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Directional detection of dark matter with anisotropic response functions

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Direct detection for sub-GeV dark matter is developing rapidly, with many novel experimental ideas and theoretical methods emerging. In this work, we extend the dielectric formalism for dark matter scattering to incorporate anisotropic material responses, enabling directionally-sensitive experiments with a broad class of target materials. Using a simple model of an anisotropic electron gas, we demonstrate the importance of many-body effects such as the plasmon, and show that even when the dark matter kinetic energies are much smaller than the plasmon energy, the tail of an anisotropic plasmon can still produce a sizeable daily modulation. We highlight the relevant experimental techniques required to establish the target response, as well as the challenges in extracting a response function which is truly free of modeling uncertainties.

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