

Detecting Axion Dark Matter by Artificial Magnetoelectric Materials

Axions are considered a key component of dark matter, characterized by very weak couplings to fermions and Chern-Simons couplings to gauge fields. We propose a novel detection mechanism based on symmetry-breaking magnetoelectric materials with a linear axionic coupling between magnetization and ferroelectric polarization. The focus is on a strain gradient Sr_2IrO_4 film, where the breaking of space-inversion symmetry results in an emergent polar phase and an out-of-plane magnetic moment, exhibiting a flexomagnetoelectric effect. In this material, the linear $\mathbf{P}||\mathbf{M}$ enables a direct coupling between the external axion field and the intrinsic axion-like field, which amplifies the weak electromagnetic signals induced by axions, paving the way for pioneering axion detection. In contrast to conventional detection techniques, this mechanism is expected to enhance the sensitivity of the axion-electron and axion-photon coupling, providing a novel platform for axion detection and advancing the study of dark matter through the magnetoelectric effect.

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