Impurity scattering in coherent and incoherent single and bilayer graphene

Sophie Gueron, M. Monteverde, C. Ojeda Aristizabal, R. Weil, K. Bennaceur, C. Glattli, M. Ferrier, H. Bouchiat, J.N. Fuchs and D. Maslov,

Laboratoire de Physique des Solides, U. Paris Sud Orsay, France
gueron@lps.u-psud.fr

The nature of the scatterers which to this day limit the mobility of graphene, and determine most of its conduction properties, is still highly debated. Some groups attempt to deduce the nature of these scatterers from the effect of the dielectric surrounding the graphene. I will describe our approach in Orsay, which consists in comparing two different scattering times, the elastic scattering time and the transport scattering time, which play different roles in the magnetoresistance of the samples. I will show that the ratio of these two times, as well as their dependence with charge density, point to dominant scattering originating from strong, neutral, short range scatterers, rather than from charged impurities.
I will also present a consequence on quantum transport of the existence of these scatterers, namely, the reproducible conductance fluctuations in these samples at low temperature, when the quantum coherence extends over the entire sample length. We exploit the possibility to control the diffusion constant with gate voltage in monolayer and bilayer graphene to test the theory of mesoscopic fluctuations. We find that the correlation energy is given by the Thouless energy, and that the correlation field corresponds to a magnetic flux quantum threading a coherent area in the sample. But we find that the ergodicity hypothesis is not verified: the gate-voltage dependent fluctuations vary with gate voltage, and are largest near the charge neutrality point, whereas the magnetic field dependent fluctuations do not change with doping. The percolating nature of transport near the charge neutrality point may explain this unexpected result.

In both experiments, we exploit the asset of monolayer and bilayer graphene, namely the fact that the different band structures lead to different gate-voltage dependences of the diffusion coefficients, enabling a quantitative test of theories over broad ranges, impossible to realize with other materials.

[1] “Transport and elastic scattering times as probes of the nature of impurity scattering in single and bilayer graphene”, M. Monteverde, C. Ojeda-Aristizabal, R. Weil, M. Ferrier, S. Guéron, H. Bouchiat, J.N. Fuchs, D.Maslov, Phys. Rev. Lett. **104**, 126801 (2010).

[2] “Conductance fluctuations and field asymmetry of rectification in graphene”, C. Ojeda-Aristizabal, M. Monteverde, R.Weil, M. Ferrier, S. Gueron, H. Bouchiat, Phys. Rev. Lett. **104**, 186802 (2010).