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Dark Matter Direct Detection and Quark/Gluon Currents in the Nucleon

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Summary

Matrix elements for WIMP dark matter interactions with nuclei are evaluated in two stages: (1) reducing the relativistic theory of WIMP-quark interactions to a non-relativistic effective theory of WIMP-nucleon interactions, and (2) using nuclear physics to assemble WIMP-nucleon interactions into matrix elements for nuclei.

Until recently, most studies focused on contact WIMP-quark interactions in the limit of zero WIMP-nucleus relative velocity, for which only two WIMP-nucleon operators appear: spin-independent and spin-dependent interactions.

Hadronic matrix elements of interest here include the strange-quark scalar current, or equivalently the pion-nucleon σ term. In the face of experimental results that appear contradictory in the traditional interaction scheme, general effective theories of WIMP-nucleon interactions have been developed. These theories involve nucleon matrix elements for all quark currents (scalar, pseudoscalar, vector, axial, and tensor). Some of these hadronic matrix elements are poorly known, and it is of interest to measure them experimentally or evaluate them theoretically.

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