Quantum interference in graphene

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We present results of the first systematic investigation of weak localisation (WL) in monolayer and bilayer graphene [1]. Although the two systems are different in their energy spectrum (massless fermions in monolayer and massive in bilayer), they both have chiral charge carriers ; this makes WL in them very different from that in conventional 2D structures. Previous studies of WL in monolayer graphene have produced inconclusive results which suggested that WL can be suppressed at all carrier densities [2]. We show that WL in both graphene systems is not suppressed, and is controlled not only by inelastic scattering but also by elastic mechanisms of intra- and intervalley scattering.

A temperature-dependent magnetoconductance is observed at all carrier densities including the electroneutrality region where the type of carrier changes from electrons to holes. The analysis of the magnetoconductance using WL theories [3] allows us to determine the dephasing rate, as well as the rates of inter- and intra-valley scattering. We study several samples of different geometry and quality, with the aim to control the scattering mechanisms responsible for the manifestation of WL. The study of WL is complemented by atomic force microscope imaging of the graphene surface to determine features that may cause elastic scattering. We also study the conductance fluctuations observed concurrently with the WL. They exist in graphene samples that are small in size at all studied carrier densities.

Our results show that WL does exist in monolayer and bilayer graphene because of significant inter-valley scattering that is present in all current graphene systems.

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