

Evolution of Neutrino Mass-Mixing Parameters in Matter with Non-Standard Interactions

We explore the role of matter effect in the evolution of neutrino oscillation parameters in the presence of lepton-flavor-conserving and lepton-flavor-violating neutral-current non-standard interactions (NSI) of the neutrino. We derive simple approximate analytical expressions showing the evolution/running of mass-mixing parameters in matter in the presence of standard interactions (SI) and SI+NSI. We observe that only the NSI parameters in the (2,3) block, namely $\varepsilon_{\mu\tau}$ and $(\gamma - \beta) \equiv (\varepsilon_{\tau\tau} - \varepsilon_{\mu\mu})$ affect the running of θ_{23} . Though all the NSI parameters influence the evolution of θ_{13} , $\varepsilon_{e\mu}$ and $\varepsilon_{e\tau}$ show a stronger impact at the energies relevant for DUNE. The solar mixing angle θ_{12} quickly approaches to $\sim 90^\circ$ with increasing energy in both SI and SI+NSI cases. The change in $\Delta m_{21,m}^2$ is quite significant as compared to $\Delta m_{31,m}^2$ both in SI and SI+NSI frameworks for the energies relevant for DUNE baseline. Flipping the signs of the NSI parameters alters the way in which mass-mixing parameters run with energy. We demonstrate the utility of our approach in addressing several important features related to neutrino oscillation such as: a) unraveling interesting degeneracies between θ_{23} and NSI parameters, b) estimating the resonance energy in presence of NSI when θ_{13} in matter becomes maximal, c) figuring out the required baselines and energies to have maximal matter effect in $\nu_\mu \rightarrow \nu_e$ transition in the presence of different NSI parameters, and d) studying the impact of NSI parameters $\varepsilon_{\mu\tau}$ and $(\gamma - \beta)$ on the $\nu_\mu \rightarrow \nu_\mu$ survival probability.

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