Georgia Tech

Materials Research Science and Engineering Center

MRSEC SEMINAR SERIES

Electron-electron Interactions and Quantum Criticality in Graphene

Dr. Bruno Uchoa

Department of Physics, University of Illinois at Urbana-Champaign

Date: Thursday, March 31, 2011

Time: 3:00 PM

Location: Marcus Nanotechnology Building

Abstract:

Graphene is a single atomic layer of carbon atoms whose quasiparticles are massless Dirac fermions. Due to the vanishing density of states at the Dirac points and absence of metallic screening, graphene is generally believed to be strongly correlated and quantum critical. In particular, interactions are expected to induce a logarithmically divergent renormalization of the Fermi velocity at the Dirac points, in all orders of perturbation theory. The electrons in graphene, nevertheless, seem to behave as non-interacting particles. In this talk, I will show evidence based on the theoretical analysis of recent x-ray data that the interactions among the quasiparticles in graphene are dynamically screened by excitonic effects, making correlations at long wavelengths much weaker than previously believed. In the context of strong local interactions, I will discuss possible examples of quantum criticality in graphene, in particular the Kondo effect. When magnetic atoms are adsorbed on top of graphene, interference effects which are intrinsic to the honeycomb lattice can lead to a novel Kondo quantum critical point, in which the local spin is effectively screened by a super-ohmic bath. I will also show that the ability to gate graphene brings the possibility of tuning the Kondo exchange coupling across the quantum critical region. This effect may permit the first experimental observation of quantum criticality in graphene at zero magnetic field.