Presenting Author: Suman Sarkar
Co-Authors: **Kazi Rafsanjani Amin, Ranjan Modak, Amandeep Singh, Subroto Mukerjee, and Aveek Bid**

Department of Physics, Indian Institute of Science, Bangalore, Karnataka, India 560012

Contact E-mail: sarkarsuman@physics.iisc.ernet.in

Role of different scattering mechanisms on the temperature dependence of transport in graphene

Detailed experimental and theoretical studies of the temperature dependence of the effect of different scattering mechanisms[1] on electrical transport properties of graphene devices are done. We have investigated the temperature dependence of the resistance of single layer graphene devices on SiO2 substrates. The temperature dependence of the electrical transport of these SLG devices could be explained within a Boltzmann transport [2] formalism involving two independent scattering mechanisms - (i) long range Coulomb scattering and (ii) short range delta potential. In all our high mobility devices an insulating behaviour was seen only very close to the Dirac point in the doping region determined by bipolar charge density fluctuations[3]. We also find that for high mobility devices the strength of long range scattering potential is much smaller than that seen for the low mobility devices. On the other hand, for the low mobility devices electrical transport properties are determined by both types of scattering potentials - long range due to charged ionized impurities[4] and short range due to completely screened charge impurities. We find that long range Coulomb scatterers can lead to low carrier mobility and insulating behaviour seen even in the high doping region in these devices. This is in contrast to the metallic conduction and high carrier mobilities seen in devices where coulomb interactions were small.

References

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[3] Martin, J. et al. Observation of electron–hole puddles in graphene using a scanning single-electron transistor. Nature Physics 4, 144–148 (2008).
[4] Chen, J.-H. et al. Charged-impurity scattering in graphene. Nature Physics 4, 377–381 (2008).

Figures

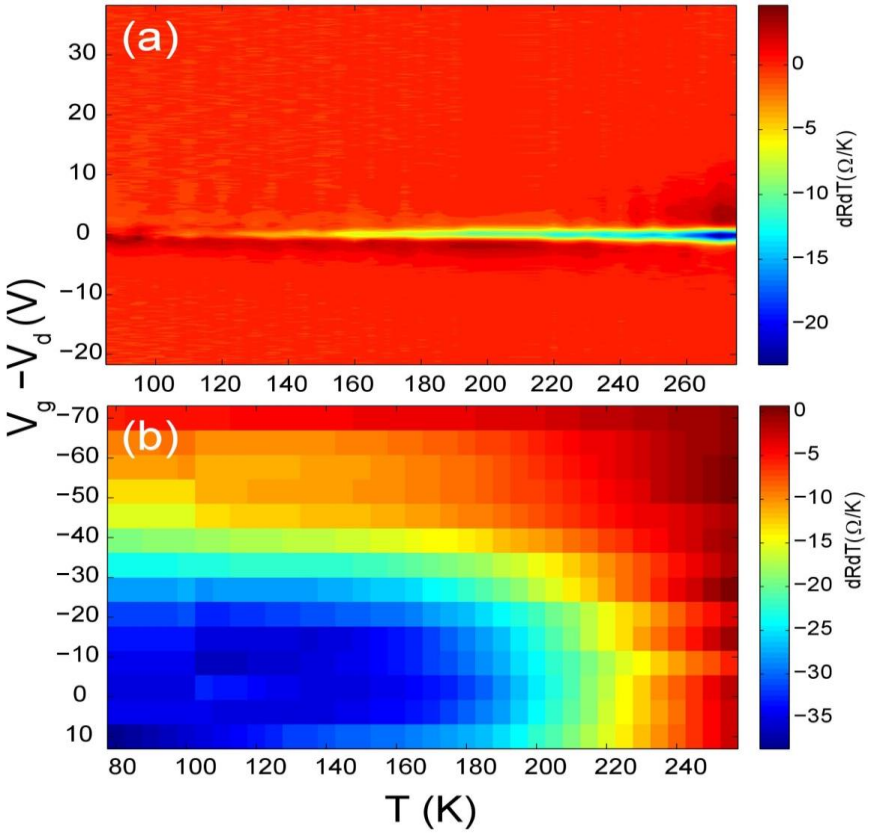

Figure 1: (a) Plot of dR/dT as a function of T and reduced gate voltage (V_g -V_d) for g28m6. (b) dR/dT as a function of T and (V_g -V_d) for g10m6.

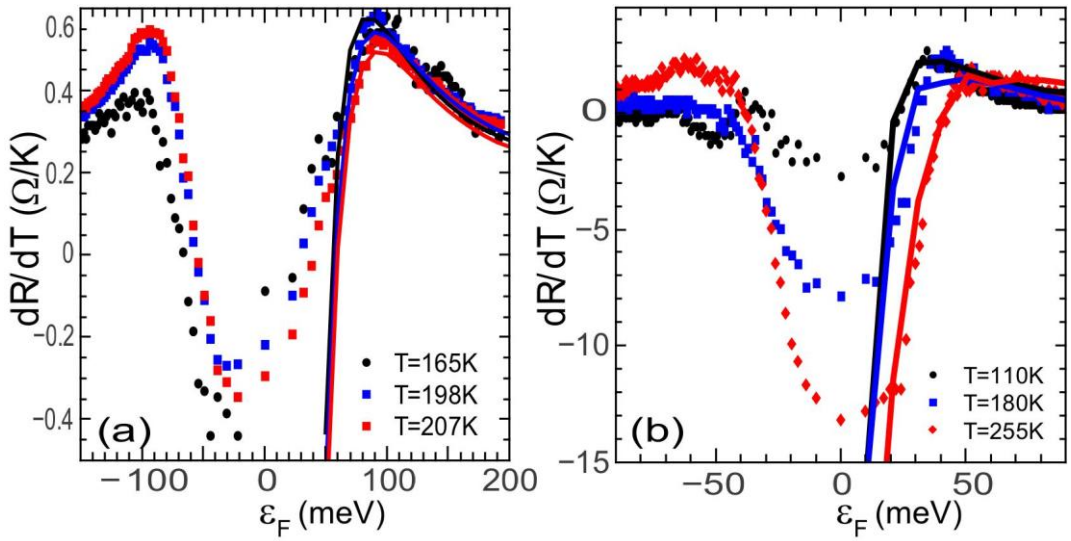

Figure 2: Variation of dR/dT with the chemical potential at different temperatures. The scatter points are the measured experimental data while the solid lines are best fits from our theoretical calculation. The data are presented for two different devices - (a) relatively low mobility device g7m5 and (b) relatively high mobility device g28m6.