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R-Parity Violating Supersymmetry and the 125 GeV Higgs signals

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We study the impact of R-parity violating Supersymmetry (RPV SUSY) on the 125 GeV Higgs production and decay modes at the LHC. We assume a heavy SUSY spectrum with multi-TeV squarks and SU(2) scalar singlets as well as the decoupling limit in the SUSY Higgs sector. In this case the lightest CP-even Higgs is SM-like when R-parity is conserved. In contrast, we show that when R-parity violating interactions are added to the SUSY framework, significant deviations may occur in some production and decay channels of the 125 GeV Higgs-like state. Indeed, we assume a single-flavor (mostly third generation) Bilinear RPV (BRPV) interactions, which generate Higgs-sneutrino mixing, lepton-chargino mixing and neutrino-neutralino mixing, and find that notable deviations of $calO(20-30\%)$ may be expected in the Higgs signal strength observables in some channels, e.g., in $pp \to h \to \mu^+\mu^-, \tau^+\tau^-$. Moreover, we find that new and detectable signals associated with BRPV Higgs decays to gauginos, $h \to \nu_\tau \tilde{\chi}_2^0$ and $h \to \tau^\pm \chi_2^\mp$, may also arise in this scenario. These decays yield a typical signature of $h \to \tau^\pm \ell^\mp + \not{E}_T$ ($\ell = e, \mu, \tau$) and may also be accompanied by an $calO(20-30\%)$ enhancement in the di-photon signal $pp \to h \to \gamma\gamma$.
We also examine potential interesting signals of Trilinear R-parity violation (TRPV) interactions in the production and decays of the Higgs-sneutrino BRPV mixed state (assuming it is the 125 GeV scalar) and show that, in this case also, large deviations up to $calO(100\%)$ are expected in e.g., $pp \to h \to \mu^+\mu^-, \tau^+\tau^-$, which are sensitive to the BRPV$\times$TRPV couplings product.

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