Spin orbit effects in quantum point contacts and quantum dots: from current polarization to Kondo effect

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The basic elemental unit in many electronic quantum devices, the *quantum point contact* (QPC), has been recently studied in systems where the spin-orbit interaction is relatively strong. In particular, we investigate how a *lateral* spin-orbit coupling, introduced by asymmetric lateral confinement potentials defining the QPC, affects the spin polarization of the current. We find that even in the absence of external magnetic fields, a variable nonzero spin polarization can be obtained by controlling the asymmetric shape of the confinement. These results suggest an approach to produce spin-polarized electron sources. Furthermore, this asymmetry-induced polarization provides a plausible explanation of recent observations of a "half" conductance plateau (in units of $2e^2/h$) in QPCs made on InAs quantum-well structures [1]. However, our estimates for the magnitude of such effect for realistic spin-orbit interaction strength in these systems do not support this explanation, and point to the important role that electron-electron interactions play in these systems [2].

This conclusion motivates our recent work incorporating the spin polarization of QPC tunneling in these structures. We discuss how even for slightly polarized injection, the Coulomb blockade and Kondo regimes of a quantum dot created with these QPCs are profoundly affected. We predict strong current polarization, intrinsically enhanced by the electronic interactions in the dot. The system behaves essentially as if the current were injected via ferromagnetic leads, despite the *total absence* of magnetization or magnetic fields. In particular, we show that while the Kondo effect is substantially affected, it remains strong and yet the resulting conductance exhibits spin polarization even for unpolarized current injection [3].

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