Searching for heavy neutral leptons through exotic Higgs decays at the ILC

In this study we investigate the feasibility of detecting heavy neutral leptons ($N_d$) through exotic Higgs decays at the proposed International Linear Collider (ILC), specifically in the channel of $e^+e^- \rightarrow qq\, H$ with $H \rightarrow \nu N_d \rightarrow \nu lW \rightarrow \nu l qq$. Analyses based on full detector simulations of the ILD are performed at the center-of-mass energy of 250 GeV for two different beam polarization schemes with a total integrated luminosity of $2 \, ab^{-1}$. A range of heavy neutral lepton masses between the $Z$ boson and Higgs boson masses are studied. The $2\sigma$ significance reach for the joint branching ratio of $BR(H \rightarrow \nu N_d) \cdot BR(N_d \rightarrow lW)$ is about 0.1%, nearly independent of the heavy neutral lepton masses, while the $5\sigma$ discovery is possible at a branching ratio of 0.3%. Interpreting these results in terms of constraints on the mixing parameters $|\varepsilon_{id}|^2$ between SM neutrinos and the heavy neutral lepton, it is expected to have a factor of 10 improvement from current constraints.

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