Chez Pierre

Presents ...

Monday, December 1, 2008

1:00pm

MIT Room 4-331

Alberto Morpurgo

Geneva University

"Transport through graphene: what's special?"

In this talk I will discuss some of the work that we did on graphene over the past two years. After a short introduction I will focus on two main topics, which illustrate some of the unique properties of graphene-based materials. Specifically, I will discuss: 1) quantum interference of electrons in single-layer graphene, and 2) the possibility to tune the band structure of bi- and tri-layer graphene electrostatically, in a simple device geometry.

My discussion of quantum interference effects will address phenomena such as weak-localization, Aharonov-Bohm conductance oscillations, and Josephson supercurrent, and will put the physics of quantum interference in the context of the electronic structure of graphene (namely, the presence of two distinct K-points). In particular, I will explain how the presence of different symmetries in the Hamiltonian is relevant for understanding the experimental results. I will also discuss how quantum interference effects can be used to probe phenomena that have not yet been observed experimentally (e.g., the presence of magnetism at graphene edges).

In the second part of the talk, I will present systematic experiments that we have done on double-gated bi-layer and tri-layer graphene, showing how the application of a perpendicular electric field enables the tuning of the material band structure. In bilayers, which are intrinsically zero-gap semiconductors, a perpendicular electric field cause the resistivity to increase strongly, due to the opening of a gap between valence and conduction band. The phenomenon, which is interesting in its own right because the insulating state possess some peculiar properties, represents a first step towards the controlled fabrication of mesoscopic devices such as quantum point contacts and quantum dots. In trilayers, which are intrinsically semi-metals with a small band overlap, a perpendicular electric field causes a large increase in the band overlap (100%), resulting in a decrease in resistivity. The analysis of the experiments provides a variety of microscopic information, and show that layers of different thickness correspond to new material systems, each of which possesses unique and distinct electronic properties.