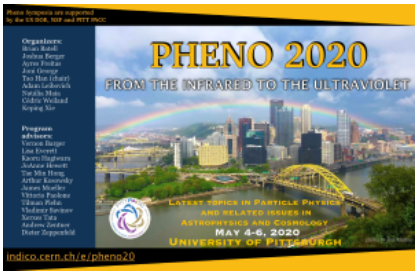

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Long-lived heavy neutrino searches at the colliders

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A gauged $U(1)_X$ extension of the Standard Model is a simple and consistent framework to naturally incorporate three right-handed neutrinos (RHNs) for generating the observed light neutrino masses and mixing by the type-I seesaw mechanism. We examine the collider testability of the $U(1)_X$ model, both in its minimal form with the conventional charges, as well as with an alternative charge assignment, via the resonant production of the $U(1)_X$ gauge boson (Z') and its subsequent decay into a pair of RHNs. We first derive an updated upper limit on the new gauge coupling g_X as a function of the Z'-boson mass from the latest LHC dilepton searches. Then we identify the maximum possible cross section for the RHN pair-production under these constraints. Finally, we investigate the possibility of having one of the RHNs long-lived, even for a TeV-scale mass. Employing the general parametrization for the light neutrino mass matrix to reproduce the observed neutrino oscillation data, we perform a parameter scan and find a simple formula for the maximum RHN lifetime as a function of the lightest neutrino mass eigenvalue $(m_{\rm lightest})$. We find that for $m_{\rm lightest} \leq 10^{-5}$ eV, one of the RHNs in the minimal $U(1)_X$ scenario can be long-lived with a displaced-vertex signature which can be searched for at the LHC and/or with a dedicated long-lived particle detector, such as MATHUSLA. In other words, once a long-lived RHN is observed, we can set an upper bound on the lightest neutrino mass in this model.

Summary

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