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Natural SUSY emergent from the landscape

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In string theory with flux compactifications, anthropic selection for structure formation from a discretuum of vacuum energy values provides at present our only understanding of the tiny yet positive value of the cosmological constant. We apply similar reasoning to a toy model of the multiverse restricted to vacua with the MSSM as the low energy effective theory. Here, one expects a statistical selection favoring large soft SUSY breaking terms leading to a derived value of the weak scale in each pocket universe (with appropriate electroweak symmetry breaking) which differs from the weak scale as measured in our universe. In contrast, the SUSY preserving μ parameter is selected uniformly on a log scale as is consistent with the distribution of SM fermion masses: this favors smaller values of μ. An anthropic selection of the weak scale to within a factor of a few of our measured value–in order to produce complex nuclei as we know them (atomic principle)–provides statistical predictions for Higgs and sparticle masses in accord with LHC measurements. The statistical selection then more often leads to (radiatively-driven) natural SUSY models over the Standard Model or finely-tuned SUSY models such as mSUGRA/CMSSM, split, mini-split, spread, high scale or PeV SUSY. The predicted Higgs and superparticle spectra might be testable at HL-LHC via higgsino pair production but is certainly testable at higher energy hadron colliders with $\sqrt{s} \sim 30 - 100$ TeV.

Author: SALAM, Mohammed

Co-authors: BAER, Howard; Prof. BARGER, Vernon (University of Wisconsin-Madison); Mr MARTINEZ, Dakotah (University of Oklahoma)

Presenter: SALAM, Mohammed

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