Effective Hamiltonian for protected edge states in graphene

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Abstract

Edge states in topological insulators (TIs) disperse symmetrically about one of the time-reversal invariant momenta Lambda in the Brillouin zone (BZ) with protected degeneracies at Lambda. Commonly TIs are distinguished from trivial insulators by the values of one or multiple topological invariants that require an analysis of the bulk band structure across the BZ. We propose an effective two-band Hamiltonian for the electronic states in graphene based on a Taylor expansion of the tight-binding Hamiltonian about the time-reversal invariant M point at the edge of the BZ. This Hamiltonian provides a faithful description of the protected edge states for both zigzag and armchair ribbons though the concept of a BZ is not part of such an effective model. We show that the edge states are determined by a band inversion in both reciprocal and real space, which allows one to select Lambda for the edge states without affecting the bulk spectrum.

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