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Quantum Point Contacts in Graphene

Quantum point contacts are cornerstones of mesoscopic physics and central building blocks for quantum electronics. Although the Fermi wavelength in high-quality bulk graphene can be tuned up to hundreds of nanometers, the observation of quantum confinement of Dirac electrons in nanostructured graphene systems has proven surprisingly challenging. Here I show ballistic transport and quantized conductance of size-confined Dirac fermions in lithographically-defined graphene constrictions. The fabricated graphene constrictions are encapsulated in hexagonal boron nitride sheets allowing for high carrier mobilities. The constrictions have widths ranging from around 200 to 800 nm. At high charge carrier densities, the observed conductance agrees excellently with the Landauer theory of ballistic transport without any adjustable parameter. Experimental data and simulations for the evolution of the conductance with magnetic field unambiguously confirm the identification of size quantization in the constriction. Close to the charge neutrality point, bias voltage spectroscopy reveals a renormalized Fermi velocity of ~1.5×10^6 m/s in our graphene constrictions. Moreover, at low carrier density transport measurements allow probing the density of localized states at edges, thus offering a unique handle on edge physics in graphene devices.