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The ILC as a natural SUSY discovery machine and precision microscope: From light higgsinos to tests of unification

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The requirement of electroweak naturalness in simple supersymmetric models motivates the existence of a cluster of four light higgsinos with mass 100-300 GeV, the lighter the better. While such light compressed spectra may be challenging to observe at LHC, future e+e- colliders with sqrt(s) > 2m(higgsino) would serve as both a SUSY discovery machine and a precision microscope.
We study higgsino pair production signatures at the ILC based on full, Geant4-based simulation of the ILD detector concept. We examine several benchmark scenarios that may or may not be accessible to HL-LHC searches, with mass differences between the higgsino states between 20 and 4 GeV. Assuming
sqrt(s)= 500 GeV and 1000 fb^-1 of integrated luminosity, the individual higgsino masses can be measured to 1-2% precision in case of the larger mass differences, and still at the level of 5% for the smallest mass difference case. The higgsino mass splittings are sensitive to the electroweak gaugino masses and can allow extraction of gaugino masses to 3 - 20% (depending on the model).
Extrapolation of gaugino masses via renormalization group running can test the hypothesis of gaugino mass unication. We also examine a case with natural generalized mirage mediation where the unication of gaugino masses at an intermediate scale apparently gives rise to a natural SUSY spectrum somewhat beyond the reach of HL-LHC.

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