

Ultraheavy multiscattering dark matter: DUNE, CYGNUS, kilotonne detectors, and tidal streams

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For scattering cross sections large enough to make the detector in direct searches optically thick to the incident dark matter, dedicated multi-scatter signatures are being sought. We provide some significant updates to the multi-scatter program. First, we refine earlier treatments of the dark matter flux through detectors, generalizing to arbitrary geometries and velocity distributions. Using this and considerations of energy deposition, we derive the reaches in cross section and mass of various proposed large volume-detectors. These include a kilotonne fiducial mass “module of opportunity” at DUNE, a kilotonne xenon detector suggested for neutrinoless double beta decay, the gaseous detector CYGNUS, and the dark matter detectors XLZD and Argo. We show that where the velocity vector can be reconstructed event-by-event, key properties of the local velocity distribution such as the mean speed can be marked, and tidal streams can be picked up if they make up about 10% of the local dark matter density.

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