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Peer Review

Review of: "Revisiting the Origin of Neutrino Flavour Transformations"

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Report on the manuscript

"Revisiting the Origin of Neutrino FlavourTransformations"

by Shi-Biao Zheng

I have several seriouse concerns about the content of the manuscript:

1) In the derivation of lemmas author used the joint probability function dependent on all

three momenta and integration over the 9-dimension space. The function of the momenta under the integral (2) is treated like a regular and differentiable one, however, there should be a delta-function factor because of the total momentum conservation for all possible combinations of the plane waves.

2) The singularity of the expression under the integral sign leads to non-relativity of the model, since the waves expand to the entire coordinate space and a distant observer get information about the decay of the neutron faster than it is allowed by the classic relativistic theory. The full derivation relativistic derivation should include Green functions and propagators and the particles in forms of wave packets, which is done in some particular cases e. g. in hep-ph 0506203. The resulting wave packets have finite width and even a subtle uncertainty in the momenta and energies may be enough for the observed oscillations, as it is discussed in [31].

3) Author wrote "This entanglement would destroy the coherence between the neutrino's mass eigenstates". This statement is not correct and should be corrected. Coherence is a measure of entanglement. Author should compare results with previous works and add comment: Journal of Physics A: Mathematical and Theoretical 55 (49), 495303 (2022); The European Physical Journal Plus 137 (2), 234 (2022); The European Physical Journal. C, Particles and Fields. 81 (4) (2021).

4) The comment after Eq. 13, the oscillations are obliterated by the detector size when the oscillation phase changes multiple times in the detection process. In (13), the phase variation rate (wavelength) is inversely proportional to the difference of momenta which, to my understanding, is quite big compared to the detector size, so the integration so the expansion of the integration over the entire volume will give the infinite detector size in order to get zero neutrino oscillations.

5) As for the derivation of the effect from the interaction with Z boson, there would be good also to have some numerical evaluation of the effect in terms of neutrino oscillation frequency. Also, the origin of exponential regularizing factor for r.h.s of (42) is not completely clear. Is it possible that there exists some field theory arguments justifying its appearance?

Declarations

Potential competing interests: No potential competing interests to declare.