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Extrinsic Spin Hall Effect in Graphene

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The intrinsic spin-orbit coupling in graphene is extremely weak, making it a promising spin conductor for spintronic devices. However, for many applications it is desirable to also be able to generate spin currents.Theoretical predictions and recent experimental results suggest one can engineer the spin Hall effect in graphene by greatly enhancing the spin-orbit coupling in the vicinity of an impurity. The extrinsic spin Hall effect then results from the spin-dependent scattering of carriers by impurities in the presence of spin-orbit interaction. This effect can be used to convert charge currents into spin currents efficiently.

I will discuss recent experimental results on spin Hall effect in graphene decorated with adatoms and metallic clusters[1,2] and show that a large spin Hall effect can appear in graphene in the presence of locally enhanced spin-orbit coupling. I will present results from single impurity scattering calculations [3], and also from a real-space implementation of the Kubo formalism [4] for tight-binding Hamiltonians with different forms of spin-orbit coupling.

[1] J. Balakrishnan et al., Nat. Phys. 9, 284 (2013).

[2] J. Balakrishnan et al., Nat. Commun. 5, 4748 (2014).

[3] A. Ferreira, T. G. Rappoport, M. A. Cazalilla, A. H. Castro Neto, Phys. Rev. Lett. 112, 066601 (2014).

[4] Jose H. Garcia, Lucian Covaci and Tatiana G. Rappoport, arXiv:1410.8140.

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