T0 Model: Unified Neutrino Formula Structure

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.

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0.1 Preamble: Scientific Integrity

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

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

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

0.2.1 Photon-Neutrino Correspondence

Physical Parallels:

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

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

Speed Comparison:

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

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

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

0.2.2 Double ξ-Suppression from Photon Analogy

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:

$$\sigma_\gamma \sim \alpha_{\text{EM}} \approx \frac{1}{137} \tag{5}$$

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

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

0.3 Neutrino Oscillations

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):

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

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:

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

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

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

Implications for T0:

- The T0 model postulates equal masses for flavor states $(\nu_e, \nu_\mu, \nu_\tau)$, 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.

0.3.1 Geometric Phases as Oscillation Mechanism

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:

$$f_{\nu_e} = 1, \tag{11}$$

$$f_{\nu_\mu} = 64, \tag{12}$$

$$f_{\nu_\tau} = 91.125. \tag{13}$$

Calculated Phase Differences:

$$\phi_{\nu_e} \propto 1 \cdot \frac{L}{E} \cdot \frac{1}{T_x}, \tag{14}$$

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

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

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 $\Delta m_{ij}^2 \neq 0$.

0.4 Fundamental Constants and Units

0.4.1 Base Parameters

T0 Base Constants:

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

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

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

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

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

0.4.2 Unit Conventions

Consistent Unit Hierarchy:

$$\text{Standard:} \quad \text{GeV} \tag{22}$$

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

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

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

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

0.5 Charged Lepton Reference Masses

0.5.1 Precise Experimental Values (PDG 2024)

Verified Particle Masses:

$$m_e = 0.51099895000 \times 10^{-3}\ \text{GeV} = 510.99895\ \text{keV} \tag{27}$$
$$m_\mu = 105.6583745 \times 10^{-3}\ \text{GeV} = 105.6583745\ \text{MeV} \tag{28}$$
$$m_\tau = 1776.86 \times 10^{-3}\ \text{GeV} = 1.77686\ \text{GeV} \tag{29}$$

Unit Conversion to eV:

$$m_e = 510998.95\ \text{eV} = 510998950\ \text{meV} \tag{30}$$
$$m_\mu = 105658374.5\ \text{eV} \tag{31}$$
$$m_\tau = 1776860000\ \text{eV} \tag{32}$$

0.6 Neutrino Quantum Numbers (T0 Hypothesis)

0.6.1 Postulated Quantum Number Assignment

Hypothetical Neutrino Quantum Numbers:

$$\nu_e: \quad n = 1, \ell = 0, j = 1/2 \quad \text{[Ground state neutrino]} \tag{33}$$
$$\nu_\mu: \quad n = 2, \ell = 1, j = 1/2 \quad \text{[First excitation]} \tag{34}$$
$$\nu_\tau: \quad n = 3, \ell = 2, j = 1/2 \quad \text{[Second excitation]} \tag{35}$$

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.

0.6.2 Geometric Factors

T0 Geometric Factors:

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

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

Calculated Values:

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

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

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

0.7 Neutrino Mass Formula

0.7.1 T0 Hypothesis: Equal Masses with Geometric Phases

T0 Hypothesis: Equal Neutrino Masses with Geometric Phases
The T0 model postulates that all flavor states $(\nu_e, \nu_\mu, \nu_\tau)$ 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:

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

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 ($\Sigma m_\nu = 0.01362$ eV < 0.07 eV).
- Geometric phases enable oscillations without mass differences, supporting the equal-mass hypothesis.
- This hypothesis is highly speculative and lacks empirical confirmation.

Formula: $m_{\nu_i} = 4.54$ meV
Total Mass:

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

Comparison with Plausible Target Value:

- ν_e, ν_μ, ν_τ: 4.54 meV vs. 15 meV (Agreement: 30.3%)
- Σm_ν: 13.62 meV vs. 45 meV (Deviation: Factor ≈ 3.30)

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

0.8 Plausible Target Value Based on Empirical Data

0.8.1 Derivation from Measurements

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: $\Sigma m_\nu = 3m_\nu < 0.07$ eV $\implies$ $m_\nu < 23.33$ meV.
- Oscillation Data: $\Delta m^2_{21} \approx 7.53 \times 10^{-5}$ eV^2, $\Delta m^2_{32} \approx 2.44 \times 10^{-3}$ eV^2, typically requiring different masses. The T0 model bypasses this via geometric phases.
- Plausible Target Value: $m_\nu \approx 15$ 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.

0.9 Experimental Comparison

0.9.1 Current Experimental Upper Limits (2025)

Experimental Limits:

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

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

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

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

$$\Delta m^2_{21} \approx 7.53 \times 10^{-5} \text{ eV}^2 \quad [\text{Solar}] \tag{45}$$

$$\Delta m^2_{32} \approx 2.44 \times 10^{-3} \text{ eV}^2 \quad [\text{Atmospheric}] \tag{46}$$

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

0.9.2 Safety Margins for T0 Hypothesis