Infrared Optical Study of Graphene in High Magnetic Fields

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Graphene, a single atomic layer of graphite, is an intriguing material because of its potential applications in low energy loss nanoelectronics and its importance for fundamental physics. Graphene can be viewed as unrolled single-wall carbon nanotubes (SWNTs) and, hence, it possesses many interesting properties of metallic SWNTs. Most amazingly, it has been predicted that the carrier dynamics in graphene is effectively relativistic, and its electronic transport can be described by the Dirac equation where the speed of light is replaced by the Fermi velocity.

I will present our first experimental study of cyclotron resonance of electrons and holes in isolated monolayer and bilayer graphene, via infrared transmission measurements in high magnetic fields. For monolayer graphene [1], we directly observe the extraordinary square root dependence of the Landau lever (LL) on both magnetic field and LL index. Our detailed observations map out this unusual spectrum near the charge neutral Dirac point, and strongly suggest that the powerful Kohn theorem does not apply in graphene so that many-particle effects may be seen even in low-mobility samples. For bilayer graphene [2], we study the intraband LL transitions in both the conduction and valence bands, and find that the LL transition energies are roughly linear in B between the lowest LLs. This highly unusual behavior reflects a change from a parabolic to a linear energy dispersion.

[1] Z. Jiang, et al, Phys. Rev. Lett. 98, 197403 (2007).
[2] E.A. Henriksen, et al, Phys. Rev. Lett. 100, 087403 (2008).

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