

# Determining the Structure of Supersymmetry-Breaking with Renormalization Group Invariants

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If collider experiments demonstrate that the Minimal Supersymmetric Standard Model (MSSM) is a good description of nature at the weak scale, the experimental priority will be the precise determination of superpartner masses. These masses are governed by the weak scale values of the soft supersymmetry (SUSY)-breaking parameters, which are in turn highly dependent on the SUSY-breaking scheme present at high scales. It is therefore of great interest to find patterns in the soft parameters that can distinguish different high scale SUSY-breaking structures, identify the scale at which the breaking is communicated to the visible sector, and determine the soft breaking parameters at that scale. In this work, we demonstrate that 1-loop Renormalization Group (RG) invariant quantities present in the MSSM may be used to answer each of these questions. We apply our method first to generic flavor-blind models of SUSY-breaking, and then examine in detail the subset of these models described by General Gauge Mediation and the constrained MSSM with non-universal Higgs masses. As RG invariance generally does not hold beyond leading-log order, we investigate the magnitude and direction of the 2-loop corrections. We find that with superpartners at the TeV scale, these 2-loop effects are either negligible, or they are of the order of optimistic experimental uncertainties and have definite signs, which allows them to be easily accounted for in the overall uncertainty.

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