Spin-dependent electron scattering in 2D electron systems

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At the nanoscale electron scattering leads to well-known quantum effects such as quasiparticle interference and electron confinement. These were elegantly demonstrated with real-space visualization in the pioneering scanning tunnelling spectroscopy (STS) experiments using quantum resonators on metallic surfaces. Here, resonators of different geometry and chemical nature were artificially fabricated by moving atoms one by one [1], and later used as quantum laboratories for quantitative studies of scattering parameters [2,3], and for the exploration of more exotic phenomena such as the quantum mirage and invisibility [4,5].
Here I present STS studies that illustrate how the influence of exchange and spin-orbit coupling affects scattering of 2D electrons. In a first example I show how the Ni(111) exchange-split surface electrons undergo spin-dependent scattering at the interface with graphene, resulting in a total spin filtering effect [6]. The magnitude of the effect will depend on the atomic structure of graphene edges. The second example will focus on the electron confinement in 1D step resonators that are fabricated on Ag(111) and the $BiAg_2$ surface alloy, material with record-high Rashba-type spin-orbit interaction [7,8]. In the latter case, electrons are confined via a novel spin-flip mechanism originated by the spin-orbit locking, the strength of it being determined by the chemical composition of the steps. The two examples reveal fundamental phenomena that can be applied in future spintronics devices based on spinterfaces and spin-orbit textured materials.

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