Imaging Coherent Electrons in Graphene

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Graphene is an exciting new material which provides a test bench for new kinds of experiments. We use a cooled scanning probe microscope (SPM) to probe the motion of electrons in graphene. At low temperatures, the coherent interference of electron waves scattered by disorder leads to universal conductance fluctuations (UCF) and weak localization effects. Using the SPM tip as a local movable scatterer, images of magnetoconductance versus tip position are obtained that show how electron interference is affected by the tip position. The weak localization dip in conductivity at zero magnetic field is obtained by averaging the magnetoconductance traces at different tip positions. The width of the dip yields the coherence length of electrons. For UCF we find conductance images that resemble speckle patterns, that change by G ~ e^2/h when the tip moves by half the Fermi wavelength.

References:

[1] J. Berezovsky et al., Nanotechnology, Vol. 21, Issue 27 (2010), pp. 274014
[2] J. Berezovsky, R.M. Westervelt, Nanotechnology Vol. 21, Issue 27 (2010), pp. 274014

Figures:

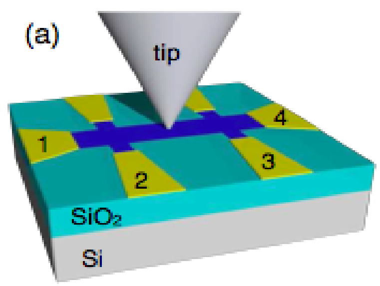

Figure 1: SPM tip as a local scatterer in graphene hall bar sample

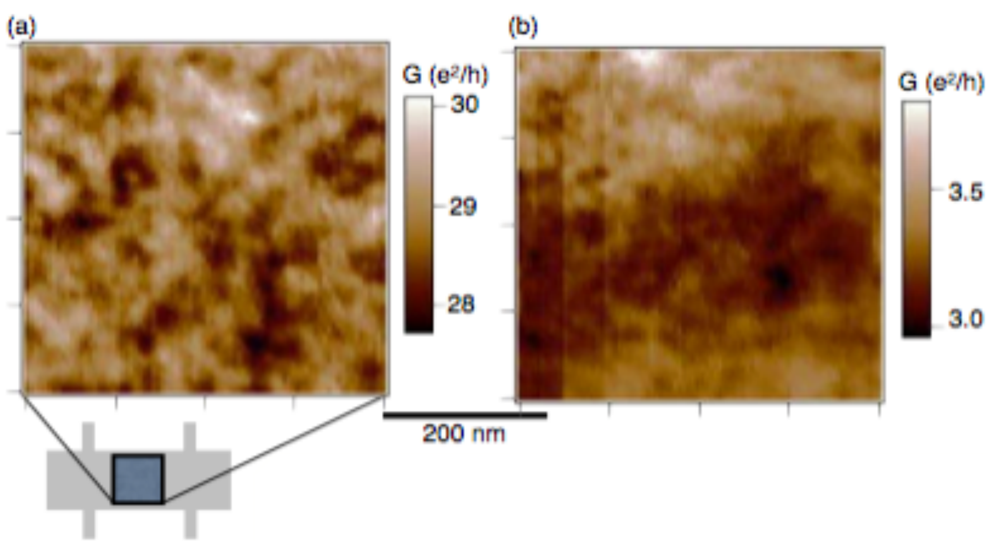

Figure 2: Conductance image vs. tip position: (a) Far from the dirac point , (b) Near the dirac point

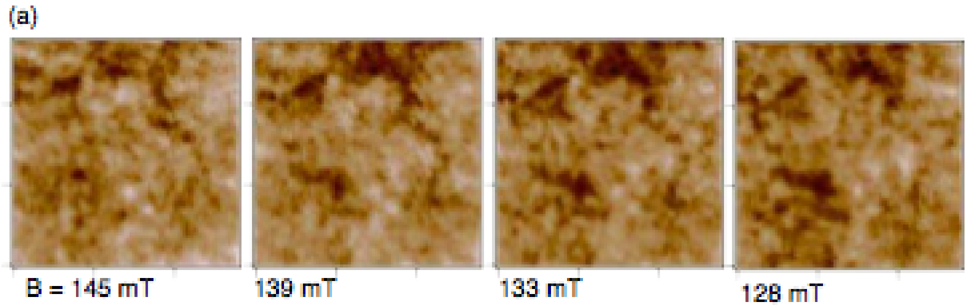

Figure 3: A series of conductance image vs. magnetic field at constant back gate voltage Vg = 0V

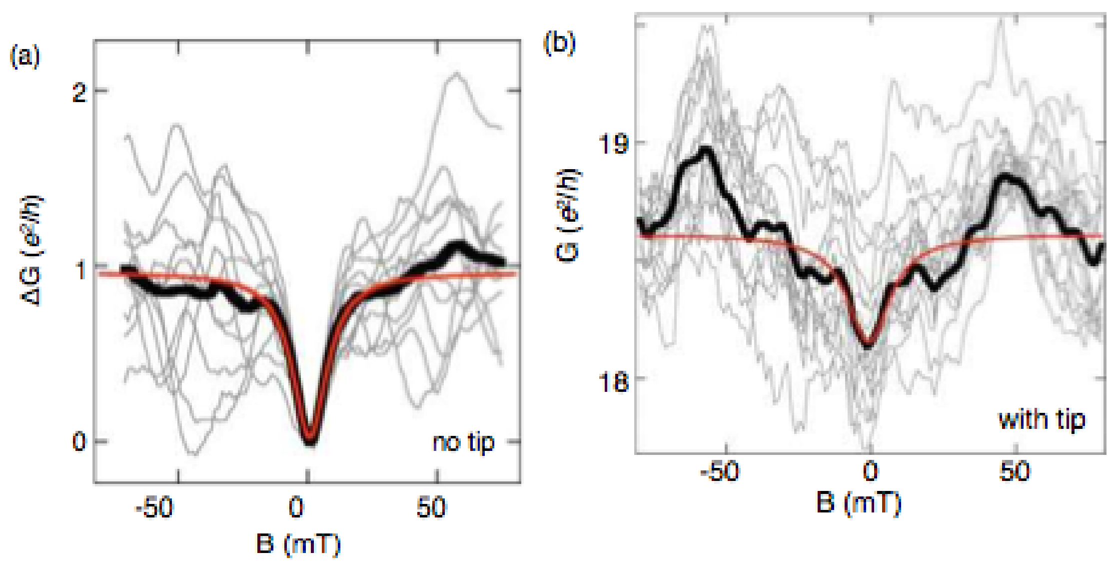

Figure 4 : Weak localization conductance dip in the sample (a) tip far from the sample with different carrier densities, (b) tip close the sample at differen positions but fixed density