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General Dark Matter Electron Interactions in Detector Materials

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We develop a novel formalism to describe the scattering of dark matter (DM) particles by electrons bound in detector materials such as silicon, germanium and graphene for a general form of the underlying DM-electron interaction. By applying non-relativistic effective field theory methods, we find that the DM and material physics factorise into a handful of DM and material "response functions". The former are obtained by taking the non-relativistic limit of the free amplitude for DM-electron scattering, whereas the latter are expressed in terms electron wave-function overlap integrals and obtained using Density Functional Theory. To illustrate the potential of our formalism, we predict scattering rates for DM-electron interactions that were not accurately tractable before, such as the magnetic dipole interaction.

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