Engineering Dirac points with ultracold fermions in a tunable optical lattice

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We report on the creation of Dirac points with adjustable properties in a tunable honeycomb optical lattice. Using momentum-resolved interband transitions, we observe a minimum band gap inside the Brillouin zone at the position of the Dirac points. We exploit the unique tunability of our lattice potential to adjust the effective mass of the Dirac fermions by breaking the inversion symmetry of the lattice. Changing the lattice anisotropy allows us to move the position of the Dirac points inside the Brillouin zone. When increasing the anisotropy beyond a critical limit, the two Dirac points merge and annihilate each other. We map out this topological transition and find excellent agreement with ab initio calculations. Our results not only pave the way for using cold atoms to model materials where the topology of the band structure plays a crucial role, but also provide the possibility to explore many-body phases resulting from the interplay of complex lattice geometries with interactions.