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Light dark matter detection with superfluid helium

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We propose a new technology for dark matter direct detection, using superfluid helium as the target material. Superfluid helium has many merits as a detector target; these include good kinematic matching to low mass dark matter, feasibility for achieving good intrinsic radiopurity, multiple signals to enable radioavtive and instrumental background rejection, and its unique ability to be cooled down to milli-Kelvin temperatures while remaining a liquid. To measure the 16 eV prompt scintillation photons, we will submerge calorimetric photodetectors in the liquid, while rotons and phonons will be detected through the quantum evaporation of helium atoms off the liquid surface, into vacuum, and then their adsorption onto a calorimeter. The binding energy from helium adsorption to the calorimeter surface allows for the amplification of these quantum evaporation signals, allowing us to potentially reach recoil energy thresholds down to 1 meV. Taking into account the relevant backgrounds and the detector discrimination power, sensitivity projections show that a small detector (~100 g scale) can already explore new dark matter parameter space. I will discuss the technology and instrumentation underlying this proposal, as well as the R&D we are performing to advance this campaign.

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