MAR11-2010-003645
Abstract for an Invited Paper
for the MAR11 Meeting of
the American Physical Society

Quantum motion of electrons and holes in the random puddle landscape of graphene[1]

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The transport properties of graphene, especially close to the Dirac point, have puzzled physicists since its discovery in 2004. Only recently a fairly complete understanding of transport in graphene has emerged [1]. The interplay of disorder, gapless nature of the dispersion, and chirality of the quasiparticles induces the anomalous transport properties of graphene close to the Dirac point. In particular, in presence of long-range disorder the carrier density landscape close to the Dirac point breaks up in electron-hole puddles. In this highly inhomogeneous density landscape the standard theoretical approaches to transport are not valid. I will present a transport theory for graphene, and bilayer graphene, that is able to properly take into account the strong disorder-induced density inhomogeneities. The theory has three main features: *1)* it treats disorder microscopically and can therefore take into account its long-range nature, *2)* it provides a fully quantum mechanical analysis of transport, *3)* it is able to model experimentally relevant sizes. In particular the theory presented can be used to calculate the transport properties in the crossover regime, particularly relevant for graphene, between the ballistic and the diffusive regime. I will present results for single layer graphene and bilayer graphene. In addition I will discuss the transport properties of disordered graphene p-n-p junctions for which the semiclassical approaches are inadequate and the full quantum transport analysis is necessary.

[1] S. Das Sarma, S. Adam, E. H. Hwang, E. Rossi, *Electronic transport in two dimensional graphene*, arXiv:1003.4731 (2010), to be published in Rev. Mod. Phys.

[1]Work done in collaboration with S. Adam, J.H. Bardarson, P.W. Brouwer, S. Das Sarma, M.S. Fuhrer, E.H. Hwang and supported by NSF-NRI-SWAN and U.S.-ONR.