Size quantization signatures in graphene quantum point contacts

B. Terrés[1,2], L. Chizhova[3], D. Jörger[1], S. Engels[1,2],
J. Burgdörfer[3], F. Libisch[3], and C. Stampfer[1,2]

[1]*JARA-FIT and 2nd Institute of Physics, RWTH Aachen University, Germany, EU*
[2]*Peter Grünberg Institute (PGI-9), Forschungszentrum Jülich, Germany, EU*
[3]*Inst. f. Theoretical Physics, Vienna University of Technology, Vienna, Austria, EU*

Quantum point contacts form a cornerstone of mesoscopic physics as central building blocks for quantum electronic devices. Graphene shows a number of exceptional properties but the demonstration of graphene quantum point contacts has proven very challenging. Recent developments in the fabrication of high-mobility graphene-hexagonal boron nitride sandwich structures have improved the chances to observe quantum confinement of Dirac electrons in quasi-one dimensional (1D) graphene systems.

Here we present joint experimental and theoretical work on ballistic transport of confined Dirac fermions in graphene quantum point contacts [Fig. 1a,b]. At high charge carrier densities, measurements agree excellently with theoretical simulations. Deviations from the expected linear behavior at low carrier densities emerge due to localized states at the edges, allowing the direct probing of trap states by transport measurements. Reproducible kinks in the conductance are associated with size quantization in the quantum point contact [Fig. 1c]. Comparing the evolution of the observed kinks with magnetic field to theoretical predictions for one-dimensional confined states in graphene confirms size quantization as their origin.

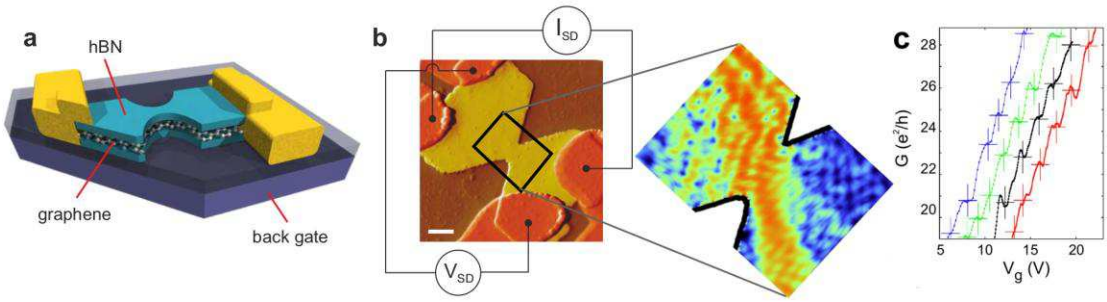

Fig. 1. **a** Graphene quantum point contact formed from a graphene-hexagonal boron nitride sandwich structure. **b** AFM picture of the investigated device. The zoom shows a scattering wave function from tight-binding calculations. **c** Measured conductance traces as function of back gate from four different cool downs. Kinks are marked by crosses.