Contribution ID: **188** Type: **Oral**

The PeV-Scale Split Supersymmetry from Higgs Mass and Electroweak Vacuum Stability

The null results of the LHC searches have put strong bounds on new physics scenario such as supersymmetry (SUSY). With the latest values of top quark mass and strong coupling, we study the upper bounds on the sfermion masses in Split SUSY from the observed Higgs boson mass and electroweak (EW) vacuum stability. To be consistent with the observed Higgs mass, we find that the largest value of supersymmetry breaking scales M_S for $\tan\beta = 2$ and $\tan\beta = 4$ are $\mathcal{O}(10^3\,\mathrm{TeV})$ and $\mathcal{O}(10^{1.5}\,\mathrm{TeV})$, thus putting an upper bound on the sfermion masses around 10^3 TeV. In addition, the Higgs quartic coupling becomes negative at much lower scale than the Standard Model (SM), and we extract the upper bound of $\mathcal{O}(10^4\,\mathrm{TeV})$ on the sfermion masses from EW vacuum stability. Therefore, we obtain the PeV-Scale Split SUSY. The key point is the extra contributions to the Renormalization Group Equation (RGE) running from the couplings among Higgs boson, Higgsinos, and gauginos. We briefly comment on the lifetime of gluinos in our study and compare it with current LHC observations. Additionally, we comment on the prospects of discovery of prompt gluinos in a 100 TeV proton-propton collider.

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Session Classification: Supersymmetry: Models, Phenomenology and Experimental Results

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