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Direct Detection of sub-MeV Dark Matter

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Conventional semiconductor detectors used for light dark matter detection via ionization signals lose sensitivity for dark matter masses below an MeV, for which the energy deposited in a scattering event falls below the bandgap. We propose to overcome this limitation by introducing dopants in the semiconductor target. Dopants have ionization energies that lie orders of magnitude below typical semiconductor bandgaps, and can be used to design detectors with tens of meV thresholds. We show that a doped semiconductor detector has the potential to probe dark matter with masses as small as tens of keV via scattering with electrons, or as small as tens of meV via absorption. In particular, we show that such a detector could test the entire parameter space of sub-MeV dark matter produced via freeze-in, and probe wide regions of parameter space of dark-photon dark matter.

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