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Magneto-infrared spectroscopy of Landau levels and Zeeman splitting of three-dimensional massless Dirac Fermions in $ZrTe_5$ R. Y. CHEN, International Center for Quantum Materials, School of Physics, Peking University, Beijing 100871, China, Z. G. CHEN, National High Magnetic Field Laboratory, Tallahassee, Florida 32310, USA, X.-Y. SONG, International Center for Quantum Materials, School of Physics, Peking University, Beijing 100871, China, J. A. SCHNEELOCH, G. D. GU, Brookhaven National Lab, Upton, New York 11973, USA, F. WANG, N. L. WANG, International Center for Quantum Materials, School of Physics, Peking University, Beijing 100871, China — We present a magneto-infrared spectroscopy study on a newly identified three-dimensional (3D) Dirac semimetal $ZrTe_5$. We observe clear transitions between Landau levels and their further splitting under magnetic field. Both the sequence of transitions and their field dependence follow quantitatively the relation expected for 3D *massless* Dirac fermions. The measurement also reveals an exceptionally low magnetic field needed to drive the compound into its quantum limit, demonstrating that $ZrTe_5$ is an extremely clean system and ideal platform for studying 3D Dirac fermions. The splitting of the Landau levels provides a direct and bulk spectroscopic evidence that a relatively weak magnetic field can produce a sizeable Zeeman effect on the 3D Dirac fermions, which lifts the spin degeneracy of Landau levels. Our analysis indicates that the compound evolves from a Dirac semimetal into a topological line-node semimetal under current magnetic field configuration. Refs: R. Y. Chen et al., Phys. Rev. B 92, 075107 (2015); R. Y. Chen et al., Phys. Rev. Lett. 115, 176404 (2015).

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