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DELight: Direct search Experiment for Light Dark Matter with superfluid helium

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Tonne-scale noble liquid detectors have set strong limits on Dark Matter (DM) candidates particularly above a few GeV/c^2 , while the parameter space for Light Dark Matter (LDM) remains largely unexplored. A sub-keV energy threshold and large exposures are essential to tackle this challenge. Solid state detectors can achieve energy thresholds in the order of 1 eV, but their relatively small masses and complicated scalability limit the possible exposure. The “Direct search Experiment for Light dark matter” (DELight) aims to overcome these challenges by employing a superfluid helium-4 target instrumented with Large Area Microcalorimeters (LAMCALs), based on Magnetic MicroCalorimeter (MMC) technology. Superfluid helium offers a more easily scalable target with low nuclear mass, ideal for LDM searches. It also provides both photon and quasiparticle signals, allowing for the discrimination of the interaction types, further reducing the background. The LAMCALs achieve the energy resolution needed to reach the 20 eV threshold in the phase-I of DELight. With an exposure of just 1 kg·day, DELight will probe new regions of the parameter space during phase-I, achieving sensitivities below 10^{-39} cm^2 at a DM mass of $200 \text{ MeV}/c^2$.

We will present the working principle of the DELight experiment and an overview of the latest progress towards its realization.

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