MAR08-2007-004901

Abstract for an Invited Paper
for the MAR08 Meeting of
the American Physical Society

Quantum Interference in Single and Bilayer Graphene

ALEXANDER SAVCHENKO, School of Physics, University of Exeter, Exeter EX4 4QL, Uk

It is known that interference of charge carriers scattered by impurities results in a quantum correction to the conductivity of a two-dimensional (2D) system. This phenomenon of weak localisation (WL) is usually seen as magnetoconductivity, as magnetic field changes the phase of interfering waves. Here we show that quantum interference in graphene – a single layer of carbon atoms [1] – is very different from that in conventional 2D systems. Due to the *chiral* nature of carriers, it becomes sensitive to different *elastic* scattering mechanisms. By changing the geometry and quality of samples we show that quantum interference in graphene can take a variety of forms, and that WL is a sensitive tool to detect defects in graphene crystals [2]. We perform a comparative study of WL in single-layers and bilayers. Although the two systems are different in their spectrum (massless and massive fermions, respectively), the carriers in both are chiral. As a result WL in a bilayer is also affected by elastic scattering [3]. Analysis of the magnetoresistance using theories [4] allows us to determine the phase-breaking time as well as times of inter- and intra-valley scattering, which together control WL. They are found at different carrier densities, including the electro-neutrality point where the nominal carrier density is zero. We show that in all cases WL is not suppressed, and that the reason for this is strong inter-valley scattering. The study of WL is complemented by AFM imaging of the surface which provides information about the nature of the defects responsible for the different manifestations of WL in graphene systems. In addition to the studies of WL, we perform analysis of universal conductance fluctuations (UCF) in both systems. They have the same physical origin as WL – quantum interference – and are controlled by the same characteristic times. We compare the times found from analysis of WL and UCF.

[1] K.S. Novoselov *et al.*, Science **306**, 666 (2004)
[2] F.V.Tikhonenko *et al.*, arXiv: 0708.1700 (to be published in Phys. Rev. Lett.)
[3] R.V. Gorbachev *et al.*, Phys. Rev. Lett. **98**, 176805 (2007).
[4] E. McCann et al., Phys. Rev. Lett. **97**, 146805 (2006); K. Kechedzhi *et al.*, Phys. Rev. Lett. **98**, 176806 (2007).