Abstract submitted to the
Conference on Concepts in Electron Correlation
September 24 - 30, 2008 Hvar, Croatia

Graphene Quantum Dots

Christoph Stampfer
Laboratory for Solid State Physics, ETH Zürich, 8093 Zürich, Switzerland
Submitted : 16-08-2008

Graphene is the first real two-dimensional solid consisting of a hexagonal lattice of carbon atoms and revealing high carrier mobility and quantum Hall effect even at room temperature. First graphene quantum devices have been recently demonstrated, such as graphene nanoribbons, quantum interference devices, and graphene single electron transistors. The development of spin-based quantum information processing relies so far mostly on GaAs quantum dots. In such devices hyperfine coupling and spin-orbit interactions are the main mechanisms limiting spin coherence times. Spin qubits in graphene hold the promise that these decoherence mechanisms are significantly reduced. Here, we report measurements showing that excited single-particle states can be detected in graphene quantum dots via co-tunneling in the Coulomb blockaded regime as well as via related features for high voltage bias. The device consisting of a single-layer graphene island with a diameter of around 140 nm is connected via two narrow graphene constrictions and is tunable by a lateral graphene gate. From transport measurements we extract a charging energy in the range of around 8.5 meV and a single-level spacing on the order of 1.6 meV. Furthermore we demonstrate the functionality of a charge-read-out using a nearby graphene constriction. Both steps, the detection of excited states and the charge-read-out are crucial for the investigation of graphene quantum devices in general as well as for future implementations of spin qubits in graphene. In particular it allows to relate the size of the quantum dot to the relevant energy scales such as charging energy and quantum confinement energy. Estimates based on the linear energy-momentum relation of graphene give carrier numbers below 10 for our devices.