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Observation of Weyl fermions in condensed matter

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In 1929, a German mathematician and physicist Hermann Weyl proposed that a massless solution of the Dirac equation represents a pair of new type of particles, the so-called Weyl fermions. However, their existence in particle physics remains elusive after more than eight decades, e.g., neutrino has been regarded as a Weyl fermion in the Standard Model until it was found to have mass. Recently, significant advances in topological materials have provided an alternative way to realize Weyl fermions in condensed matter as an emergent phenomenon. Weyl semimetals are predicted as a class of topological materials that can be regarded as three-dimensional analogs of graphene breaking time reversal or inversion symmetry. Electrons in a Weyl semimetal behave exactly as Weyl fermions, which have many exotic properties, such as chiral anomaly, magnetic monopoles in the crystal momentum space, and open Fermi arcs on the surface. In this talk I will report our experimental discovery of a Weyl semimetal in TaAs by observing Fermi arcs with a characteristic spin texture in the surface states and Weyl nodes in the bulk states using angle-resolved photoemission spectroscopy.