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The TESSERACT Project for Sub-GeV Dark Matter Direct Detection

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The TESSERACT project is currently in a R&D and planning phase, funded under the DOE Dark Matter New Initiatives program, and aims to produce fully defined experiments (dubbed HeRALD and SPICE) that will explore DM mass parameter space down to 10 MeV, with upgrade paths to sub-MeV. It will be sensitive to both nuclear recoil DM (NRDM) and electron recoils (ERDM). An initial period of targeted R&D is needed to make technical choices and retire technical risks, leading to a well-defined set of design parameters with baseline values. Multiple target materials will be used, sharing identical readout. In addition to maximizing sensitivity to a variety of DM interactions, this provides an independent handle on instrumental backgrounds. The HeRALD experiment will use superfluid helium as a target material. Helium, with its light mass, has good NRDM sensitivity, but minimal sensitivity to low-mass dark photons. The SPICE experiment will use polar crystals, which will ultimately have the best sensitivity to dark photon mediated DM, but require lower energy thresholds than LHe for the same NRDM reach. Scintillating crystals such as GaAs have sensitivity to ERDM with kinetic energy greater than the electronic bandgap of the material. Both LHe and GaAs produce scintillation light as well as phonon signals, and the relative timing and signal strengths may be used to reduce both instrumental backgrounds and those due to radioactivity.

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