MAR08-2007-003450

Abstract for an Invited Paper
for the MAR08 Meeting of
the American Physical Society

Excitations from Filled Landau Levels in Graphene

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Recent experimental progress has allowed the fabrication of graphene, a two-dimensional honeycomb lattice of carbon atoms that forms the basic planar structure in graphite. Graphene exhibits a host of interesting properties that can be understood in terms of a non-interacting system whose single-particle excitations are described by the Dirac equation. What, then, is the role of the Coulomb interactions between electrons in graphene? In this talk, I will present a study of the collective excitations of graphene in the quantum Hall regime. These excitations open a window into the nature of Coulomb interaction effects and may be observable by optical spectroscopy. Such excitations are well-understood in the case of the standard two-dimensional electron gas (2DEG), in which the low-lying collective mode spectrum may be interpreted in terms of a single particle-hole pair bound into a stable exciton by Coulomb forces. Using a similar analysis for graphene, we find that, in spite of the linear electronic dispersion near the Dirac points, the exciton spectrum is qualitatively quite similar to that of the 2DEG. On the other hand, the additional pseudospin degree of freedom strongly enhances many-body corrections relative to the 2DEG case. We also find that the presence or absence of certain branches of the exciton spectrum is sensitive to the number of filled spin and pseudospin sublevels. Finally, I will discuss these results in relation to infrared spectroscopy measurements and comment on the screening of the Coulomb interaction in graphene.