Theory of electronic and transport properties in nanoribbons with different types of protected edge states

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Edge states discovered in many currently heavily investigated 2D materials like topological insulators [1] and transitions metal dichalcogenides MX_2 (M=Mo, X=S,Se,Te) [2] are interesting new charge/spin/valley [3] degree of freedom carriers. Those states may potentially offer dissipationless transport in moderately disordered samples even up to room temperatures [4]. Interestingly, sometimes states occurring in formally trivial systems are also robust against defects [5]. In the following work we study electronic properties of quasi-one-dimensional nanostructures, exhibiting various types of edge states protected against backscattering.

In first part we analyze differences between chiral [6], helical [7] and recently proposed antichiral [8] low-energy effective models on a honeycomb lattice. We show how different kinds of edge-bulk states interplay affects transport in disordered zigzag and armchair-type nanoribbons and discuss differences between backscattering suppression mechanisms. In next step we introduce smooth electrostatic potentials defined on those nanoribbons, modelling quantum-dot like confinement. We investigate how details of different models and their topology affects spectra of localized states and how inter-dot coupling affects transport in single-particle regime. Finally, low-energy approximations are compared with more advanced tight-binding models of gapped graphene and TMDC's representant MoS_2 [9].

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