Tunable many body interactions in graphene

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The discovery of graphene in 2004 has opened a new exciting area of research in condensed matter physics. Not only graphene is the first real two dimensional material ever observed in nature, but it is also characterized by an unusual electronic structure with respect to most condensed matter systems. Indeed, the low energy excitations in graphene behave as Dirac fermions, chiral quasiparticles with zero effective mass, and obey the relativistic Dirac equation, where the speed of light is replaced by the Fermi velocity. This is in striking contrast with most of materials known today, where the low energy excitations obey the non-relativistic Shcroedinger equation and have finite effective mass.
This unusual electronic structure leads to a variety of novel properties and huge potential for applications, the most striking one being the failure of the standard Landau-Fermi liquid picture for quasiparticles.
In this talk I will present an overview of the electronic structure of this amazing two dimensional material and will discuss how this linear dispersion can be easily modified by quantum size effects, substrate interaction, doping and disorder.
Moreover, I'll discuss how fundamental properties such as electron-phonon and electron-electron interactions are modified with respect to a standard metal and do not obey the Fermi liquid picture for quasiparticles.
The implications of our study on the properties of Dirac materials and their potential role for applications are also discussed.