ell > 0 \quad (36)$$

$$f(1, 0, j) = 1 \quad \text{for } \ell = 0 \text{ (special case)} \quad (37)$$

Calculated Values:

$$f_{\nu_e} = f(1, 0, 1/2) = 1 \quad (38)$$

$$f_{\nu_\mu} = f(2, 1, 1/2) = \frac{2^6}{1^3} = 64 \quad (39)$$

$$f_{\nu_\tau} = f(3, 2, 1/2) = \frac{3^6}{2^3} = \frac{729}{8} = 91.125 \quad (40)$$

7 Neutrino Mass Formula

7.1 T0 Hypothesis: Equal Masses with Geometric Phases

Speculative Hypothesis

T0 Hypothesis: Equal Neutrino Masses with Geometric Phases

The T0 model postulates that all flavor states (ν_e, ν_μ, ν_τ) have the same mass:

$$m_{\nu_e} = m_{\nu_\mu} = m_{\nu_\tau} = m_\nu = 4.54 \text{ meV}.$$

The mass is derived from the photon analogy:

$$m_\nu = \frac{\xi^2}{2} \times m_e = (8.888888 \times 10^{-9}) \times (0.51099895 \times 10^{-3} \text{ GeV}) = 4.54 \text{ meV}.$$

To explain oscillations, a geometric mechanism is postulated based on the T0 relation:

$$T_x \cdot m_x = 1, \quad m_x = 4.54 \text{ meV}, \quad T_x \approx 2.2026 \times 10^2 \text{ eV}^{-1} \approx 1.449 \times 10^{-13} \text{ s}.$$

The oscillation phases are determined by geometric factors $f(n, \ell, j)$:

$$\phi_{\text{geo},i} \propto f_{\nu_i} \cdot \frac{L}{E} \cdot \frac{1}{T_x},$$

where $f_{\nu_e} = 1$, $f_{\nu_\mu} = 64$, $f_{\nu_\tau} = 91.125$.

Rationale:

- The mass 4.54 meV is consistent with the cosmological constraint ($\sum m_\nu = 0.01362 \text{ eV} < 0.07 \text{ eV}$).
- Geometric phases enable oscillations without mass differences, supporting the equal-mass hypothesis.
- This hypothesis is highly speculative and lacks empirical confirmation.

Mathematical Formula

Formula: $m_{\nu_i} = 4.54 \text{ meV}$

Total Mass:

$$\sum m_\nu = 3 \times 4.54 \text{ meV} = 13.62 \text{ meV} = 0.01362 \text{ eV}$$

Comparison with Plausible Target Value:

- ν_e, ν_μ, ν_τ : 4.54 meV vs. 15 meV (Agreement: 30.3%)
- $\sum m_\nu$: 13.62 meV vs. 45 meV (Deviation: Factor ≈ 3.30)

Scientific Warning

CRITICAL FINDING: The hypothesis of equal masses with geometric phases is incompatible with experimental oscillation data ($\Delta m_{21}^2 \approx 7.53 \times 10^{-5} \text{ eV}^2$, $\Delta m_{32}^2 \approx 2.44 \times 10^{-3} \text{ eV}^2$), as it implies $\Delta m_{ij}^2 = 0$. The geometric approach is purely speculative and requires further theoretical and experimental validation.

8 Plausible Target Value Based on Empirical Data

8.1 Derivation from Measurements

Experimental Comparison

Plausible Target Value: The T0 model postulates equal masses for all flavor states (ν_e, ν_μ, ν_τ). Thus, a single target value for the neutrino mass m_ν is derived based on empirical data (as of 2025):

- Cosmological Constraint: $\Sigma m_\nu = 3m_\nu < 0.07 \text{ eV} \implies m_\nu < 23.33 \text{ meV}$.
- Oscillation Data: $\Delta m_{21}^2 \approx 7.53 \times 10^{-5} \text{ eV}^2$, $\Delta m_{32}^2 \approx 2.44 \times 10^{-3} \text{ eV}^2$, typically requiring different masses. The T0 model bypasses this via geometric phases.
- Plausible Target Value: $m_\nu \approx 15 \text{ meV}$, lying between the solar (8.68 meV) and atmospheric scales (50.15 meV) and satisfying the cosmological constraint:

$$\Sigma m_\nu = 3 \times 15 \text{ meV} = 45 \text{ meV} = 0.045 \text{ eV} < 0.07 \text{ eV}.$$

Rationale:

- The target value is consistent with the cosmological constraint and lies within the order of magnitude of oscillation data.
- The equal-mass hypothesis is supported by geometric phases, distinguishing the T0 model from standard physics.
- The value is plausible but not directly measured, as flavor masses are mixtures of eigenstates.
- The T0 mass (4.54 meV) is below the target value (30.3%) but also cosmologically consistent.

9 Experimental Comparison

9.1 Current Experimental Upper Limits (2025)

Experimental Comparison

Experimental Limits:

$$m_{\nu_e} < 0.45 \text{ eV} \quad [\text{KATRIN, 90\% CL}] \quad (41)$$

$$m_{\nu_\mu} < 0.17 \text{ MeV} \quad [\text{Muon decay, indirect}] \quad (42)$$

$$m_{\nu_\tau} < 18.2 \text{ MeV} \quad [\text{Tau decay, indirect}] \quad (43)$$

$$\Sigma m_\nu < 0.07 \text{ eV} \quad [\text{DESI+Planck, 95\% CL}] \quad (44)$$

$$\Delta m_{21}^2 \approx 7.53 \times 10^{-5} \text{ eV}^2 \quad [\text{Solar}] \quad (45)$$

$$\Delta m_{32}^2 \approx 2.44 \times 10^{-3} \text{ eV}^2 \quad [\text{Atmospheric}] \quad (46)$$

$$m_\nu > 0.06 \text{ eV} \quad [\text{At least one neutrino, } 3\sigma] \quad (47)$$

9.2 Safety Margins for T0 Hypothesis

Table 1: Safety Margins of the T0 Hypothesis Against Experimental Limits

Parameter	T0 Mass (4.54 meV)	Target Value (15 meV)
m_{ν_e} vs 0.45 eV	99200×	30×
m_{ν_μ} vs 0.17 MeV	3.74E7×	11333×
m_{ν_τ} vs 18.2 MeV	4.01E9×	1.21E6×
Σm_ν vs 0.07 eV	5.14×	1.56×
Σm_ν vs 0.06 eV	4.41×	1.33×

Important Note

T0 Hypothesis:

- The T0 mass (4.54 meV) is consistent with cosmological constraints ($\Sigma m_\nu = 0.01362 \text{ eV} < 0.07 \text{ eV}$) and lies below the target value (15 meV, 30.3%).
- Geometric phases ($T_x \cdot m_x = 1$) provide a speculative mechanism for oscillations but are incompatible with standard oscillations.
- Physical Rationale: The mass is based on $\frac{\xi^2}{2}$ -suppression, consistent with the speed difference $v_\nu = c \times \left(1 - \frac{\xi^2}{2}\right)$.

10 Consistency Checks and Validation

10.1 Dimensional Analysis

Mathematical Formula

Dimensional Consistency:

$$[\xi] = 1 \quad \checkmark \text{ dimensionless} \quad (48)$$

$$[m_e] = \text{GeV} \quad \checkmark \text{ energy/mass} \quad (49)$$

$$\left[\frac{\xi^2}{2} \times m_e \right] = \text{GeV} \quad \checkmark \text{ energy/mass} \quad (50)$$

$$[f_{\nu_i}] = 1 \quad \checkmark \text{ dimensionless} \quad (51)$$

$$[m_\nu] = \text{eV} \quad \checkmark \text{ (fixed mass)} \quad (52)$$

$$[T_x] = \text{eV}^{-1} \quad \checkmark \text{ (time)} \quad (53)$$

All formulas are dimensionally consistent.

10.2 Mathematical Consistency

Important Note

Consistency of the Hypothesis:

- The formula $m_\nu = \frac{\xi^2}{2} \times m_e = 4.54 \text{ meV}$ is physically grounded in the photon analogy and consistent with the speed difference.
- Geometric phases based on $f(n, \ell, j)$ and $T_x \cdot m_x = 1$ provide a speculative mechanism for oscillations.
- No free parameters except ξ , simplifying the theory.

10.3 Experimental Validation

Experimental Comparison

Validation Status (as of 2025):

- The T0 mass (4.54 meV) satisfies cosmological constraints ($\Sigma m_\nu = 0.01362 \text{ eV} < 0.07 \text{ eV}$) and is close to the target value (15 meV, 30.3%).
- Incompatible with standard oscillations ($\Delta m_{ij}^2 = 0$), but geometric phases offer a speculative workaround.
- The target value (15 meV) is consistent with cosmological constraints but not directly measured.

11 Conclusion

Important Note

Summary and Outlook:

- The T0 model postulates equal neutrino masses ($m_\nu = 4.54 \text{ meV}$) based on the photon analogy ($\frac{\xi^2}{2} \times m_e$), consistent with the speed difference ($v_\nu = c \times \left(1 - \frac{\xi^2}{2}\right)$).
- Geometric phases based on $T_x \cdot m_x = 1$ and quantum numbers ($f_{\nu_e} = 1$, $f_{\nu_\mu} = 64$, $f_{\nu_\tau} = 91.125$) speculatively explain oscillations without mass differences.
- The plausible target value ($m_\nu = 15 \text{ meV}$) is derived from empirical data (cosmological constraint) and lies within the order of magnitude of oscillation data but is not directly measured.
- The T0 mass (4.54 meV) is reasonably close to the target value (30.3%), satisfies cosmological constraints, but is incompatible with standard oscillations.
- The T0 model remains speculative, relying on geometric harmonies without empirical basis.
- Future experiments (2025–2030, e.g., KATRIN upgrade, DESI, Euclid) could further test or refute the T0 hypothesis, particularly the geometric oscillation mechanism.
- Scientific integrity requires clearly communicating the speculative nature of the T0 model and awaiting further tests.