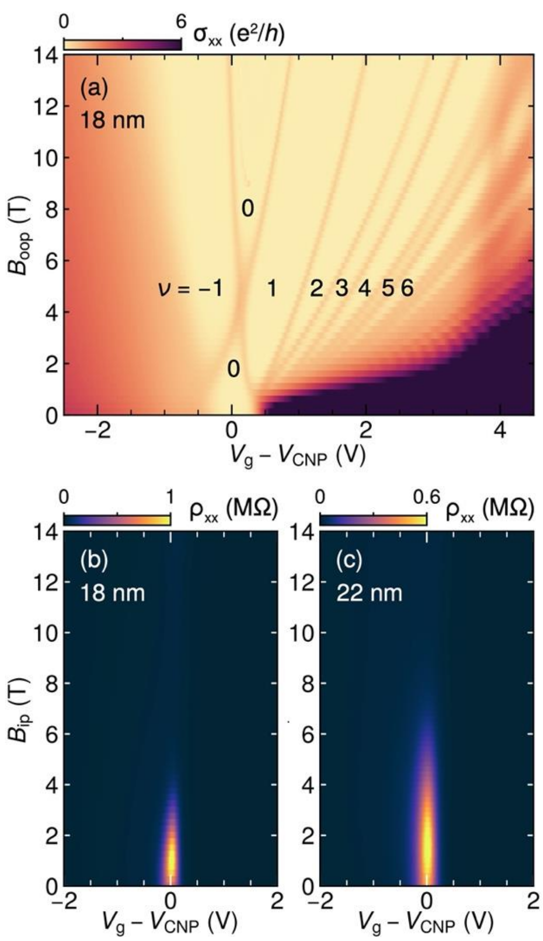
Title: Zeeman Field-Induced Two-Dimensional Weyl Semimetal Phase in Cadmium Arsenide Thin Films

Abstract

We report a topological phase transition in MBE-grown, quantum-confined cadmium arsenide (Cd_3As_2) thin films under an in-plane Zeeman field when the Fermi level is tuned into the topological gap via an electric field. Symmetry considerations in this case predict the appearance of a two-dimensional Weyl semimetal (2D WSM), with a pair of Weyl nodes of opposite chirality at charge neutrality that are protected by space-time inversion (C_2T) symmetry. We show that the 2D WSM phase displays unique transport signatures, including saturated resistivities on the order of h/e^2 that persist over a range of in-plane magnetic fields. Moreover, applying a small out-of-plane magnetic field, while keeping the in-plane field within the stability range of the 2D WSM phase, gives rise to a well-developed odd integer quantum Hall effect, characteristic of degenerate, massive Weyl fermions. A minimal four-band $k{\cdot}p$ model of Cd_3As_2, which incorporates first-principles effective g factors, qualitatively explains our findings.

Figure



Caption

Out-of-plane and in-plane magnetotransport.
(a) Longitudinal conductivity σ_{xx} as a function of the out-of-plane field B_{oop} and the scaled (relative to V_{CNP}) top-gate voltage for the 18 nm Cd_3As_2 sample (device, hb1). Quantum Hall plateau regions are indexed by their filling factor ν up to 6. The measured voltage V_g is offset by V_{CNP}, which corresponds to the charge neutrality condition.
(b) Longitudinal resistivity ρ_{xx} as a function of the in-plane field B_{ip} and the top-gate voltage for the 18 nm Cd_3As_2 sample (device, hb1). The same is shown in (c) for the 22 nm sample. $V_{CNP} = -1.35$ V for the 18 nm sample, $V_{CNP} = -1.165$ V for the 22 nm sample. Measurements were done at $T = 2$ K in the transverse configuration.

Reference:

B. Guo … S. Stemmer, *Phys. Rev. Lett.* 131, 046601 (2023)