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A topological Dirac insulator in a quantum spin Hall phase DAVID HSIEH, DONG QIAN, LEWIS WRAY, YUQI XIA, Department of Physics, Princeton University, YEW SAN HOR, ROBERT CAVA, Department of Chemistry, Princeton University, ZAHID HASAN, Department of Physics, Princeton University — When electrons are subject to a large external magnetic field, the conventional charge quantum Hall effect dictates that an electronic excitation gap is generated in the sample bulk, but metallic conduction is permitted at the boundary. Recent theoretical models suggest that certain bulk insulators with large spin orbit interactions may also naturally support conducting topological boundary states in the quantum limit, which opens up the possibility for studying unusual quantum Hall-like phenomena in zero external magnetic fields. Bulk $Bi_{1-x}Sb_x$ single crystals are predicted to be prime candidates for one such unusual Hall phase of matter known as the topological insulator. The hallmark of a topological insulator is the existence of metallic surface states that are higher-dimensional analogues of the edge states that characterize a quantum spin Hall insulator. Here, using incident-photon-energy-modulated angle-resolved photoemission spectroscopy, we report the direct observation of massive Dirac particles in the bulk of $Bi_{0.9}Sb_{0.1}$ and provide a comprehensive mapping of the Dirac insulators gapless surface electron bands. These findings taken together suggest that the observed surface state on the boundary of the bulk insulator is a realization of the topological metal.

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