Rashba spin splitting in nanostructures

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Spin-orbit coupling effects in semiconductor heterostructures have recently attracted a great interest because they provide a useful tool to manipulate the spin degree of freedom of the electron by coupling to the orbital motion, and vice versa. As a result, spin-orbit coupling has become one of the key ingredients for phase-coherent spintronics applications[1]. We focus here on the spin-orbit coupling induced by structural inversion asymmetry, i.e., the Rashba effect[2]. It is typically important in small-gap zinc–blende–type semiconductors and can be tuned by external gate voltages.

We present results concerning the effect of Rashba spin-orbit coupling on the band structure, and transport properties of quantum wires. First, we discuss how spin currents can be generated through adiabatic pumping[3] using the tunability of the strength of the Rashba spin-orbit coupling in quantum wires[4]. Second, we study transport in a quantum wire when the spin precession length is comparable to the wire width (strong spin-orbit coupling regime)[5]. In this regime we find that spin-orbit coupling can lead to spin-accumulation in the wire.

Furthermore, we discuss the effect of Rashba spin-orbit coupling on the electronic structure and the magnetic response of few-electron interacting quantum dots[6]. In particular, we find a suppression of Hund's rule due to the competition of the Rashba effect and exchange interaction, and a paramagnetic behavior of the dot in a closed shell configuration.

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