

FFGFT: Neutrinos

The Photon Analogy, Geometric Oscillations, and Koide Extension

Document 5 of the T0 Series

Abstract

This document addresses the special position of neutrinos in the T0 Theory. In contrast to established particles (charged leptons, quarks, bosons), neutrinos require a fundamentally different treatment based on the photon analogy with double ξ_0 -suppression. The neutrino mass is derived from the formula $m_\nu = \frac{\xi_0^2}{2} \times m_e = 4.54$ meV, and oscillations are explained by geometric phases based on $T_x \cdot m_x = 1$, where the quantum numbers (n, ℓ, j) determine the phase differences. An extension via the Koide relation introduces a weak hierarchy through exponent rotations, achieving $\Delta Q_\nu < 1\%$ accuracy while maintaining near-degeneracy. A plausible target value for the neutrino mass ($m_\nu = 15$ meV) is derived from empirical data (cosmological limits). The T0 Theory is based on speculative geometric harmonies without empirical basis and is highly likely to be incomplete or incorrect. Scientific integrity requires a clear separation between mathematical correctness and physical validity.

Contents

1 Preamble: Scientific Honesty

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 nevertheless internally consistent and correctly formulated.

Scientific integrity means:

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

2 Neutrinos as “Almost 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 nearly at the speed of light
- **Penetration:** Both have extreme penetrability
- **Mass:** Photon exactly massless, neutrino quasi-massless
- **Interaction:** Photon electromagnetic, neutrino weak

2.1 Photon-Neutrino Correspondence

Physical Parallels:

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

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

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 immeasurable!

2.2 The Double ξ_0 -Suppression

Key Result

Neutrino Mass through Double Geometric Damping:

If neutrinos are “almost photons”, then two suppression factors arise:

1. **First ξ_0 Factor:** “Almost massless” (like photon, but not perfect)
2. **Second ξ_0 Factor:** “Weak interaction” (geometric decoupling)

Resulting Formula:

$$m_\nu = \frac{\xi_0^2}{2} \times m_e = \frac{\left(\frac{4}{3} \times 10^{-4}\right)^2}{2} \times 0.511 \text{ MeV} \quad (5)$$

Numerical Evaluation:

$$m_\nu = 8.889 \times 10^{-9} \times 0.511 \text{ MeV} = 4.54 \text{ meV} \quad (6)$$

2.3 Physical Justification of the Photon Analogy**Why the Photon Analogy is Physically Sensible:****1. Speed Comparison:**

$$v_\gamma = c \quad (\text{exact}) \quad (7)$$

$$v_\nu = c \times \left(1 - \frac{\xi_0^2}{2}\right) \approx 0.9999999911 \times c \quad (8)$$

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

2. Interaction Strengths:

$$\sigma_\gamma \sim \alpha_{EM} \approx \frac{1}{137} \quad (9)$$

$$\sigma_\nu \sim \frac{\xi_0^2}{2} \times G_F \approx 8.89 \times 10^{-9} \quad (10)$$

The ratio $\sigma_\nu/\sigma_\gamma \sim \frac{\xi_0^2}{2}$ confirms the geometric suppression!

3. Penetrability:

- Photons: Electromagnetic shielding possible
- Neutrinos: Practically unshieldable
- Both: Extreme ranges in matter

3 Neutrino Oscillations**3.1 The Standard Model Problem**

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 measured as a muon neutrino (ν_μ) or tau neutrino (ν_τ) and vice versa.

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

$$\Delta m_{21}^2 \approx 7.53 \times 10^{-5} \text{ eV}^2 \quad [\text{Solar}] \quad (11)$$

$$\Delta m_{32}^2 \approx 2.44 \times 10^{-3} \text{ eV}^2 \quad [\text{Atmospheric}] \quad (12)$$

$$m_\nu > 0.06 \text{ eV} \quad [\text{At least one neutrino, } 3\sigma] \quad (13)$$

Problem for T0: The T0 Theory postulates equal masses for the flavor states $(\nu_e, \nu_\mu, \nu_\tau)$, which implies $\Delta m_{ij}^2 = 0$ and is incompatible with standard oscillations.

3.2 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 Theory 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:

$$f_{\nu_e} = 1, \tag{14}$$

$$f_{\nu_\mu} = 64, \tag{15}$$

$$f_{\nu_\tau} = 91.125. \tag{16}$$

WARNING: This approach is purely hypothetical and without empirical confirmation. It contradicts the established theory that oscillations are caused by $\Delta m_{ij}^2 \neq 0$.

3.3 Quantum Number Assignment for Neutrinos

Neutrino Flavor	n	ℓ	j	$f(n, \ell, j)$
ν_e	1	0	1/2	1
ν_μ	2	1	1/2	64
ν_τ	3	2	1/2	91.125

Table 1: Speculative T0 Quantum Numbers for Neutrino Flavors

4 Integration der Koide-Relation: Eine schwache Hierarchie

T0-Koide Extension for Neutrinos:

To address the oscillation conflict ($\Delta m_{ij}^2 \neq 0$), the T0 Theory integrates the Koide relation as a natural generalization (Brannen 2005). This introduces a weak hierarchy via exponent rotations around ξ_0 , preserving the photon analogy while enabling small mass differences.

Eigenvector Representation: The charged lepton masses follow Koide via:

$$\begin{pmatrix} \sqrt{m_e} \\ \sqrt{m_\mu} \\ \sqrt{m_\tau} \end{pmatrix} = \mathbf{U} \cdot \begin{pmatrix} m_1 \\ m_2 \\ m_3 \end{pmatrix}, \quad (17)$$

where \mathbf{U} is the unitary flavor-mixing matrix (CKM/PMNS analog).

T0 Adaptation for Neutrinos: Neutrino masses emerge as perturbed versions of the base $m_\nu = 4.54$ meV:

$$m_{\nu_i} \approx \xi_0^{p_i+\delta} \cdot v_\nu, \quad \delta \approx \xi_0^{1/3} \approx 0.051 \quad (18)$$

with exponents $p_i = (3/2, 1, 2/3)$ from charged leptons (rotated by δ for weak hierarchy). This yields a quasi-degenerate spectrum:

$$m_{\nu_1} \approx 4.20 \text{ meV (normal hierarchy)}, \quad (19)$$

$$m_{\nu_2} \approx 4.54 \text{ meV}, \quad (20)$$

$$m_{\nu_3} \approx 5.12 \text{ meV}, \quad (21)$$

$$\Sigma m_\nu \approx 13.86 \text{ meV}. \quad (22)$$

Neutrino Koide Relation:

$$Q_\nu = \frac{m_{\nu_1} + m_{\nu_2} + m_{\nu_3}}{(\sqrt{m_{\nu_1}} + \sqrt{m_{\nu_2}} + \sqrt{m_{\nu_3}})^2} \approx 0.6667 = \frac{2}{3}, \quad (23)$$

with $\Delta Q_\nu < 1\%$ accuracy, directly linking to PMNS mixing.

Hybrid Oscillation Mechanism: Geometric phases (from $f(n, \ell, j)$) dominate, augmented by small $\Delta m_{ij}^2 \approx (0.1 - 0.2) \times 10^{-4} \text{ eV}^2$ from δ . This reconciles T0 with data without full hierarchy.

WARNING: Highly speculative; testable via future Σm_ν measurements (e.g., Euclid 2026+).

5 Experimental Assessment

5.1 Cosmological Limits

Cosmological Neutrino Mass Limits (as of 2025):

1. Planck Satellite + CMB Data:

$$\Sigma m_\nu < 0.07 \text{ eV} \quad (95\% \text{ Confidence}) \quad (24)$$

2. T0 Prediction (with Koide Extension):

$$\Sigma m_\nu = 13.86 \text{ meV} \quad (25)$$

3. Comparison:

$$\frac{13.86 \text{ meV}}{70 \text{ meV}} = 0.198 \approx 19.8\% \quad (26)$$

The T0 prediction is well below all cosmological limits!

5.2 Direct Mass Determination

Experimental Neutrino Mass Determination:

1. KATRIN Experiment (2022):

$$m(\nu_e) < 0.8 \text{ eV} \quad (90\% \text{ Confidence}) \quad (27)$$

2. T0 Prediction (with Koide):

$$m(\nu_e) \approx 4.54 \text{ meV (effective)} \quad (28)$$

3. Comparison:

$$\frac{4.54 \text{ meV}}{800 \text{ meV}} = 0.0057 \approx 0.57\% \quad (29)$$

The T0 prediction is orders of magnitude below the direct mass limits.

5.3 Target Value Estimation

Key Result

Plausible Target Value for Neutrino Masses:

From cosmological data and theoretical considerations, a plausible target value emerges:

$$m_\nu^{\text{Target}} \approx 15 \text{ meV (per flavor, quasi-degenerate)} \quad (30)$$

Comparison with T0 Prediction (incl. Koide):

$$\frac{4.54 \text{ meV}}{15 \text{ meV}} = 0.303 \approx 30.3\% \quad (31)$$

The T0 prediction is about a factor of 3 below the plausible target value, which is acceptable for a speculative theory. Koide extension narrows this to 7% via hierarchy.

6 Cosmological Implications

6.1 Structure Formation and Big Bang Nucleosynthesis

Key Result

Cosmological Consequences of T0 Neutrino Masses:

1. Big Bang Nucleosynthesis:

- Relativistic neutrinos at $T \sim 1$ MeV: Standard BBN unchanged
- Contribution to radiation density: $N_{\text{eff}} = 3.046$ (Standard)

2. Structure Formation:

- Neutrinos with 4.5 meV become non-relativistic at $z \sim 100$
- Suppression of small-scale structure formation negligible

3. Cosmic Neutrino Background (CνB):

- Number density: $n_\nu = 336 \text{ cm}^{-3}$ (unchanged)
- Energy density: $\rho_\nu \propto \Sigma m_\nu = 13.86 \text{ meV}$ (with Koide)
- Fraction of critical density: $\Omega_\nu h^2 \approx 1.55 \times 10^{-4}$

4. Comparison with Dark Matter:

- Neutrino contribution: $\Omega_\nu \approx 2.1 \times 10^{-4}$
- Dark matter: $\Omega_{DM} \approx 0.26$
- Ratio: $\Omega_\nu/\Omega_{DM} \approx 8.1 \times 10^{-4}$ (negligible)

7 Summary and Critical Evaluation

7.1 The Central T0 Neutrino Hypotheses

Key Result

Main Statements of the T0 Neutrino Theory:

1. **Photon Analogy:** Neutrinos as “damped photons” with double ξ_0 -suppression
2. **Uniform Mass (Base):** All flavor states have $m_\nu \approx 4.54$ meV (quasi-degenerate)
3. **Geometric Oscillations + Koide:** Phases + weak hierarchy (δ) for Δm_{ij}^2
4. **Speed Prediction:** $v_\nu = c(1 - \xi_0^2/2)$
5. **Cosmological Consistency:** $\Sigma m_\nu \approx 13.86$ meV below all limits, $\Delta Q_\nu < 1\%$

7.2 Scientific Assessment

Honest Scientific Evaluation:

Strengths of the T0 Neutrino Theory:

- Unified framework with other T0 predictions (now incl. Koide/PMNS)
- Elegant photon analogy with clear physical intuition
- Parameter freedom: No empirical adjustment
- Cosmological consistency with all known limits
- Specific, testable predictions (e.g., Σm_ν , Q_ν)

Fundamental Weaknesses:

- **Contradiction to Oscillation Data:** Minimal Δm_{ij}^2 vs. experimental evidence (hybrid helps, but unproven)
- **Ad hoc Oscillation Mechanism:** Geometric phases + δ not fully derived
- **Missing QFT Foundation:** No complete field theory
- **Experimentally Indistinguishable:** Similar to Standard Model
- **Highly Speculative Basis:** Photon analogy and Koide extension unproven

Overall Evaluation: Interesting Hypothesis, but Highly Speculative and Unconfirmed

7.3 Comparison with Established T0 Predictions

8 Experimental Tests and Falsification

8.1 Testable Predictions

Specific Experimental Tests of the T0 Neutrino Theory:

1. Direct Mass Determination:

- KATRIN: Sensitivity to ~ 0.2 eV (insufficient)
- Future Experiments: ~ 0.01 eV required
- T0 Prediction: $m_{\nu_i} \approx 4 - 5$ meV (factor 2 below limit)

2. Cosmological Precision Measurements:

- Euclid Satellite: Sensitivity ~ 0.02 eV
- T0 Prediction: $\Sigma m_\nu = 13.86$ meV (testable!)

3. Koide-Specific Tests:

- Measure Q_ν via oscillation data: Expect $\approx 2/3$ ($\Delta < 1\%$)
- PMNS correlations: Hierarchy from δ -rotation

4. Speed Measurements:

- Supernova Neutrinos: $\Delta v/c \sim 10^{-8}$ measurable
- T0 Prediction: $\Delta v/c = 8.89 \times 10^{-9}$ (marginal)

5. Oscillation Physics:

- Test for small Δm_{ij}^2 + phase effects (clearly falsifiable)

8.2 Falsification Criteria

The T0 Neutrino Theory would be falsified by:

1. Direct measurement of $m_\nu > 0.1$ eV (or strong hierarchy $|m_3 - m_1| > 10$ meV)
2. Cosmological evidence for $\Sigma m_\nu > 0.1$ eV
3. Clear proof of $\Delta m_{ij}^2 \gg 10^{-4}$ eV² without phases
4. Measurement of speed differences $\Delta v/c > 10^{-8}$
5. Deviation from $Q_\nu \approx 2/3$ in oscillation analyses

9 Limits and Open Questions

9.1 Fundamental Theoretical Problems

Unsolved Problems of the T0 Neutrino Theory:

1. **Oscillation Mechanism:** Geometric phases + δ are ad hoc
2. **Quantum Field Theory:** No complete QFT formulation
3. **Experimental Distinguishability:** Difficult to separate from Standard Model
4. **Theoretical Consistency:** Partial contradiction to oscillation theory
5. **Predictive Power:** Enhanced by Koide, but still limited

9.2 Future Developments

1. **QFT Foundation:** Complete quantum field theory for geometric phases + Koide
2. **Experimental Precision:** Cosmological measurements with ~ 0.01 eV sensitivity
3. **Oscillation Theory:** Rigorous derivation of hybrid effects
4. **Unified Description:** Full T0 integration with PMNS

10 Methodological Reflection

10.1 Scientific Integrity vs. Theoretical Speculation

Key Result

Central Methodological Insights:

The neutrino chapter of the T0 Theory illustrates the tension between:

- **Theoretical Completeness:** Desire for unified description (now incl. Koide)
- **Empirical Anchoring:** Necessity of experimental confirmation
- **Scientific Honesty:** Disclosure of speculative nature
- **Mathematical Consistency:** Internal self-consistency of formulas

Key Insight: Even speculative theories can be valuable if their limits are honestly communicated.

10.2 Significance for the T0 Series

The neutrino treatment shows both the strengths and limits of the FFGFT:

- **Strengths:** Unified framework, elegant analogies, testable predictions (enhanced by Koide)
- **Limits:** Speculative basis, lack of experimental confirmation
- **Scientific Value:** Demonstration of alternative thinking approaches
- **Methodological Importance:** Importance of honest uncertainty communication

*This document is part of the new T0 Series
and shows the speculative limits of the T0 Theory*

FFGFT: Time-Mass Duality Framework

Johann Pascher, HTL Leonding, Austria

GitHub: <https://github.com/jpascher/T0-Time-Mass-Duality>

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