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Closing the window for WIMPy inelastic dark matter with heavy nuclei

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The kinematics of WIMP dark matter-nuclear scattering is drastically altered if the interaction is inelastic, i.e. dark matter is up-scattered to a heavier state with certain mass splitting. With $\mathcal{O}(100)$ keV mass splitting inelastic dark matter will evade the search in most direct detection experiments, where the momentum transfer is limited either by the mass of target nuclei, or by the detector response. We propose a novel way to search for inelastic dark matter with heavy elements. In such experiments, through inelastic scattering on target nuclei dark matter can yield a signal either via nuclear recoil or nuclear excitation. We illustrate this method using results from low-energy gamma quanta searches in low-background experiments with Hf and Os metal samples, and measurements with CaWO_4 and PbWO_4 crystals as scintillating bolometers. We place novel bounds on WIMPy inelastic dark matter up to the mass splitting of about 640 keV, and provide forecasts for the reach of future experiments.

Summary

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