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Fat Jet Signature of a Heavy Neutrino at Lepton Collider

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In this work, we study the discovery prospect of a heavy neutrino in the intermediate to very high mass range at e^+e^- collider. We consider two different c.m.energies $\sqrt{s} = 1.4$ TeV and 3 TeV, respectively, that are relevant for CLIC. Contrary to the LHC, the production cross-section of a heavy neutrino at e^+e^- collider is fairly large. We consider two different mass ranges $M_N = 600 - 1200\,\mathrm{GeV}$, that can be probed at 1.4 TeV run of CLIC, and $M_N = 1300 - 2700\,\mathrm{GeV}$, that can be discovered with 3 TeV c.m.energy. We consider the production mode $e^+e^- \to \nu_e N$, and the subsequent decays of N into an electron $e^\pm$ and $W^\mp$ gauge boson. We further consider the hadronic decay modes of $W^\pm$. For such a heavy N, the $W^\pm$'s are highly boosted. Hence, the quarks from $W^\pm$ are collimated, leading to a single fat-jet. Therefore, the final state is $e^\pm + j_{fat} + \mathrm{Missing\,momentum}$. We pursue an in-depth study for this final state, with both cut-based and multivariate analysis(MVA). We show that a heavy neutrino with mass $600 - 2700\,\mathrm{GeV}$ and mixing $|V_{eN}|^2 \sim 10^{-5} - 10^{-6}$ can be discovered with 5σ significance at e^+e^- collider with $\mathcal{L} \sim 500\,\mathrm{fb}^{-1}$ luminosity, which is an order of magnitude betterment as opposed to the LHC limit.

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