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Direct observation of Landau level resonance and mass generation in three dimensional topological Dirac semimetal thin films XIANG YUAN, PEIHONG CHENG, HUGEN YAN, Fudan University, ZHIQIANG LI, Sichuan University, FAXIAN XIU , Fudan University — Three-dimensional topological Dirac semimetals have hitherto stimulated unprecedented research interests as a new class of quantum materials. Breaking certain types of symmetries has been proposed to enable the manipulation of Dirac fermions; and that was soon realized by external modulations such as magnetic fields. However, an intrinsic manipulation of Dirac states, which is more efficient and desirable, remains a significant challenge. Here, we report a systematic study of quasi-particle dynamics and band evolution in Cd3As2 thin films with controlled Chromium (Cr) doping by both magneto-infrared spectroscopy and electrical transport. For the first time, we observe sqrt-B relation of inter-Landau-level resonance, an important signature of ultra-relativistic Dirac state inaccessible in previous optical experiments. A crossover from quantum to quasi-classical behavior makes it possible to directly probe the mass of Dirac fermions. Importantly, Cr doping allows for a Dirac mass acquisition and topological phase transition. Corroborating with the density-functional theory calculations, we show that the mass generation can be explained by the explicit C4 rotation symmetry breaking and the resultant Dirac gap engineering through Cr substitution for Cd atoms. The manipulation of the system symmetry and Dirac mass in Cd3As2 thin films provides a tuning knob to explore the exotic states stemming from the parent phase of Dirac semimetals.

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