T-shaped spin-separator based on a magnetic two-dimensional electron gas

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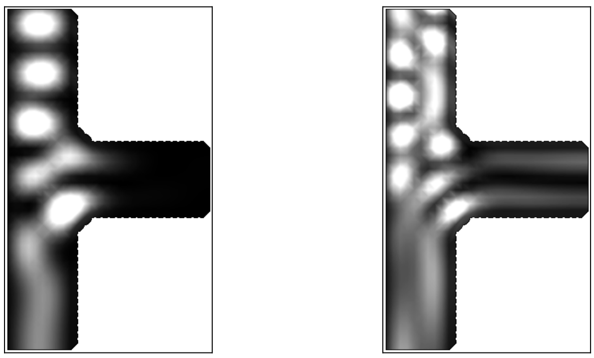
The so-called tree-terminal ballistic junctions (TBJs) consist of three quantum wires connected via ballistic cavity to form a Y-shaped or T-shaped current splitter, which in principle can operate at high speed with a very low power consumption. The interesting and unexpected transport characteristic of TBJs is the almost reflectionless separation of 1D conductance modes, which occurs at the junction area. This spectacular example of the so-called *wave function engineering* has been experimentally demonstrated for T-branch switches, patterned from two-dimensional electron gas [1, 2].



(a) (b)

Fig.1 Squared modulus of the Zeeman splitted wave functions for "up" (a) and "down" (b) spin directions (brighter areas correspond to higher density). Spin-orbit (SO) interaction is not taken into account, note a rounded corners of the central junction area.

Here we propose to extend the idea of reflectionless charge current redirection on the magnetic system where one-dimensional channels are spin polarized (see Fig.1). We present the theoretical model of T-shaped ballistic junction patterned from a high mobility modulation doped CdMgTe/Cd(Mn)Te quantum well. Nanostructure is modeled as a discrete lattice with tight-binding Hamiltonian. To make simulation more realistic, system includes rounded corners and finite edge potential. The numerical calculations are performed using the Kwant code [3]. It is intended that parameters of our model closely reflect the experimental characteristics of a real device. In particular, we carefully examined the role of spin-orbit interaction, which is usually omitted in the theoretical analysis of the ballistic mode separation. Results are discussed in terms of current density, wave function and local density of states (LDOS) with respect to the average spin orientation and magnetic field direction.

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