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Sub-GeV Sterile Neutrino as a Probe of Neutrino Mass Generation in the Minimal Left-Right Symmetric Model

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The minimal left-right symmetric model (mLRSM) provides an elegant and testable framework for addressing the origin of neutrino masses. We examine the constraints on the sub-GeV sterile neutrino in the type-II seesaw scenario of the mLRSM without left-right mixing, taking limits from collider searches, meson decays, supernovae, neutrinoless double beta ($0\nu\beta\beta$) decay and cosmology. Specifically, we derive the $0\nu\beta\beta$ decay constraints using the advanced effective field theory approach and up-to-date nuclear matrix element calculations. Besides, we update the SN1987A cooling bound with the state-of-the-art simulations, provide new constraints from the energy deposition in the supernova ejecta, and incorporate the stringent sterile neutrino lifetime upper limit from the big bang nucleosynthesis. Our results identify the parameter region compatible with all current experimental and observational constraints, where the sterile neutrino mass lies between 700 MeV and 1 GeV and the right-handed W boson mass is slightly below 20 TeV. This region is exclusively probed by the future tonne-scale $0\nu\beta\beta$ decay experiments, providing a unique window to test the mLRSM and the possible origin of neutrino masses.

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