Landau Level Spectroscopy of Kane Electrons in Cd_3As_2

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In many cases, the low-energy electronic excitations in solids can be conveniently described by effective relativistic-like Hamiltonians providing more elegant and simple description as compared to the classical approach based on the Schrödinger-type Hamiltonian. Those systems, characterized by the linear in momentum dispersion, imply intriguing properties such as $\sqrt{B}$ dependence of Landau levels, dynamical conductivity increasing linearly with the photon energy or Klein tunneling.
Semimetal-to-semiconductor transition in zinc-blende semiconductors, when the energy band gap separating the s-type conduction band from p-type valence bands drops to zero, represents possible realization of a relativistic system. Experimentally, this situation may be achieved in the ternary compound $Hg_{1-x}Cd_xTe$ by tuning the composition, which gives rise to 3D conical band at Γ-point, hosting massless Kane electrons[1].
Recently, a renewed attention has been drawn to Cd_3As_2 after the discovery[2] of well-defined 3D conical features in agreement with preceding theoretical study interpreted in terms of symmetry-protected Dirac electrons. However, a more complex scenario has been proposed based on cyclotron resonance experiments[3] and an effective k.p model introduced by Bodnar[4] in the past. In fact, the band structure may include two types of conical features, appearing at different energy scales. The massless electrons at the larger scale, evidenced in the magneto-optics but also in ARPES, are not Dirac but instead Kane electrons, resembling those in gapless HgCdTe. The massless Dirac electrons are also likely present, but at relatively low energies and they have not been, to our knowledge, directly observed experimentally so far.
Here we extend our previous magneto-reflectivity study[3] by transmission experiments on thin free-standing layers. In addition to the cyclotron-resonance mode observed in reflectivity experiments an additional series of excitations nearly following $\sqrt{B}$ dependence is revealed. These latter transitions are identified as interband inter-Landau level transitions between pairs of levels origination from the flat to the conical conduction band. The comparison with predictions of the Bodnar model[5] allows us to estimate the relevant parameters in the model: the (inverted) band gap and strength of the crystal field splitting providing thus a rough scale/shape of Dirac cones in Cd_3As_2.

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