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Improving heavy Dirac neutrino prospects at future hadron colliders using machine learning

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In this work, by using machine learning methods, we study the sensitivities of heavy pseudo-Dirac neutrino N in the inverse seesaw at the high-energy hadron colliders. The production process for the signal is $pp \to \ell^\pm N \to 3\ell + E_T^{\rm miss}$, while the dominant background is $pp \to W^\pm Z \to 3\ell + E_T^{\rm miss}$. We use either the Multi-Layer Perceptron or the Boosted Decision Tree with Gradient Boosting
to analyze the kinematic observables and optimize the signal/background discrimination. It is found that the reconstructed Z boson mass and heavy neutrino mass from the charged leptons and missing transverse energy play crucial roles to separate the signal/background events. We estimate the prospects of heavy-light neutrino mixing $|V_{\ell N}|^2$ (with $\ell = e,\, \mu$) using machine learning at the hadron colliders with $\sqrt{s} = 14$ TeV, 27 TeV, and 100 TeV, and find that $|V_{\ell N}|^2$ can be improved up to $calO(10^{-6})$ for heavy neutrino mass $m_N = 100$ GeV and $calO(10^{-4})$ for $m_N = 1$ TeV.

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