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DELIGHT: Direct Search Experiment for Light Dark Matter with Superfluid Helium

While the search for Dark Matter in the form of massive WIMPs sets stronger and stronger limits, the low mass region of the DM-nucleon scattering parameter space has been barely probed. An efficient detection of Light Dark Matter (LDM) requires a sub-keV detection energy threshold and large exposure. Solid state detectors can reach O(10 eV) threshold, but they are limited in exposure by their relatively small size.

The “Direct search Experiment for Light dark matter”(DELIGHT) aims at using superfluid helium-4 as target. Helium is particularly suited thanks to its low nuclear mass and radiopurity, while allowing for a scalable technology and providing both photon and quasiparticle signal channels for interaction type discrimination. DELIGHT will deploy Magnetic Micro-Calorimeters (MMCs) operating at a temperature of 20 mK, promising high resolution and a threshold of a few eV. With an exposure of only 1 kg×d and an energy threshold of 20 eV, in its first phase DELIGHT has sensitivity to so far unexplored regions of the parameter space for LDM masses below $100 \text{ MeV}/c^2$ with an expected sensitivity lower than 10^{-39} cm^2 at $20 \text{ MeV}/c^2$.

We present the working principle of the detector technologies as well as an overview of the ongoing R&D towards the realization of DELIGHT.

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