Exploring new-physics effects of scalar NSI at long baseline experiments

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Abstract:

The experimental observation of the phenomena of neutrino oscillations was the first firm experimental evidence of physics beyond the Standard Model (SM). The SM of particle physics needs an extension to explain the neutrino masses and mixing. The models describing beyond SM physics usually comes with some additional unknown couplings of neutrinos termed as Non Standard Interactions (NSIs). The idea of NSI was initially explored by Wolfenstein [1], where he studied how a vector mediated NSI can introduce matter effects in neutrinos. Apart from vector NSI, there is also an interesting possibility of neutrinos coupling with matter fermions via a scalar, called scalar NSI [2, 3]. Unlike the vector NSI, the effect of scalar NSI appears as a medium dependent correction to the neutrino mass term, which may offer unique phenomenology in neutrino oscillations.

In this work, we studied the impact of scalar NSI on the measurement sensitivities of oscillation parameters at three upcoming long-baseline (LBL) experiments: DUNE, [4], T2HK [5] and T2HKK [6]. The presence of scalar NSI may significantly impact the neutrino oscillation probabilities as well as the event rates at the detectors. We show the scalar NSI parameters can alter the physics sensitivities of these experiments. We then perform a synergy study among the LBL experiments (DUNE+T2HK, DUNE+T2HKK) which may offer a better capability of constraining the scalar NSI parameters as well as an improved sensitivity towards CP-violation and mass hierarchy [7]. We also probe scalar NSI to constrain the absolute masses of neutrinos via neutrino oscillation experiments.

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