Contribution ID: **199** Type: **Parallel talk**

Scalar-NSI: An unique tool to probe New Physics

Wednesday 16 October 2024 14:15 (15 minutes)

In the current precision era of neutrino physics, the subdominant new physics scenarios, such as non-standard interactions (NSIs) are of great interest for exploring physics beyond the standard model (BSM). Scalar NSI (SNSI), which is mediated by a scalar field, has been a fascinating area of study in recent times. Unlike vector NSI, SNSI modifies the standard neutrino mass matrix through the Yukawa couplings and appears as an additional mass matrix consisting of real and complex elements. We investigate the effect of complex off-diagonal SNSI parameters, which are characterised by their magnitudes $\eta_{\alpha\beta}$ and new phases $\phi_{\alpha\beta}$. The linear scaling of matter density with the SNSI motivates its study in the long baseline (LBL) experiments. Thus, we have considered two future LBL experiments, DUNE and P2SO, to constrain these SNSI parameters. We also checked their effect on the measurement of various standard oscillation parameters. We then demonstrated the correlation between different oscillation parameters and the SNSI parameters $\eta_{\alpha\beta}$ and found that the new CP phases ($\phi_{\alpha\beta}$) can have significant impact on the sensitivity to determine the unknowns of the neutrino sector. We found that the oscillation parameter Δm^2_{31} exhibits non-trivial behaviour when SNSI parameters are present. Additionally, we noticed that $\phi_{\mu\tau}$ plays an important role for the determination of various oscillation parameters.

Track type

Neutrino Physics

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Session Classification: Parallel - Neutrino