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Modeling cryogenic Dark Matter detectors for SuperCDMS

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Leading cosmological surveys and models provide strong indications for cold Dark Matter (DM) being one of the major constituents of our Universe. There are many experimental efforts utilizing highly sensitive, low-background detectors with the goal of observing the hypothesized flux of DM halo particles streaming through the Earth.

The SuperCDMS experiment will employ two types of state-of-the-art cryogenic Ge and Si detectors capable of detecting sub-keV energy depositions from potential DM interactions. In order to extend the sensitivity to lower experimental thresholds and DM masses below 10 GeV/c^2, a precise understanding of the detector response down to the semiconductor bandgap energy of $\mathcal{O}$(eV) is required.

One of the key techniques to interpret data from test facilities operating SuperCDMS prototype detectors and guiding the development of new devices is to perform comprehensive Monte-Carlo simulations of the involved detector physics. The SuperCDMS Detector Monte-Carlo (DMC) framework is based on the GEANT4 Condensed Matter Physics (G4CMP) package. This package adds phonon and charge modeling in solid-state crystals – including electron and hole propagation, phonon and charge carrier scattering, as well as phonon emission by accelerated charge carriers – on top of GEANT4's particle physics and solid-state detector response. Moreover, our DMC framework facilitates modeling of the sensor physics and readout electronics of our cryogenic detectors.

This talk will present an overview of our phonon and charge sensor based detector technology, the key aspects of G4CMP and recent achievements in modeling SuperCDMS prototype detectors with our DMC framework.

Keyword-1

Dark Matter experiment

Keyword-2

Detector Monte-Carlo

Keyword-3

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