Article

Not peer-reviewed version

Seesaw Model of Neutrino Mass Estimation with a Dirac Mass of 585 GeV Electroweak Fermion and the Unified Stoney Mass

Satya Seshavatharam U.V *, Gunavardhana Naidu T, Lakshminarayana S

Posted Date: 22 July 2025

doi: 10.20944/preprints202507.1680.v1

Keywords: neutrinos; Seesaw method; Dirac mass; electroweak fermion of 585 GeV; GUT scale; Stoney mass

Preprints.org (www.preprints.org) | NOT PEER-REVIEWED | Posted: 22 July 2025 doi:10.20944/preprints202507.1680.v1

Article

Seesaw Model of Neutrino Mass Estimation with a Dirac Mass of 585 GeV Electroweak Fermion and the Unified Stoney Mass

U. V. S. Seshavatharam [1,2,*], T. Gunavardhana Naidu [3] and S. Lakshminarayana [4]

[1] Honorary faculty, I-SERVE, Survey no-42, Hitech city, Hyderabad-500084,Telangana, India
[2] Quality Assurance Dept, Casting, DIP Division, Electrosteel Castings Ltd, Srikalahasthi-517641, AP, India
[3] Dept. of Physics, Aditya Institute of Technology and Management, Tekkali-532201, AP, India
[4] Dept. of Nuclear Physics, Andhra University, Visakhapatnam-530003, AP, India
* **Correspondence:** Seshavatharam.uvs@gmail.com

Abstract

In this work, we propose a novel approach to estimate neutrino masses using a Dirac seesaw mechanism grounded in our 4G model of final unification. The framework utilizes a Dirac mass of 585 GeV, an assumed electroweak fermion having its existence connected with nuclear structure and the unified Stoney mass of 1.859e-9 kg. Neutrino mass hierarchies are constructed using integer scaling parameters 1,2 and 3 connected with the lepton series and square roots of charged lepton mass ratios associated with electron. Estimated rest masses of the three neutrinos are 0.289 meV/c², 8.297 meV/c² and 51.03 meV/c² respectively, yielding a total neutrino mass sum of 59.63 meV. Including antineutrinos, the combined mass sum is 0.12 eV, consistent with cosmological constraints and the Dirac neutrino hypothesis. For data fitting, we consider a coefficient of 0.88. This coefficient may be refined with future observations and theoretical developments.

Keywords: neutrinos; Seesaw method; Dirac mass; electroweak fermion of 585 GeV; GUT scale; Stoney mass

---

1. Introduction

The origin and absolute scale of neutrino masses remain one of the central mysteries in particle physics. We approach this problem through a Dirac seesaw framework [1-8] inspired by our proposed 4G model of final unification having four different gravitational constants and an electroweak fermion of rest energy 585 GeV [9,10,11]. Within this model, we derive neutrino masses based on a high-scale Dirac mass term of 585 GeV and a unified gravitational mass associated with the Stoney scale [12,13]. To better match the mass observations, a fitting coefficient of 0.88 is applied. It can have a range of (0.85 to 0.9).

2. Modified Seesaw Mass Formula

Based on the Seesaw model, we adopt a modified formula in the following way. It needs a critical review at fundamental level. For the time being it can be considered as a reference mass formula.

$$m_{l\upsilon} \cong k * n * \sqrt{\frac{m_{lepton}}{m_e}} \left(\frac{M_D^2}{M_{GUT}} \right) \cong 0.88 * n * \sqrt{\frac{m_{lepton}}{m_e}} \left(\frac{M_{wf}^2}{M_{Stoney}} \right) \tag{1}$$

where,

$m_{l\upsilon} \cong$ Mass of lepton neutrino

$k \cong$ A coefficient needs attention and review $\cong 0.88$

$n = 1, 2, 3$ for electron, muon and tau respectively.

$$\frac{m_{lepton}}{m_e} \cong \frac{\text{Mass of electron or Muon or Tau}}{\text{Mass of electron}}$$

$M_D \cong$ Dirac mass $\cong M_{wf} \cong 584.725\ \text{GeV}/c^2$

$\cong$ Proposed electroweak fermion of our 4G model of final unification [9,10,11]

$M_{Gut} \cong$ Grand Unified mass unit

$$\cong M_{Stoney} \cong \sqrt{\frac{e^2}{4\pi\varepsilon_0 G_N}} \cong 1.85921\times10^{-9}\ \text{kg} \cong \text{Stoney mass [12,13]}$$

$G_N \cong$ Newtonian gravitational constant

The factor 0.88 is included as a phenomenological correction factor, likely tied to radiative or cosmological damping effects. These values suggest a hierarchical pattern among neutrino masses, with the electron neutrino being the lightest and tau neutrino the heaviest. This mass distribution is a natural outcome of the formula used and reflects the scaling with lepton mass and generation index. In terms of gravitational and electromagnetic force ratio associated with M_{wf} having a charge e can be expressed as,

$$m_{l\upsilon} \cong 0.88 * n * \sqrt{\frac{4\pi\varepsilon_0 G_N M_{wf}^2}{e^2}} \sqrt{\frac{m_{lepton}}{m_e}} \left(M_{wf}\right)$$

(2)

3. Calculated Neutrino Masses and the Cosmological Observations

At n=1, Electron neutrino mass is $m_{e\upsilon} \cong 0.289\ \text{meV}/c^2$

At n=2, Muon neutrino mass is $m_{\mu\upsilon} \cong 8.297\ \text{meV}/c^2$

At n=3, Tau neutrino mass is $m_{\tau\upsilon} \cong 51.03\ \text{meV}/c^2$

Sum of the three neutrino rest masses can be expressed as,

$$\sum m_\upsilon c^2 \cong (0.289) + (8.297) + (51.03) \cong\ 59.63\ \text{meV} \quad (3)$$

Sum of the three anti neutrino rest masses can also be expressed as,

$$\sum \overline{m_\upsilon} c^2 \cong (0.289) + (8.3) + (51.0) \cong\ 59.63\ \text{meV}$$

(4)

$$\sum m_\upsilon c^2 + \sum \overline{m_\upsilon} c^2 \cong 2 * 59.63 \cong\ 119.26\ \text{meV} \quad (5)$$

This value is consistent with cosmological observations (Planck 2018, DESI 2024) [17,18].

4. Mass Splitting of the Estimated Neutrinos Using the Squared Mass Differences

For the above estimated neutrino masses,

$$\left(m_{\tau\upsilon}^2 - m_{\mu\upsilon}^2\right)c^4 \cong 2.54\times10^{-3}\ \text{eV}^2 \quad (6)$$

$$\left(m_{\mu\upsilon}^2 - m_{e\upsilon}^2\right)c^4 \cong 6.875\times10^{-5}\ \text{eV}^2 \quad (7)$$

These values are well-aligned with experimental data from solar and atmospheric neutrino oscillations [19,20]. The mass-squared differences are key observables in neutrino physics. Their compatibility with experimental results provides support for the proposed mass model and helps validate the scaling relations applied [14-18].

doi:10.20944/preprints202507.1680.v1

5. To Replace the Stoney Scale and the Planck Scale

The Stoney scale [11,12], introduced by George Stoney before the advent of quantum theory, is based on the elementary constants e, G_N and c and defines a natural gravitational-electromagnetic mass scale. It is given by,

$$M_{Stoney} \cong \sqrt{\frac{e^2}{4\pi\varepsilon_0 G_N}} \cong 1.85921\times 10^{-9}\ \text{kg} \qquad (8)$$

Using the definition of the fine-structure constant,

$$\alpha \cong \frac{e^2}{4\pi\varepsilon_0 \hbar c} \qquad (9)$$

We obtain the relation,

$$M_{Stoney} \cong \sqrt{\alpha}\left(\sqrt{\frac{\hbar c}{G_N}}\right) \cong \sqrt{\alpha}\left(M_{Planck}\right) \qquad (10)$$

This shows that the Stoney mass is naturally suppressed compared to the Planck mass by a factor of $\sqrt{\alpha} \cong \frac{1}{11.7}$. In this context, the Stoney mass may be viewed as an intermediate scale connecting gravity and electromagnetism, and its appearance in our seesaw formulation highlights a possible coupling between charged lepton mass ratios and unified gravitational effects. Thus, our proposed seesaw relation can be expressed as,

$$m_{l\upsilon} \cong \frac{k*n}{\sqrt{\alpha}} * \sqrt{\frac{m_{lepton}}{m_e}}\left(\frac{M_{wf}^2}{M_{Planck}}\right) \qquad (11)$$

where $k \cong (0.85 \text{ to } 0.9) \cong 0.88$

Following this relation, quantitatively, in a trial-error method, we have noticed that,

$$\frac{k}{\sqrt{\alpha}} \cong \ln\left(\frac{M_{wf}}{\sqrt{m_p m_e}}\right) \cong 10.193$$
$$\rightarrow k \cong \sqrt{\alpha}\times \ln\left(\frac{M_{wf}}{\sqrt{m_p m_e}}\right) \cong 0.871 \qquad (12)$$

Now $\frac{k*n}{\sqrt{\alpha}}$ can be expressed as,

$$\frac{k*n}{\sqrt{\alpha}} \cong n*\ln\left(\frac{M_{wf}}{\sqrt{m_p m_e}}\right) \cong \ln\left(\frac{M_{wf}}{\sqrt{m_p m_e}}\right)^n$$

(13)

Thus,

$$m_{l\upsilon} \cong \ln\left(\frac{M_{wf}}{\sqrt{m_p m_e}}\right)^n * \sqrt{\frac{m_{lepton}}{m_e}}\left(\frac{M_{wf}^2}{M_{Planck}}\right) \qquad (14)$$

6. General Discussion

Our approach assumes Dirac neutrinos, supported by the absence of neutrino less double beta decay and lepton number violation. This contrasts with conventional Type-I seesaw models which typically favour Majorana neutrinos due to lepton number violation considerations. The model's consistency with cosmological bounds (total mass < 0.12 eV) strengthens its viability. The introduction of the 0.88 coefficient seems to direct towards a deeper unification of physics or understated suppression effects inherent in cosmic evolution.

The use of a Dirac framework suggests that neutrinos have distinct antiparticles and conserve lepton number. This choice is not only conceptually economical but also observationally motivated.

Furthermore, the cosmological data from Planck and DESI provides strong upper limits on the neutrino mass sum, and our results satisfy these bounds comfortably. Currently, there is limited clarity on the cosmological distinction between neutrinos and antineutrinos-particularly regarding their thermal histories, possible annihilation, and relic asymmetries. Further theoretical and observational studies are required to explore these aspects, especially in the context of Dirac neutrino models where lepton number conservation plays a crucial role.Although neutrinos and antineutrinos can, in principle, annihilate via weak interactions, such annihilations become highly suppressed after thermal decoupling in the early universe. In the context of Dirac neutrinos, where lepton number is conserved and neutrinos are distinct from antineutrinos, it remains unclear whether any relic asymmetry could have influenced their annihilation history. This issue merits deeper theoretical investigation.

7. Conclusions

Our 4G model of final unification, combined with a Dirac seesaw mechanism and lepton mass ratios, yields physically meaningful neutrino mass estimates consistent with known neutrino oscillations and cosmological data. Further exploration of the proposed 585 GeV Dirac mass and the unified gravitational Stoney mass may uncover deeper structures in neutrino physics. This approach offers a compelling alternative to conventional Majorana-based models, and its alignment with data encourages further theoretical and phenomenological development. Future studies may focus on refining the damping coefficient, exploring links with quantum gravity, and identifying potential experimental signals.

Data Availability Statement: The data that support the findings of this study are openly available.

Acknowledgements: Authors are very much thankful to the 'ChatGPT' for helping us in drafting the paper for its best presentation. Author Seshavatharam is indebted to professors Padma Shri M. Nagaphani Sarma, Chairman, Shri K.V. Krishna Murthy, founder Chairman, Institute of Scientific Research in Vedas (I-SERVE), Hyderabad, India and Shri K.V.R.S. Murthy, former scientist IICT (CSIR), Govt. of India, Director, Research and Development, I-SERVE, for their valuable guidance and great support in developing this subject.

Conflict of Interest: Authors declare no conflict of interest in this paper or subject.

References

1. Xuheng Luo et al. Dirac neutrinos and Neff. JCAP 06, 058, 2020.
2. Martin Hirsch, Rahul Srivastava, José W.F. Valle, Can one ever prove that neutrinos are Dirac particles? Physics Letters B, 781, 302-305, 2018.
3. Bilenky SM. Neutrinos: Majorana or Dirac? Universe. 6(9),134, 2020.
4. M. Sajjad Athar et al. Status and Perspectives of Neutrino Physics. Progress in Particle and Nuclear Physics, 124, 103947, 2022.
5. Aditya Dev. Neutrino Oscillations and Mass Models.arXiv:2310.17685v1,2023
6. Radovan Dermisek. Neutrino masses and mixing, quark-lepton symmetry, and strong right-handed neutrino hierarchy. Phys. Rev. D 70, 073016, 2004.
7. Dimitar Valev. Neutrino and graviton rest mass estimations by a phenomenological approach. arXiv:hep-ph/0507255v6, 2005.
8. KATRIN Collaboration. Direct neutrino-mass measurement based on 259 days of KATRIN data. Science. 388(6743),180-185, 2025.
9. Seshavatharam U. V. S., Gunavardhana Naidu T and Lakshminarayana S. To confirm the existence of heavy weak fermion of rest energy 585 GeV. AIP Conf. Proc. 2451, 020003, 2022.
10. Seshavatharam U. V. S., Gunavardhana Naidu T and Lakshminarayana S. Nuclear evidences for confirming the physical existence of 585 GeV weak fermion and galactic observations of TeV radiation. International Journal of Advanced Astronomy. 13, (1), 1-17, 2025.

11. Seshavatharam, U. V. S., Naidu, T. G. and Lakshminarayana, S. On the Possible Role of the Planck Length in Fitting the Neutron Lifetime. Preprints 2025, 2025070530
12. Barrow, J. D. Natural Units Before Planck. Quarterly Journal of the Royal Astronomical Society, 24, 24-26,1983.
13. Andrew Wutke. From Newton to universal Planck natural units– disentangling the constants of nature. J. Phys. Commun. 7 (2023) 115001
14. Majkic, R. Neutrino Masses Prediction. Journal of High Energy Physics, Gravitation and Cosmology, 10, 1367-1379, 2024.
15. de Salas PF, Gariazzo S, Mena O, Ternes CA and Tórtola M. Neutrino Mass Ordering From Oscillations and Beyond: 2018 Status and Future Prospects. Front. Astron. Space Sci. 5, 36, 2018.
16. R. Abbasi et al. Critical look at the cosmological neutrino mass bound. Phys. Rev. Lett. 134, 091801,2025.
17. A.G. Adame, et al. DESI Collaboration, 2024. Final results on the sum of neutrino masses from BAO and Lyman-α forest. JCAP02, 021,2025.
18. Gabriel P. Lynch and Lloyd Knox. What’s the matter with Σmν? arXiv:2503.14470v1 [astro-ph.CO], 2025.
19. Masayuki Nakahata. History of solar neutrino observations. Prog. Theor. Exp. Phys. 2022 12B103(22 pages)
20. Wan, Linyan. Atmospheric Neutrinos Revisited. Physics, 16, Dec. 2023.