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Neutrinoless Double Beta Decay and Heavy Sterile Neutrinos

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The experimental rate of neutrinoless double beta decay can be saturated by the exchange of virtual sterile neutrinos, that mix with the ordinary neutrinos and are heavier than 200 MeV. Interestingly, this hypothesis is subject only to marginal experimental constraints, because of the new nuclear matrix elements. This possibility has been analyzed in the context of the Type I seesaw model, performing also exploratory investigations of the implications for heavy neutrino mass spectra, rare decays of mesons as well as neutrino-decay search, LHC, and lepton flavor violation.The heavy sterile neutrinos can saturate the rate only when their masses are below some 10 TeV, but in this case, the suppression of the light-neutrino masses has to be more than the ratio of the electroweak scale and the heavy-neutrino scale; i.e., more suppressed than the naive seesaw expectation. We have classified the cases when this condition holds true in the minimal version of the seesaw model, showing its compatibility (1)~with neutrinoless double beta rate being dominated by heavy neutrinos and (2)~with any light neutrino mass spectra. The absence of excessive fine-tunings and the radiative stability of light neutrino mass matrices, together with a saturating sterile neutrino contribution, imply an upper bound on the heavy neutrino masses of about 10 GeV. We extend our analysis to the Extended seesaw scenario, where the light and the heavy sterile neutrino contributions are completely decoupled, allowing the sterile neutrinos to saturate the present experimental bound on neutrinoless double beta decay. In the models analyzed, the rate of this process is not strictly connected with the values of the light neutrino masses, and a fast transition rate is compatible with neutrinos lighter than 100 meV.

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