Spin-Resolved Transport Properties of Inhomogeneous Graphene Nanostructures

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We address the problem of spin-resolved scattering through spin-orbit nanostructures in single-layer graphene, *i.e.*, regions of inhomogeneous spin-orbit coupling on the nanometer scale. Our main motivation stems from a recent experiment that reported a large enhancement of *extrinsic* or Rashba spin-orbit coupling splitting in single-layer graphene grown on Ni(111) intercalated with a gold monolayer [1], and a recent theoretical proposal that shows how the presence of indium and thallium *ad*-atoms can enhance the gap associated to this *intrinsic* spin-orbit coupling [2].

In particular, we discuss the phenomenon of spin-double refraction and its consequences on the spin polarization. We study the transmission properties of a single, a double interface [3] and a periodic system [4] between a region without spin-orbit coupling – normal region – and a region with finite spin-orbit coupling – spin-orbit region. Furthermore, we analyze the polarization properties of these systems. In the case of the periodic system, the simple form of the band condition enables us to estimate the size of gaps due to avoided band crossings and gives insight into the dependence of the band-structure on the width of the potential. We also investigate band structures for the case where the lattice momentum forms a finite incidence angle with respect to the modulation direction of the spin-orbit coupling.

Finally, we address the problem of spin and charge adiabatic quantum pumping in the presence of applied external gate voltages. We show that under particular conditions it is possible to find parameter regimes in which the charge current is negligible compared to the spin current [5].

References

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