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QUEST-DMC: detection of sub-GeV dark matter with nanowires in a superfluid He-3 calorimeter

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Several independent observations suggest that there is more mass in the Universe than has been directly observed. Dark matter is a hypothetical new form of matter that does not interact with the electromagnetic field and has a very weak interaction with ordinary baryonic matter. WIMPs (weakly interacting massive particles) are a dark matter candidate currently widely investigated in experiments, but most experiments are constrained to spin-independent interactions in the 10–100 GeV/c2 mass range.

QUEST-DMC (Quantum Enhanced Superfluid Technologies for Dark Matter and Cosmology) is a newly formed collaboration, between Lancaster, Oxford, Royal Holloway University of London, and Sussex Universities, supported through the Quantum Technologies for Fundamental Physics UK programme.

QUEST-DMC will use superfluid He-3 as a dark matter collision target, aiming to reach the world-leading sensitivity to spin-dependent interactions of 0.1-1 GeV/c2 mass dark matter candidates.

Here we discuss a simulation of the superfluid He-3 bolometer's energy sensitivity, and argue that recoil energy of <10 eV can be detected using nanomechanical resonators, controlling the dominant sources of background and using quantum sensors readouts as SQUIDs.

We report the recent development of dark matter bolometers based on these studies and the first results obtained from running the bolometers at the Lancaster micro-kelvin facilities, highlighting the future prospects in terms of spin dependent and spin independent sensitivity for this promising dark matter investigation.

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