Chez Pierre

Presents ...

Wednesday, February 24, 2016
11:00am
MIT Room 4-331

Special Chez Pierre Seminar

Christian Schönenberger

University of Basel

”Electron Optics in Suspended Graphene“

Graphene is an intriguing material: electrons are chiral Dirac particles yielding a plethora of new phenomena such as Klein tunneling, fractional quantum Hall plateaus and unconventional Andreev reflection. All these effects require graphene of high quality and low carrier density. However, in real devices there is typically a considerable random potential present due to charge impurities in the substrate or adsorbates on graphene itself limiting the transport mobility. To overcome this problem, we have developed a versatile technology that allows to suspend graphene and complement it with arbitrary bottom and top-gate structures. Using current annealing we demonstrate **exceptional high nobilities** in monolayer graphene approaching 100 m2/Vs. These suspended devices are **ballistic over micrometer length scales** and display intriguing interference patterns in the electrical conductance when different gate potentials and magnetic fields are applied. Specifically, I will discuss ballistic electric graphene devices in which one can study **electric analogs** of a **mirror**, a **guiding fiber**, and **Fabry-Perot resonators**, well known in optics. There are great similarities between the propagation of light in a dielectric and electrons in graphene, but also differences. In particular, a negative refractive index is straightforward to realize in graphene, but hard in optics. In my talk I will also discuss the effect of a magnetic field on the electron states in ultraclean pn junctions where one can monitor the evolution from zero-field cavity standing waves and low field cavity modes to the quasicalassical **snake-state** and quantum Hall edge state at higher field.

References

[1] P. Rickhaus, Ming-Hao Liu, P. Makk, R. Maurand, S. Hess, S. Zihlmann, M. Weiss, K. Richter, and C. Schönenberger, *Guiding of Electrons in a Few-Mode Ballistic Graphene Channel*, Nano Lett. 15, 5819 (2015

[2] P. Rickhaus, P. Makk, Ming-Hao Liu, E. Tóvári, M. Weiss, R. Maurand, K. Richter and C. Schönenberger, *Snake trajectories in ultraclean graphene p–n junctions*, Nature Comm. 6, 6470 (2015).

[3] Min-Hao Liu, P. Rickhaus, P. Makk, T. Tovari, R. Maurand, F. Tkatschenko, M. Weiss, C. Schönenberger, and K. Richter, *Scalable tight-binding model for graphene*, Phys. Rev. Lett. 114:036601 (2015)

[4] R. Maurand, P. Rickhaus, P. Makk, S. Hess, E. Tovari, C. Handschin, M. Weiss, and C. Schönenberger, *Fabrication of ballistic suspended graphene with local-gating*, Carbon 79:486–492 (2014).

[5] P. Rickhaus, R. Maurand, M. Weiss, C. Schönenberger, Ming-Hao Liu, and K. Richter, *Ballistic interferences in suspended graphene*, Nature Comm. 4, 2342 (2013).