Mixing of Edge States at a Bipolar Graphene Junction

Hennrik Schmidt[1,2], Johannes Rode[1], Christopher Belke[1], Dmitri Smirnov[1], and Rolf J. Haug[1]

[1] *Institut für Festkörperphysik, Leibniz Universität Hannover, Germany*
[2] *Graphene Research Center, National University of Singapore*

The unique nature of single layer graphene makes it possible to continuously tune the charge carrier concentration and also the carrier type from electrons to holes in this truly two-dimensional system. This can be used to create regions of different doping or polarity in the sample, for example with the use of local gates [1] or chemical doping [2]. We use an Atomic Force Microscope to change the doping level of a monolayer graphene sheet in a defined region while conserving the unique transport properties as well as mobilities in the order of 10^4 cm^2(Vs)$^{-1}$. Using a global backgate voltage, the resulting system of areas with different charge carrier densities is then tuned into different states, i.e. a unipolar n-n/p-p or a bipolar p-n junction. At low temperatures, edge channel transport is studied in a perpendicular magnetic field in which, due to the different filling factors, the edge channels equilibrate at the junction. The longitudinal resistance measured across it shows the expected quantized resistance values for the unipolar case, depending on the direction of edge channels and therefore the magnetic field. In the p-n case (0.2 V$\leq V_{BG} \leq$ 5.5 V), the edge states in the two areas are counterpropagating. While for B=4 T and T=1.5 K the difference in the longitudinal resistances also shows the expected quantized value, it decreases for higher magnetic fields, suggesting a suppression of edge-channel mixing at the p-n interface [3].

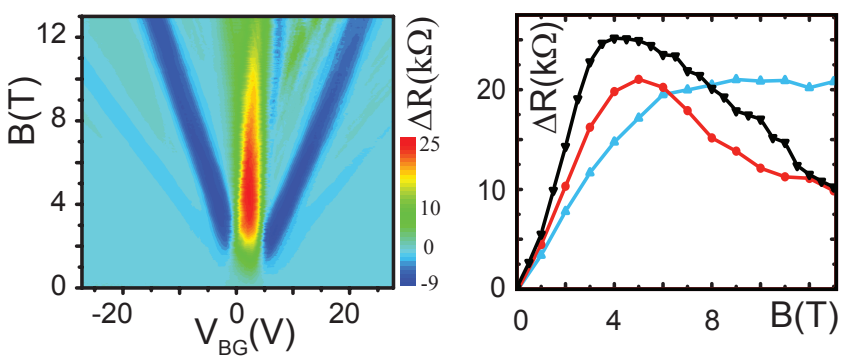

Figure 1: Left: The difference of longitudinal resistances before and after edge state equilibration as a function of backgate voltage and magnetic field at T =1.5 K. Right: This difference in the p-n regime at V_{BG}= 2.5 V and T =1.5 K (black), 125 K (red), and 270 K (cyan), as a function of magnetic field.

[1] J. R. Williams, L. DiCarlo, and C. M. Marcus, Science **317** 638 (2007).
[2] T. Lohmann, K. von Klitzing, and J. H. Smet, Nano Lett. **9**,1973 (2009).
[3] H. Schmidt, J. Rode, C. Belke, D. Smirnov, and R. J. Haug, arXiv:**1212.2824** (2012).