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Sensitivity of Alkali Halide Cryogenic Scintillation-Phonon Detectors to Dark Matter Signals

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Searches for particle dark matter are one of the most active fields in physics, with many experiments using different methods to search for possible dark matter candidates. Direct-detection experiments look for rare interactions between some detector mass and these dark matter particles. Cryogenic scintillator detectors have the advantage that there are many possible scintillator materials that can be used to optimize the experiment, and the low temperatures allow excellent background discrimination using phonon detectors.
Our group at Queen's University has developed an optical cryostat to measure the properties of scintillators at low temperatures for possible use in cryogenic scintillator detectors. Alkali halide crystals show promise in this field because of their high light yield and fast scintillation time. The DAMA/LIBRA experiment utilizes Thallium-doped NaI (NaI(Tl)) crystals at room temperature to search for dark matter direct-detection, and have claimed a modulation signal for dark matter. We propose a cryogenic scintillator detector based on alkali halide crystals, to test this hypothesis with a similar target material as DAMA but with added background discrimination.
We present the results of our experiments with alkali halide crystals at low temperatures, and apply them to determine the sensitivity of alkali halide cryogenic scintillation-phonon detectors to dark matter.

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