Collider Phenomenology of the Heavy Neutrinos

We study the collider signature of pseudo-Dirac heavy neutrinos in the inverse seesaw scenario, where the heavy neutrinos with mass at the electro-weak scale can have sizable mixings with the Standard Model neutrinos, while providing the tiny light neutrino masses by the inverse seesaw mechanism. Based on a simple, concrete model realizing the inverse seesaw scenario, we fix the model parameters so as to reproduce the neutrino oscillation data and to satisfy other experimental constraints, assuming two typical flavor structures of the model and the different types of hierarchical light neutrino mass spectra. For completeness, we also consider a general parametrization for the model parameters by introducing an arbitrary orthogonal matrix and the nonzero Dirac and Majorana phases. We perform a parameter scan to identify an allowed parameter region which satisfies all experimental constraints. With the fixed parameters, we analyze the heavy neutrino signal at the LHC through trilepton final states with large missing energy and at the ILC through a single lepton plus dijet with large missing energy. We find that in some cases, the heavy neutrino signal can be observed with a large statistical significance via different flavor charged lepton final states.

In the LHC era the important production mechanism of the heavy neutrino could be quark-gluon and gluon-gluon fusions. We also study the proton-photon (radiated from another proton) interactions at the 1-jet and 2-jet levels to produce the heavy neutrinos. Using the searches at the ATLAS (JHEP07(2015)162) and CMS (Physics Letters B 748 (2015) 144–166) for the same-sign dilepton plus dijet we put an upper bound on the heavy neutrino mixing angle when the heavy neutrino is Majorana. We show that including all the production channels one can even improve the upper bound. On the other hand due to the smallness of the lepton number breaking parameter for a pseudo-Dirac heavy neutrino, the 'smoking gun' collider signature of same-sign dileptons is suppressed and the heavy neutrinos would manifest at the LHC dominantly through lepton number conserving trilepton final states with missing energy. Using the CMS search for the anomalous multilepton with missing energy (Phys. Rev. D 90, 032006) we put an improved upper bound on the mixing angle including all the production channels.