MAR13-2012-020337

Abstract for an Invited Paper
for the MAR13 Meeting of
the American Physical Society

Coulomb Drag and Magnetotransport in Graphene Double Layers[1]

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Graphene double layers, a set of two closely spaced graphene monolayers seperated by an ultra-thin dielectric, represent an interesting electron system to explore correlated electron states. We discuss the fabrication of such samples using a layer-by-layer transfer approach, the electron transport in individual layers at zero and in a high magnetic field, and Coulomb drag measurements. Coulomb drag, probed by flowing a drive current in one layer, and measuring the voltage drop in the opposite layer provides a direct measurement of the electron-electron scattering between the two layers, and can be used to probe the electron system ground state. Coulomb drag in graphene, measured as a function of both layer densities and temperature reveals two distinct regimes: (i) diffusive drag at elevated temperatures, above 50 K, and (ii) mesoscopic fluctuations-dominated drag at low temperatures [1, 2]. A second topic discussed here is a technique that allows a direct measurement of the Fermi energy in an electron system with an accuracy independent of the sample size, using a graphene double layer heterostructure. The underlying principle of the technique is that an interlayer bias applied to bring the top layer to the charge neutrality point is equal to the Fermi energy of the bottom layer, which in effect renders the top graphene layer a resistively detected Kelvin probe [3]. We illustrate this method by measuring the Fermi velocity, Landau level spacing, and Landau level broadening in monolayer graphene. Work done in collaboration with S. Kim, I. Jo, J. Nah, D. Dillen, K. Lee, B. Fallahazad, Z. Yao, and S. K. Banerjee.

[1] S. Kim *et al.*, *Phys. Rev. B* **83**, 161401 (2011).
[2] S. Kim, E. Tutuc, *Sol. State Comm.* **152**, 1283 (2012).
[3] S. Kim *et al.*, *Phys. Rev. Lett.* **108**, 116404 (2012).

[1]We thank ONR, NRI, and NSF for support.