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Direct detection of dark matter via single-electron excitations in semiconductors ROUVEN ESSIG, MARIVI FERNANDEZ-SERRA, Stony Brook University, JEREMY MARDON, Stanford University, ADRIAN SOTO, Stony Brook University, TOMER VOLANSKY, Tel Aviv University, TIEN-TIEN YU, Stony Brook University — Over the last several decades, there has been an enormous experimental effort to search for dark matter (DM). Traditionally, semiconductors have been used to detect DM via scattering with nuclei and the subsequent relaxation of the crystal. However, if DM has mass below order 10 GeV these methods lose detection sensitivity. This is because the DM is lighter than a typical nucleus and, since DM particles move at non-relativistic speeds, they cannot transfer enough energy and momentum to the crystal to produce observable signals. In our work [arXiv:1509.01598], we demonstrate that DM-electron scattering in semiconductors increases the sensitivity of DM detection in this mass regime by several orders of magnitude and is a viable avenue for the direct detection of sub-GeV DM. We use density functional theory (DFT) to calculate the crystal wavefunctions and the band energies, which we correct with an empirical scissor operator. These wavefunctions are used to do perturbation theory, which allows us to calculate the DM-electron scattering rates. In this talk we will focus on the computational and theoretical challenges, discuss future directions and present new expected limits for DM-electron scattering.

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