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New physics signals at long baseline experiments

Amol Dighe and Shamayita Ray

Tata Institute of Fundamental Research, Homi Bhabha Road, Mumbai 400005, India

E-mail: amol@theory.tifr.res.in, shamayitar@theory.tifr.res.in

Abstract. We develop a formalism that gives analytically tractable expressions for flavor conversion probabilities at long baseline experiments, in the presence of any number of sterile neutrino species or with CPT violation. Using a perturbative expansion in the small parameters we show that, even in a completely general analysis, only certain specific combinations of the mixing parameters are relevant and hence can be probed in the experiments. We identify the long baseline experiments which will be able to probe those observable combinations in a clean manner and estimate their reach in measuring or constraining those observables.

Sterile neutrinos with masses ~ 0.1 eV or higher, allowed with the current oscillation data, can potentially play an important role in astrophysics and cosmology. For a single sterile species with such a mass, we show that clean identification of sterile mixing would be possible at neutrino factories for $\theta_{24}\theta_{34} \lesssim 0.005$ (3σ) and $\theta_{14} \lesssim 0.06$ rad (3σ) with the current bound of $\theta_{13} < 0.2$ rad; a better θ_{13} bound would allow probing smaller values of sterile mixing. Generalizing the formalism for any number of sterile neutrinos we demonstrate that only certain combinations of sterile mixing parameters are relevant irrespective of the number of sterile neutrinos. This also leads to a stringent test of the scenario with multiple sterile neutrinos.

In the presence of CPT violation we show that their contribution to the neutrino Hamiltonian can be bounded to $\lesssim 10^{-23}$ GeV, by considering the NOvA experiment for the muon sector, and neutrino factories for the electron sector. This formalism also allows us to translate the bounds on the parameters describing non-standard interactions of neutrinos into the bounds on CPT violating quantities.

Finally we would like to mention that the energy dependence of the signatures of CPT violation and sterile neutrinos is different and these two new physics signatures may be disentangled with a combined analysis.

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References

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