

Sensitivity for four-body tau-lepton decays at Belle and Belle II experiments

Content

We study the expected sensitivity at Belle and Belle II for four-body $\tau \mp \rightarrow X \pm l \mp l \mp \nu \tau$ decays where $l=e$ or μ and $X=\pi, K, \rho$ and K^* mesons. These decay processes violate the total lepton number ($|\Delta L|=2$) and they can be induced by the exchange of Majorana neutrinos. In particular, we consider lifetimes in the accessible ranges of $\tau_N = 5, 100$ ps and extract the limits on $|V\ell N|^2$ without any additional assumption on the relative size of the mixing matrix elements. For an integrated luminosity collected of 1 ab^{-1} at Belle, we found significant sensitivity on branching fractions of the order $\text{BR}(\tau \mp \rightarrow X \pm l \mp l \mp \nu \tau) \sim 10^{-8}$. For an integrated luminosity expected of 50 ab^{-1} and intermediate luminosity of 10 ab^{-1} at the Belle II, we found significant sensitivity on branching fractions of the order $\text{BR}(\tau \mp \rightarrow X \pm l \mp l \mp \nu \tau) \sim 10^{-9} - 10^{-8}$. We use these sensitivities to set limits for the exclusion regions on the parameter space $(m_N, |V\ell N|^2)$ associated with the heavy neutrino; such that for a $|V\ell N|^2 \sim \mathcal{O}(10^{-5})$ at $\tau_N=100$ ps, we find the bounds as $0.140 < m_N < 1.776$ GeV for $\tau \rightarrow X + e - e - \nu \tau$ and $0.245 < m_N < 1.671$ GeV for $\tau \rightarrow X + \mu - \mu - \nu \tau$. [arXiv-hep:1912.01720].

Summary

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