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Charged Higgs in MSSM and Beyond

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Charged Higgs boson ($H^{\pm}$), which exists in many Supersymmetric (SUSY)/Non-SUSY models, is one of the most important evidences for new physics beyond the Standard Model. This talk is about a numerical study over the constrained Minimal Supersymmetric Standard Model (CMSSM), next-to-MSSM (NMSSM) and U(1) extended MSSM (UMSSM). In this work, we investigate the allowed mass ranges of the charged Higgs boson and its dominant decay patterns, which might come into prominence in the near future collider experiments. We observe within our data that a wide mass range is allowed as $0.5(1) < m_{H^{\pm}} < 17$ TeV in UMSSM (NMSSM). According to results, the most leading decay channel is mostly $H^{\pm} \to tb$ such that $\mathrm{BR}(H^{\pm} \to tb) \sim 80\%$. While this mode remains dominant over the whole allowed parameter space of CMSSM, we realize some special domains in the NMSSM and UMSSM, in which $\mathrm{BR}(H^{\pm} \to tb) < 10\%$. In this context, the decay patterns of the charged Higgs can play a significant role to distinguish among the SUSY models. In addition to the tb decay mode, we find that the narrow mass scale in CMSSM allows only the decay modes for the charged Higgs boson to $\tau\nu$ ($\sim 16\%$), and their supersymmetric partners $\tilde{\tau}\tilde{\nu}$ ($\sim 13\%$). On the other hand, it is possible to realize the mode in NMSSM and UMSSM in which the charged Higgs boson decays into a chargino and neutralino pair up to about 25%. However, this decay mode requires non-universal boundary conditions within the MSSM framework to be available, since CMSSM yields $\mathrm{BR}(H^{\pm} \to \tilde{\chi}_1^0 \tilde{\chi}_1^{\pm}) < 1\%$. It can also be probed in near future collider experiments through the missing energy and CP-violation measurements. Moreover, the chargino mass is realized as $m_{\tilde{\chi}_1^{\pm}} > 1$ TeV in NMSSM and UMSSM, and these solutions will be likely tested soon in collider experiments through the chargino-neutralino production.

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