Semiconductor-to-semimetal transition in 3D HgCdTe: infrared magneto-spectroscopy study

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Bulk $Hg_{1-x}Cd_xTe$ alloys are zinc-blend compounds exhibiting a semiconductor-to-semimetal transition at critical cadmium concentration $x_c \approx 0.17$. At the point of this phase transition, HgCdTe becomes a zero-gap material with linear (conical) electronic dispersion [1]. Recently, a temperature-induced transition from a conventional two-dimensional semiconductor to a topological insulator has been demonstrated through magneto transport studies on HgTe/CdHgTe quantum wells [2].

Here, we employ IR magneto-spectroscopy to probe a composition- or temperature-driven semiconductor-to-semimetal transition in 3D HgCdTe. We show that changing the temperature from 4K to 120K enables continuous tuning of the band structure in $Hg_{0.85}Cd_{0.15}Te$ from inverted to normal alignment through a critical gapless state realized at ~80K, where the inter-Landau level transitions exhibit a characteristic sqrt(B) dependence intersecting at zero energy. A similar evolution of Landau levels is observed at 4.2K when varying the composition: $x_c \approx 0.15$ (semimetal), $x_c \approx 0.17$ (near-gapless), $x_c \approx 0.19$ (conventional semiconductor).

[1] Orlita, M. et al. Observation of three-dimensional massleass Kane fermions in a zinc-blende crystal. Nature Physics 10, 233-238(2014)
[2] Wiedmann, S. et al. Temperature-driven transition from a semiconductor to a topological insulator. Phys. Rev. B **91**, 205311 (2015).

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