STRONG CURRENT MODULATION IN QUANTUM WIRES WITH LOCALIZED RASHBA INTERACTION

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The Rashba interaction is a salient spin-orbit interaction in semiconductors which occurs due to interfacial electric fields in asymmetric heterostructures [1]. This removes the spin degeneracy of conduction electron states and the resulting splitting can be tuned with external gates [2]. When the Rashba interaction is localized in a one-dimensional (1D) channel, the injected spins in the Rashba region perform a spin precession, leading to a modulated transmission when the leads are ferromagnetic [3]. Recently, we have predicted strongly modulated transmission lineshapes when the quasi-1D wire is attached to *normal* leads, see Fig. 1. These antiresonances originate from the interference between a direct channel through the Rashba region and a channel that interacts with a quasibound state formed by the Rashba potential in the region (the Rashba *dot*). We demonstrated that the Rashba intersubband coupling controls the coupling between the continuum and discrete states and that the lineshape is of the Fano form [4].

When electron-electron interaction is taken into account, our results show that considerable repulsion energy results from charging the dot [5]. The conductance resonances in the Coulomb blockade regime have a Fano form, while in the strong coupling regime we predict an oscillating conductance as a function of the Rashba strength. Furthermore, in the presence of an external magnetic field an energy pseudogap develops in the wire spectrum. We find abrupt changes in the transmission curves when the Fermi energy lies within the pseudogap [6]. The lineshapes are narrow and asymmetric and the transmission reaches zero for energies near the gap closing.

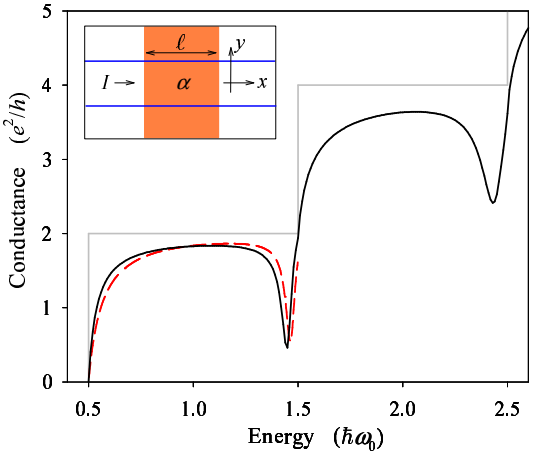

Fig. 1 Characteristic linear conductance curve of a quantum wire with local Rashba interaction (solid line). We show with dashed line the result from a coupled channel model that captures the main ingredients of the effect. We include the case without Rashba interaction (gray line) for comparison. Note the strong conductance modulation close to the onset of the second conductance plateau.

The system discussed here could work as a current modulator device. For slight variations of the Fermi energy, which can be externally controlled, we show that the transmission changes dramatically between two limit values across the antiresonance. Importantly, the current modulation is robust against intersubband mixing, magnetic field changes, and smooth variations of the wire interfaces,

References

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