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Jet substructure shedding light on heavy Majorana neutrinos at the LHC

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The existence of tiny neutrino masses and flavor mixings can be explained naturally in various seesaw models, many of which typically having additional Majorana type SM gauge singlet right handed neutrinos (N). If they are at around the electroweak scale and furnished with sizeable mixings with light active neutrinos, they can be produced at high energy colliders, such as the Large Hadron Collider (LHC). A characteristic signature would be same sign lepton pairs, violating lepton number, together with light jets – $pp \rightarrow N\ell^{\pm}$, $N \rightarrow \ell^{\pm}W^{\mp}$, $W^{\mp} \rightarrow jj$. We propose a new search strategy utilising jet substructure techniques, observing that for a heavy right handed neutrino mass M_N much above $M_{W^{\pm}}$, the two jets coming out of the boosted $W^{\pm}$ may be interpreted as a single fat-jet (J). Hence, the distinguishing signal topology will be $\ell^{\pm}\ell^{\pm}J$. Performing a comprehensive study of the different signal regions along with complete background analysis, in tandem with detector level simulations, we compute statistical significance limits. We find that heavy neutrinos can be explored effectively for mass ranges $300\,\mathrm{GeV} \leq M_N \leq 800\,\mathrm{GeV}$ and different light-heavy neutrino mixing $|V_{\mu N}|^2$. At the 13 TeV LHC with 3000 fb^{-1} integrated luminosity one can competently explore mixing angles much below present LHC limits, and moreover exceed bounds from electroweak precision data.

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