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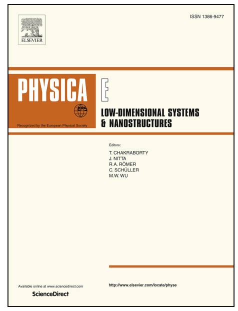

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Analytic and numeric computation of edge states and conductivity of a Kane-Mele nanoribbon

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Abstract

We compute analytic expressions for the edge states in a zigzag Kane-Mele nanoribbon (KMNR) by solving the eigenvalue equations in presence of intrinsic and Rashba spin-orbit couplings. Owing to the P-T symmetry of the Hamiltonian the edge states are protected by topological invariance and hence are found to be robust. This is not the case where either of the spin-orbit couplings in the Kane-Mele Hamiltonian is switched off. We have done a systematic study for each of the above cases, for example, a pristine graphene, graphene with an intrinsic spin-orbit coupling, graphene with a Rashba spin-orbit coupling, a Kane-Mele nanoribbon and supported our results on the robustness of the edge states by analytic computation of the electronic probability amplitudes, the local density of states (LDOS), band structures and the conductance spectra.

Keywords: Kane-Mele nanoribbon, Band structure, Electronic wavefunction, LDOS, Charge conductance

1. Introduction

The successful fabrication of graphene [1] has generated intense research activities to study the electronic properties of this novel two dimensional (2D) electronic system. Graphene has a honeycomb lattice structure due to the sp^2 hybridization of carbon atoms and the π-electrons can hop between nearest neighbors. The valence and conduction bands of graphene touch each other at two nonequivalent Dirac points, K and K', which have opposite chiralities and form a time-reversed pair. The band structure around those points has the Dirac form, $E_{\vec{k}} = \hbar v|\vec{k}|$, where v ($\simeq 10^6$ ms^{-1}) is the Fermi velocity. The Dirac nature of the electrons [2] is responsible for many interesting properties of graphene [3], such as unconventional quantum Hall effect [1, 4, 5], half metallicity [6, 7], Klein tunneling through a barrier [8], high carrier mobility [9, 10] and many more. Owing to these features, graphene is recognized as one of the promising materials for realizing next-generation electronic devices.

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