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Inverse-seesaw-induced non-unitarity in solar neutrinos

Neutrino oscillations establish that neutrinos have nonzero masses, yet the mechanism responsible for their mass generation remains experimentally unconfirmed. The inverse seesaw provides a framework in which potentially observable deviations from the unitarity of the effective lepton mixing matrix can arise. We investigate how diagonal non-unitarity modifies the electron-neutrino survival probability, P_{ee}(E), for solar neutrinos. We implement a numerical propagator that incorporates non-unitarity corrections into the effective matter Hamiltonian, including the modified neutral-current contribution, and solve the evolution equation using a realistic solar density profile. The numerical framework is validated against analytical limits and the standard Parke formula. We find that non-unitarity-induced distortions are largest in the transition region between vacuum- and matter-dominated propagation and remain at approximately the percent level or below within the solar bound considered. We also explore the implications for the solar–KamLAND tension in the determination of \Delta m^2_{21}. In a comparison of representative solar and KamLAND best-fit values, the discrepancy is minimized near \eta_{ee}\simeq -0.042, close to the adopted solar constraint. This result identifies the direction and approximate magnitude of the non-unitarity effect required to reduce the discrepancy, but does not constitute evidence for non-unitarity from a global statistical fit. Our findings illustrate the potential relevance of solar-neutrino propagation to phenomenological studies of non-unitarity in low-scale neutrino mass-generation scenarios.

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