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Topological phase transition in Fe(Te, Se)

A topological phase transition can be induced by controlling topological bands through changes in chemical composition, application of strain, external fields, and so on. In the iron-based superconductor Fe(Te,Se), a topological phase transition is expected by changing Te/Se compositions, and it is considered a promising route to manipulating the topologically superconducting states and Majorana zero modes. However, such a topological phase transition has never been resolved. Here, we investigate the electronic structures of $FeTe_xSe_{1-x}$ single crystals of a wide Te/Se composition range across the topological phase transition, using high-resolution angle-resolved photoemission spectroscopy. With the data from $FeTe_{0.55}Se_{0.45}$, we provide the first direct demonstration of the band inversion along the k_z axis. We further find that the topological phase transition occurs at $FeTe_{0.45}Se_{0.55}$ via the thorough examination of different Te/Se composition samples. Most importantly, our high resolution measurements reveal that a special Te/Se composition exists, at which the Dirac point is located exactly at the Fermi level, which is essential for realizing clean and isolated Majorana zero modes in the vortex cores.

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