Anomalous magneto-transport of Dirac-like fermions in a spin-polarized oxide two-dimensional electron system

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Abstract: We present anomalous magneto-transport dominated by non-trivial Berry curvature and Dirac-like fermions is exhibited by an artificial 2DES at (111) $LaAlO_3/EuTiO_3/SrTiO_3$ interface, where structural and electronic properties are tailored to mimic that of magnetic gapped topological insulators.

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In a two-dimensional electron system (2DES), the breaking of the inversion, time-reversal and bulk crystal-field symmetries, combined with spin-orbit coupling (SOC), gives rise to exotic quantum phenomena. By engineering a spin-polarized oxide 2DES with Rashba-like SOC and hexagonal band warping, here we present the first report of an anomalous quantum correction to the magnetoconductance by Dirac-like fermions experiencing competing weak anti-localization and weak localization back-scattering (Fig. 1(a) and ref. [1]), with a phenomenology analogous to that of gapped topological insulators [2]. The results were obtained on the 2DES formed at the epitaxially grown interfaces between (111) $LaAlO_3$, $EuTiO_3$, and $SrTiO_3$ single crystal, characterized by a trigonal crystal field splitting and ferromagnetism induced by Eu and Ti ions magnetic ordering [3]. The anomalous magnetoconductance disappears at the magnetic critical temperature [4], showing a direct link with the ferromagnetic order. The data are explained theoretically in a single band scenario as the combined effects of the Rashba-SOC, of the band- warping induced by the 2DES trigonal symmetry, and of the magnetic gap opening at spin-orbit induced Dirac-like point, giving rise to a non-trivial Berry phase (Fig. 1(b, c)). These findings open perspectives for the engineering of novel spin-polarized functional 2DES holding promises in spin-orbitronics and topological electronics.

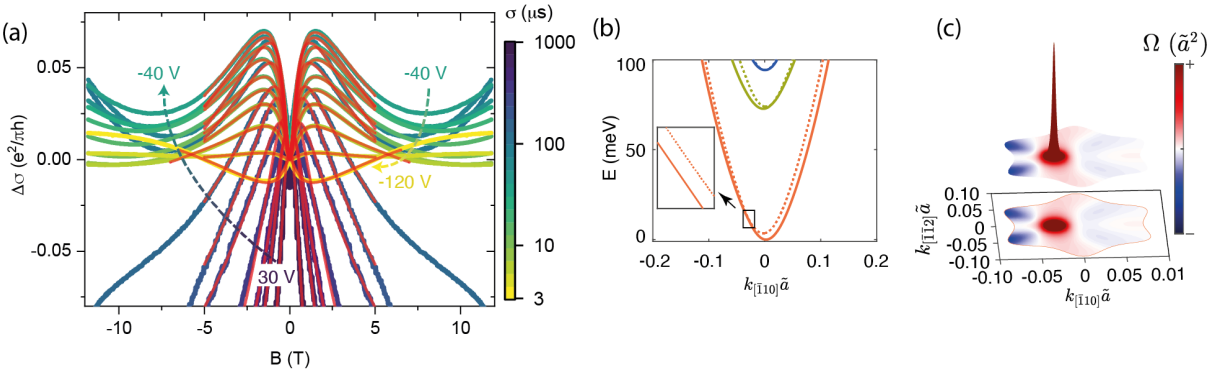

Fig. 1 (a) Gate dependence of the anomalous magnetoconductance. (b) Electronic band structure in presence of in-plane magnetization. (c) The corresponding non-trivial Berry curvature with a hot-spot at the avoided crossing point.

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