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**Quantized Faraday and Kerr rotation and axion electrodynamics of a 3D topological insulator**

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Topological insulators have been proposed to be best characterized as bulk magnetoelectric materials which show response functions quantized in terms of fundamental physical constants. It has been predicted that this manifests as Faraday and Kerr rotations quantized in units of the fine structure constant $\alpha = e^2/2\epsilon_0 hc$. We use a charge-transfer-doping preparation to lower the chemical potential of $Bi_2Se_3$ films into the bulk gap and as low as $\sim$ 30 meV above the Dirac point, and then probe their low-energy electrodynamic response with high-precision time-domain terahertz polarimetry. As a function of field, a crossover from semi-classical cyclotron resonance to a quantum regime was observed. In this regime, although the DC transport is still semi-classical, we observed quantized Faraday and Kerr rotations. A non-trivial Berry's phase offset to these values is consistent with half-integer quantized conductance on each surface and therefore provides evidence for the long-sought axion electrodynamics and topological magnetoelectric effect. Among other aspects, the unique time structure used in these measurements allow us a direct measure of the fine structure constant based on a topological invariant of a solid-state system. I will also discuss how optics can detect quantized Hall conductance without involving the edge states. Main reference: arXiv:1603.04317.