Coulomb Interacting Dirac Fermions in Disordered Graphene

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Recent advances in microfabrication of graphitic samples that are only a few carbon layers thick have made it possible to test the early theoretical predictions of the anomalous properties of this system. The electronic band structure of graphene is characterized by the presence of a pair of inequivalent nodal points where the valence and conduction bands touch as a pair of opposing cones with the opening angle given by the Fermi velocity. The low-energy quasiparticle excitations in the vicinity of such nodal points can be described as Dirac fermions which carry a physical spin 1/2 and possess an additional orbital ("pseudo-spin" or "valley") quantum number corresponding to the double degeneracy of the electronic Bloch states in graphene.

In a (nearly) degenerate semimetal such as graphene, the Coulomb interactions are expected to play an important role due to their poor screening. Besides, any interplay between the Coulomb interactions and disorder is likely to further modify the behavior of an idealized (clean and non-interacting) Dirac fermion system.

In this work, we focus on the effects of strong Coulomb correlations and make a number of specific experimental predictions that can be used for interpreting the results of tunneling, photoemission, and magnetization measurements.

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