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G4CMP: Condensed Matter Physics Simulation Using the Geant4 Toolkit

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G4CMP simulates phonon and charge transport in cryogenic semiconductor crystals using the Geant4 toolkit. The transport code is capable of simulating the propagation of acoustic phonons as well as electron and hole charge carriers. Processes for anisotropic phonon propagation, oblique charge-carrier propagation, and phonon emission by accelerated charge carriers are included. The simulation reproduces theoretical predictions and experimental observations such as phonon caustics, heat-pulse propagation times, and mean charge-carrier drift velocities. In addition to presenting the physics and features supported by G4CMP, this report outlines example applications from the dark matter and quantum information science communities. These communities are applying G4CMP to model and design devices for which the energy transported by phonons and charge carriers is germane to the performance of superconducting instruments and circuits placed on silicon and germanium substrates.

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