

## High Energy Physics - Phenomenology

# Fine-Tuning Implications of Direct Dark Matter Searches in the MSSM

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We study theoretical implications of direct dark matter searches in the minimal supersymmetric standard model (MSSM). We assume that no accidental cancellations occur in the spin-independent elastic neutralino-quark scattering cross section, but do not impose any relations among the weak-scale MSSM parameters. We show that direct detection cross section below  $10^{-44}$  cm<sup>2</sup> requires the lightest supersymmetric particle (LSP) neutralino to be close to either a pure gaugino or pure Higgsino limit, with smaller cross sections correlated with smaller admixture of the subdominant components. The current XENON100 bound rules out essentially all models in which the lightest neutralino has the Higgsino fraction between 0.2 and 0.8. Furthermore, smaller direct detection cross sections correlate with stronger fine-tuning in the electroweak symmetry breaking sector. In the gaugino LSP scenario, the current XENON100 bound already implies some fine-tuning: for example, at least 10% tuning is required if the LSP mass is above 70 GeV. In both gaugino and Higgsino LSP scenarios, the direct dark matter searches currently being conducted and designed should lead to a discovery if no accidental cancellations or fine-tuning at a level below 1% is present.

Comments: v4: A clarification and references added. No change to physics contents of the paper

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