Spin-orbit and Kondo effect in graphene

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One of the greatest challenges for the development of spin-based devices is the understanding of mechanisms that give rise to spin-polarized currents. Advances in the field have been achieved by studying the effect of different types of spin-orbit interactions in semiconductor materials. Rashba spin-orbit interactions are of particular interest for systems with surfaces since they present a natural breaking of space-inversion symmetry, a condition for its existence. Graphene, a monolayer of graphite, is not expected to exhibit large Rashba couplings in isolation, but recently, several groups have successfully produced samples with band-splittings consistent with large values of the Rashba coupling. Two important effects result from large Rashba interactions: the linear dispersion at the Dirac points becomes quadratic (with the consequent change in the density of states) and new Dirac points are generated around the (K; K') points. The properties of zigzag graphene ribbons are equally affected, with edge states magnetization highly dependent on momentum[1].

Because Rashba changes the density of states in graphene, it is natural to wonder about its consequences on the Kondo effect. The role of spin-orbit interactions on the Kondo effect, an issue posed for the first time by D. Gainon and A. Hegger in 1969[2], has been the topic of much controversy in later years, with many partial (and sometimes contradictory) answers. We have obtained the exact solution for a two-dimensional Anderson impurity model in the presence of Rashba interactions and its effects in the Kondo regime, with and without particle-hole symmetry[3]. The main features are: a two-channel Kondo regime with antiferro- and ferromagnetic couplings and the presence of Dzyaloshiinski-Moriya interactions when particle-hole symmetry is broken. Interesting results are also obtained for graphene where an exponential enhanced Kondo temperature is predicted.

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