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Spatial Imaging of Charge Transport in Silicon and Germanium at Low Temperature

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Both silicon and germanium exhibit non-trivial charge transport at cryogenic (sub-kelvin) temperatures. Due to the anisotropic mass-tensors of the energy minima in the conduction bands, free electrons travel obliquely to the applied electric field. This oblique motion causes the carriers which occupy different energy minima to spatially separate as they move through the crystal.

The purpose of the charge-transport experiment is to observe the oblique propagation of electrons by exciting a point source of charge carriers with a focused laser pulse on one face of a 4mm thick silicon or germanium crystal. After the electrons are drifted through the crystal by a uniform electric field, the pattern of charge density arriving on the opposite face is mapped and used to reconstruct the trajectories of the charge clusters.

This test will be useful for refining the Monte Carlo analysis utilized in the Cryogenic Dark Matter Search (CDMS) experiment to model the transport of charge carriers through the high-purity silicon and germanium crystals which are used as dark matter detectors.

We will present the results of the charge-transport experiment, along with measurements of inter-valley scattering as a function of both the applied electric field and temperature.

Author: MOFFATT, Robert (Stanford University)

Co-authors: Dr PHIPPS, Arran (UC Berkeley); Dr TOMADA, Astrid (SLAC); Dr SHANK, Ben (Stanford University); Prof. SADOULET, Bernard (UC Berkeley); Prof. YOUNG, Betty (Stanford University / Santa Clara University); Prof. CABRERA, Blas (Stanford University); Mr CORCORAN, Brendan (Stanford University); YEN, Jeffrey (Stanford University); Mr KREIKEBAUM, John Mark (Berkeley); Prof. SUNDQVIST, Kyle (UC Berkeley); Dr CHERRY, Matt (SLAC); Dr BRINK, Paul (SLAC); Dr REDL, Peter (Stanford University)

Presenter: MOFFATT, Robert (Stanford University)

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