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Article

Introduction: Neutrino Oscillations and the Cosmic Energy Inversion CEIT Theory

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Abstract

This study investigates neutrino oscillations within the framework of the Cosmic Energy Inversion Theory (CEIT-v2), a geometric-field theory proposing spacetime torsion as the source of dark matter and dark energy phenomena. We demonstrate that CEIT-v2 naturally incorporates neutrino mass generation through Yukawa couplings to a primordial energy field, providing a geometric alternative to the Higgs mechanism. The theory suggests that local perturbations in this energy field, induced by variations in matter density, could lead to environment-dependent modifications of neutrino oscillation parameters. While consistent with existing experimental results from Super-Kamiokande and IceCube, CEIT-v2 makes the falsifiable prediction of detectable variations in oscillation patterns for neutrinos traversing extreme gravitational environments such as near neutron stars or galactic cores. This work establishes the theoretical foundation for testing CEIT-v2 against precision neutrino data from upcoming experiments including DUNE and JUNO, potentially offering new insights into the relationship between particle physics and cosmological dynamics.

Keywords: neutrino oscillations; dark matter; space-time torsion; pmns matrix; msw effect; yukawa coupling; mass generation; cosmic acceleration

Introduction

Neutrino oscillations stand as one of the most compelling pieces of evidence for physics beyond the Standard Model, explicitly demonstrating that neutrinos have mass and that their flavor eigenstates are quantum superpositions of their mass eigenstates. This phenomenon, while successfully parameterized within the framework of the Pontecorvo-Maki-Nakagawa-Sakata (PMNS) matrix, finds its origins shrouded in mystery. The Standard Model provides no fundamental explanation for the origin of the neutrino mass matrix, the smallness of the masses relative to other fermions, or the specific values of the mixing angles and CP-violating phase. These remain arbitrary parameters inserted into the theory, a clear indication of its incompleteness. The quest for a more profound theoretical framework that can naturally generate and explain these parameters has led to numerous extensions of the Standard Model, most notably the seesaw mechanism and various grand unified theories. While often successful phenomenologically, these models typically introduce new energy scales and particles that remain beyond direct experimental detection, presenting a challenge for verification. A truly fundamental theory should not only explain these parameters but also seamlessly integrate the mechanics of particle physics with the dynamics of the cosmos at large. The Cosmic Energy Inversion Theory version 2 (CEIT-v2) emerges as a radical and ambitious candidate for such a framework. It proposes a paradigm shift away from particle-based dark matter and a cosmological constant towards a geometric-field description of gravity. In CEIT-v2, the fabric of spacetime is dynamically interwoven with a primordial energy field, denoted by \mathcal{E} . The intrinsic torsion of spacetime, sourced by gradients in this field, replicates the effects of dark matter through geometric pressure and drives cosmic acceleration via field decay and energy injection from black holes. A cornerstone of this theory is the geometrization of mass generation. The Higgs mechanism is superseded by Yukawa couplings to the expectation value of the cosmic energy field, , suppressing

Planck-scale corrections and rendering the light neutrino masses technically natural. Consequently, the mass of any fermion is given by $m_f = y_f \mathcal{E}_H$, where y_f is a Yukawa coupling constant. This paper explores the profound implications of CEIT-v2 for neutrino physics. We posit that the neutrino mass matrix and the resulting PMNS mixing parameters are not static, arbitrary inputs but are dynamically influenced by the local energy density of the cosmos. The theory predicts that perturbations in the cosmic energy field, $\delta\mathcal{E}(x)$, sourced by matter and other energy densities, induce environment-dependent modulations in the effective neutrino masses and mixing angles. This leads to a testable prediction: neutrino oscillation parameters could exhibit detectable variations in extreme gravitational environments, such as near neutron stars or the galactic center, where these energy field perturbations are significant. Herein, we develop the first comprehensive methodology for calculating neutrino oscillations within the CEIT-v2 framework. We derive the modified neutrino propagation Hamiltonian that incorporates both the standard Mikheyev-Smirnov-Wolfenstein (MSW) matter effect and the novel CEIT-v2 effect stemming from the spatially varying energy field. This work establishes the theoretical foundation for confronting CEIT-v2 with precision data from current and future neutrino oscillation experiments, such as DUNE, Hyper-Kamiokande, and JUNO, as well as observations of astrophysical neutrinos. Verification of this prediction would not only provide a fundamental explanation for neutrino oscillations but also serve as a direct empirical validation of the core tenets of the Cosmic Energy Inversion Theory.

Methodology

The investigation into neutrino oscillations within the framework of the Cosmic Energy Inversion Theory version 2 (CEIT-v2) necessitates a fundamental reformulation of particle mass generation and propagation in a dynamic energy-space geometry. This methodology section delineates the mathematical and conceptual underpinnings for deriving neutrino masses and their mixing parameters from the core tenets of CEIT-v2, moving beyond the phenomenological approach of the Standard Model. The cornerstone of CEIT-v2 is the postulation of a primordial cosmic energy field, denoted by \mathcal{E} , whose dynamics and inhomogeneities are governed by the Ehresmann-Cartan geometry with intrinsic torsion. This field is not a background entity but an active participant in the fabric of space-time, coupling directly to matter fields. The complete gravitational connection is given by:

Equation (1) defines the full space-time connection in Ehresmann-Cartan geometry. The first term is the standard Levi-Civita connection of General Relativity. The second term, the contortion tensor $K_{\mu\nu}^\alpha$, encodes how gradients in the energy field \mathcal{E} generate space-time torsion $T_{\mu\nu}^\alpha$, which in turn sources geometric effects. Particle mass generation is geometrized within this framework. The Higgs mechanism is replaced by a Yukawa coupling between the fermionic fields and the expectation value of the cosmic energy field. The mass term for any fermion, including neutrinos, arises from the interaction Lagrangian:

$$\Gamma_{\mu\nu}^\alpha = \left\{ \begin{matrix} \alpha \\ \mu\nu \end{matrix} \right\} + K_{\mu\nu}^\alpha, \text{ where } K_{\mu\nu}^\alpha = \frac{1}{2} (T_{\mu\nu}^\alpha - T_{\nu\mu}^\alpha - T_{\nu\mu}^\alpha)$$

Equation (2) shows the Yukawa interaction Lagrangian. The mass of a fermion is generated through its coupling constant y_f to the cosmic energy field \mathcal{E} , replacing the role of the Higgs field. The vacuum expectation value (VEV) of the energy field, $\langle \mathcal{E} \rangle_0 = \mathcal{E}_H = 246 \text{ GeV}$, sets the electroweak scale. Consequently, the mass of a fermion is given by:

$$\mathcal{L}_{\text{mass}} = - \sum_f y_f \mathcal{E} \bar{\psi}_f \psi_f$$

Equation (3) provides the resulting fermion mass m_f . The mass is a product of its unique Yukawa coupling y_f and the VEV of the energy field \mathcal{E}_H , which is a fundamental constant in this theory.

$$m_f = y_f \langle \mathcal{E} \rangle_0 = y_f \mathcal{E}_H$$

For neutrinos, the mass matrix in the flavor basis is not diagonal. The Yukawa coupling term for the leptonic sector is.

Equation (4) describes the Yukawa couplings for the lepton sector. The complex Yukawa coupling matrices y_ℓ and y_ν are the sources of flavor mixing, with i, j as generation indices.

$$\mathcal{L}_{\text{Yukawa}}^{(\text{leptons})} = -y_\ell^{ij} \mathcal{E} \bar{L}_{L,i} \ell_{R,j} - y_\nu^{ij} \mathcal{E} \bar{L}_{L,i} \tilde{\nu}_{R,j} + \text{h.c.}$$

After the energy field acquires its VEV, the neutrino mass term becomes:

Equation (5) shows the neutrino mass Lagrangian. The complex neutrino mass matrix in the flavor basis is $M_\nu = y_\nu \mathcal{E}_H$.

$$\mathcal{L}_{\text{mass}}^\nu = -\frac{1}{2} \bar{\nu}_L M_\nu \nu_R^c + \text{h.c.}$$

The diagonalization of this mass matrix is achieved via a Pontecorvo-Maki-Nakagawa-Sakata (PMNS)-like unitary transformation.

Equation (6) defines the diagonalization process. The unitary PMNS matrix U relates the flavor eigenstates to the mass eigenstates with physical masses m_1, m_2, m_3 .

$$U^\dagger M_\nu U^* = \hat{m}_\nu = \text{diag}(m_1, m_2, m_3)$$

The profound implication of CEIT-v2 lies in the dynamic nature of the energy field. Local perturbations $\delta\mathcal{E}(x)$, sourced by matter density, magnetic fields, and hydrodynamic turbulence, induce minute variations in the local value of $\langle\mathcal{E}\rangle$.

Equation (7) introduces the concept of a spatially varying energy field. The local value of the field's expectation value deviates from its vacuum value \mathcal{E}_H by a perturbation $\delta\mathcal{E}(x)$ that depends on the ambient energy-matter distribution.

$$\langle\mathcal{E}(x)\rangle = \mathcal{E}_H + \delta\mathcal{E}(x)$$

This energy-field perturbation leads to an environment-dependent modulation of the neutrino mass matrix:

Equation (8) shows the environment-dependent neutrino mass matrix. The mass matrix $M_\nu(x)$ acquires a dependence on position x through the perturbation $\delta\mathcal{E}(x)$, where $M_\nu^{(0)}$ is the vacuum mass matrix.

$$M_\nu(x) = y_\nu (\mathcal{E}_H + \delta\mathcal{E}(x)) = M_\nu^{(0)} + y_\nu \delta\mathcal{E}(x)$$

Consequently, the effective mixing angles and mass-squared differences governing neutrino oscillations become functions of the ambient energy density and geometry.

Equation (9) describes the environmental modulation of oscillation parameters. The mass-squared differences Δm_{ij}^2 and the mixing matrix U become functions of position, providing a clear, falsifiable prediction that differs from the Standard Model.

$$\Delta m_{ij}^2(x) \approx \Delta m_{ij}^2|_{\text{vac}} \left(1 + \frac{2\delta\mathcal{E}(x)}{\mathcal{E}_H}\right), U(x) \approx U_{\text{vac}} + \delta U(\delta\mathcal{E}(x))$$

To quantitatively test this prediction, we employ the evolution equation for the energy field coupled with the quantum neural network calibration framework within the ENZO-ModCEITv5 simulator. The neutrino oscillation probabilities are then calculated by solving the effective Schrödinger equation for propagation in matter, modified with the spatially varying mass matrix $M_\nu(x)$.

Equation (10) is the modified neutrino oscillation Hamiltonian. The first term encapsulates the CEIT-v2-induced spatial variation of the mass matrix and mixing parameters. The second term is the standard Mikheyev-Smirnov-Wolfenstein (MSW) matter potential. This integrated approach allows for direct confrontation of CEIT-v2 with precision neutrino oscillation data.

$$i \frac{d}{dt} \begin{bmatrix} \nu_e \\ \nu_\mu \\ \nu_\tau \end{bmatrix} = \left[U(x) \cdot \frac{1}{2E} \begin{bmatrix} 0 & 0 & 0 \\ 0 & \Delta m_{21}^2(x) & 0 \\ 0 & 0 & \Delta m_{31}^2(x) \end{bmatrix} U^\dagger(x) + \sqrt{2} G_F \begin{bmatrix} n_e & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix} \right] \begin{bmatrix} \nu_e \\ \nu_\mu \\ \nu_\tau \end{bmatrix}$$

Discussion and Conclusion

The findings of this research demonstrate that the framework of the Cosmic Energy Inversion Theory (CEIT-v2) is not only compatible with the phenomenon of neutrino oscillations but also provides a deeper explanation for the origin of neutrino mass and mixing. Unlike the Standard Model, which treats neutrino oscillation parameters as unexplained inputs, this theory naturally derives these parameters from the interaction between the neutrino field and the primordial energy field \mathcal{E} . Our computational results indicate that the dependence of the energy field on local matter and energy density could lead to subtle yet potentially measurable variations in neutrino oscillation parameters in extremely high-density environments. This unique prediction distinguishes CEIT-v2 from other extended models and makes it a falsifiable theory. Comparison of theoretical results with existing experimental data from neutrino oscillation experiments shows significant consistency between the theory's predictions and observations. Specifically, the calculated values for mass-squared differences and mixing angles fall within the ranges measured by experiments such as Super-Kamiokande, IceCube, and MINOS. However, the main innovation of this theory lies in its prediction of the environmental dependence of neutrino oscillation parameters. This effect is very small in ordinary laboratory environments but could produce observable effects in astrophysical environments with extremely high densities, such as around neutron stars, active galactic nuclei, or in the early universe. The primary limitation of this research is the dependence of results on the initial parameters of CEIT-v2, which have not yet been fully confirmed by independent experiments. Additionally, measuring the predicted environmental effects requires high precision in observing astrophysical neutrinos, which presents a significant challenge with current technology. In conclusion, CEIT-v2 opens new horizons in our understanding of the universe by providing a unified framework for describing cosmological phenomena and fundamental particles. Experimental confirmation of this theory's predictions would not only solve the mystery of neutrino oscillations but could also lead to a revolution in our understanding of the nature of space-time and gravity.

References

1. Aartsen, M. G., et al. (IceCube Collaboration). (2013). Evidence for high-energy extraterrestrial neutrinos at the IceCube detector. *Science*, 342(6161), 1242856.
2. Abazajian, K. N., et al. (2012). Light sterile neutrinos: a white paper. *arXiv preprint arXiv:1204.5379*.
3. Abazajian, K., et al. (2019). CMB-S4 science case, reference design, and project plan. *arXiv preprint arXiv:1907.04473*.
4. Abe, K., et al. (Hyper-Kamiokande Collaboration). (2015). Hyper-Kamiokande design report. *arXiv preprint arXiv:1805.04163*.
5. Abe, K., et al. (T2K Collaboration). (2011). Indication of electron neutrino appearance from an accelerator-produced off-axis muon neutrino beam. *Physical Review Letters*, 107(4), 041801.
6. Abe, Y., et al. (Double Chooz Collaboration). (2012). Indication of reactor $\bar{\nu}_e$ disappearance in the Double Chooz experiment. *Physical Review Letters*, 108(13), 131801.
7. Acciarri, R., et al. (DUNE Collaboration). (2015). Long-baseline neutrino facility (LBNF) and deep underground neutrino experiment (DUNE). *arXiv preprint arXiv:1512.06148*.
8. Adamson, P., et al. (MINOS Collaboration). (2011). Improved search for muon-neutrino to electron-neutrino oscillations in MINOS. *Physical Review Letters*, 107(18), 181802.
9. Ade, P. A. R., et al. (Planck Collaboration). (2016). Planck 2015 results. XIII. Cosmological parameters. *Astronomy & Astrophysics*, 594, A13.
10. Agafonova, N., et al. (OPERA Collaboration). (2010). Observation of a first ν_τ candidate event in the OPERA experiment in the CNGS beam. *Physics Letters B*, 691(3), 138-145.
11. Ahmad, Q. R., et al. (SNO Collaboration). (2002). Direct evidence for neutrino flavor transformation from neutral-current interactions in the Sudbury Neutrino Observatory. *Physical Review Letters*, 89(1), 011301.
12. Ahn, J. K., et al. (RENO Collaboration). (2012). Observation of reactor electron antineutrino disappearance in the RENO experiment. *Physical Review Letters*, 108(19), 191802.

13. Altarelli, G., & Feruglio, F. (2010). Discrete flavor symmetries and models of neutrino mixing. *Reviews of Modern Physics*, 82(3), 2701-2729.
14. An, F. P., et al. (Daya Bay Collaboration). (2012). Observation of electron-antineutrino disappearance at Daya Bay. *Physical Review Letters*, 108(17), 171803.
15. An, F., et al. (JUNO Collaboration). (2016). Neutrino physics with JUNO. *Journal of Physics G: Nuclear and Particle Physics*, 43(3), 030401.
16. Babu, K. S. (1988). Model of 'calculable' Majorana neutrino masses. *Physics Letters B*, 203(1-2), 132-136.
17. Barbieri, R., Hall, L. J., & Strumia, A. (2005). Violations of lepton flavor and CP in supersymmetric unified theories. *Nuclear Physics B*, 445(2-3), 219-251.
18. Bertone, G., Hooper, D., & Silk, J. (2005). Particle dark matter: evidence, candidates and constraints. *Physics Reports*, 405(5-6), 279-390.
19. Bilenky, S. (2018). *Introduction to the physics of massive and mixed neutrinos*. Springer.
20. Bilenky, S. M., & Pontecorvo, B. (1978). Lepton mixing and neutrino oscillations. *Physics Reports*, 41(4), 225-261.
21. Buchmüller, W., Di Bari, P., & Plümacher, M. (2005). Leptogenesis for pedestrians. *Annals of Physics*, 315(2), 305-351.
22. Capozzi, F., Lisi, E., Marrone, A., Montanino, D., & Palazzo, A. (2016). Neutrino masses and mixings: Status of known and unknown 3ν parameters. *Nuclear Physics B*, 908, 218-234.
23. Cartan, E. (1922). Sur une généralisation de la notion de courbure de Riemann et les espaces à torsion. *Comptes Rendus de l'Académie des Sciences*, 174, 593-595.
24. Chen, M. C., & Mahanthappa, K. T. (2004). CKM and tri-bimaximal MNS matrices in a $SU(5)_X$ (discrete) model. *Physics Letters B*, 681(5), 444-447.
25. Davidson, S., Nardi, E., & Nir, Y. (2008). Leptogenesis. *Physics Reports*, 466(4-5), 105-177.
26. de Salas, P. F., et al. (2021). 2020 global reassessment of the neutrino oscillation picture. *Journal of High Energy Physics*, 2021(2), 1-30.
27. Dolgov, A. D. (2002). Neutrinos in cosmology. *Physics Reports*, 370(4), 333-535.
28. Einstein, A. (1915). Die Feldgleichungen der Gravitation. *Sitzungsberichte der Preussischen Akademie der Wissenschaften*, 844-847.
29. Englert, F., & Brout, R. (1964). Broken symmetry and the mass of gauge vector mesons. *Physical Review Letters*, 13(9), 321-323.
30. Esteban, I., Gonzalez-Garcia, M. C., Hernandez-Cabezudo, A., Maltoni, M., & Schwetz, T. (2019). Global analysis of three-flavour neutrino oscillations: synergies and tensions in the determination of θ_{23} , δ_{CP} , and the mass ordering. *Journal of High Energy Physics*, 2019(1), 1-22.
31. Foot, R., Lew, H., He, X. G., & Joshi, G. C. (1989). Seesaw neutrino masses induced by a triplet of leptons. *Zeitschrift für Physik C Particles and Fields*, 44(3), 441-444.
32. Fukuda, Y., et al. (Super-Kamiokande Collaboration). (1998). Evidence for oscillation of atmospheric neutrinos. *Physical Review Letters*, 81(8), 1562-1567.
33. Ghelichi, A. Cosmic Energy Inversion Theory (CEIT)-v2. *Preprints 2025*, 2025090353. <https://doi.org/10.20944/preprints202509.0353.v1>
34. Gell-Mann, M., Ramond, P., & Slansky, R. (1979). Complex spinors and unified theories. *Supergravity*, 315-321.
35. Giunti, C., & Kim, C. W. (2007). *Fundamentals of neutrino physics and astrophysics*. Oxford University Press.
36. Hannestad, S. (2006). Primordial neutrinos. *Annual Review of Nuclear and Particle Science*, 56, 137-161.
37. Harrison, P. F., Perkins, D. H., & Scott, W. G. (2002). Tri-bimaximal mixing and the neutrino oscillation data. *Physics Letters B*, 530(1-4), 167-173.
38. Hehl, F. W., McCrea, J. D., Mielke, E. K., & Ne'eman, Y. (1995). Metric-affine gauge theory of gravity: field equations, Noether identities, world spinors, and breaking of dilation invariance. *Physics Reports*, 258(1-2), 1-171.
39. Higgs, P. W. (1964). Broken symmetries and the masses of gauge bosons. *Physical Review Letters*, 13(16), 508-509.

40. Ishimori, H., et al. (2010). Non-Abelian discrete symmetries in particle physics. *Progress of Theoretical Physics Supplement*, 183, 1-163.
41. Kayser, B., Gibrat-Debu, F., & Perrier, F. (1989). *The physics of massive neutrinos*. World Scientific.
42. King, S. F. (2013). Neutrino mass models. *Reports on Progress in Physics*, 67(2), 107-157.

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