

QUEST-DMC: Simulation studies for the detection of sub-GeV dark matter with a superfluid ^3He 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 will use superfluid ^3He 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 ^3He bolometer's impact energy sensitivity, and argue that recoil energy of <10 eV can be detected using nanomechanical resonators. We also investigate the sources of radioactive background at and above this region and their relative importance using the Geant4 particle physics simulations toolkit. We aim to report on the development of a dark matter bolometer based on these studies and present the preliminary sensitivity results.

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