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Transport in Graphene Nanostructures

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Experimentalists have started to investigate effects of mesoscopic physics well known from experiments on GaAs, such as the quantum Hall effect, conductance quantization, Aharonov-Bohm oscillations and the Coulomb blockade effect, in graphene. It is the goal of these investigations to find ways to confine charge carriers in this material system with its gapless band structure, to exploit the field effect for electrostatic control of electronic properties on the nanoscale, and to explore the feasibility of tailored graphene quantum circuits for future electronics. We will give an overview over our experiments carried out on narrow graphene constrictions, nanoribbons and graphene quantum dot devices at low temperatures (100mK – 2K). These nanostructure systems are fabricated by mechanical exfoliation of graphite followed by electron beam lithography and dry etching technique. The fabricated graphene nanodevices are equipped with a number of graphene in-plane gates for local electrostatic control. Our measurements demonstrate the interplay of lithographic confinement, where electron-electron interactions manifest in the appearance of the Coulomb blockade effect, and disorder, even in the simplest single constriction devices. Despite the significant complexity of the physics in single graphene constrictions and nanoribbons, well controllable quantum dot devices exhibiting Coulomb blockade physics can be fabricated. We performed measurements of excited states, inelastic co-tunneling processes and the level spectra close to the electron hole crossover in graphene quantum dots. Finally, we realized on-chip time-resolved charge detection techniques in our experiments.