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Experimental Realization of a Three-Dimensional Topological Insulator[1]

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Three-dimensional(3D) topological insulators (TIs) are a new state of quantum matter with a bulk gap generated by the spin orbit interaction and odd number of relativistic Dirac fermions on the surface. The robust surface states of TIs can be the host for many striking quantum phenomena, such as an image magnetic monopole induced by an electric charge and Majorana fermions induced by the proximity effect from a superconductor. Recently, a class of stoichiometric materials, Bi_2Te_3, Bi_2Se_3, and Sb_2Te_3, were theoretically predicted to be the simplest 3D TIs whose surface states consist of a single Dirac cone. By investigating the surface state of Bi_2Te_3 with angle-resolved photoemission spectroscopy, we demonstrate that the surface state consists of a single nondegenerate Dirac cone. Furthermore, with appropriate hole doping, the Fermi level can be tuned to intersect only the surface states, indicating a full energy gap for the bulk states. These results establish that Bi_2Te_3 is a simple model system for the 3D TI with a single Dirac cone on the surface. The large bulk gap of Bi_2Te_3 also points to promising potential for high-temperature spintronics applications.

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