Time resolved charge detection in electrostatically defined quantum dots in bilayer graphene

ESR8 Rebekka Garreis ETH Zürich, Switzerland

Graphene is a promising candidate for future nano-electronic devices including building blocks for quantum information processing. Reasons for this include the expected long spin-lifetimes and high carrier mobilities. So far, these spin lifetimes could only be estimated with a lower bound experimentally. To obtain the spin-lifetime a device is needed that allows one to confine charges and to measure their dynamics in a time-resolved way simultaneously. This is possible with a charge detector in close proximity to a graphene quantum dot.

Here, we use bilayer graphene with its electrostatically induced band gap to fabricate a fully gate-defined device with quantum dots [1,2], one of which is used as a charge detector [3]. Since a quantum dot is nothing else but charges defined in zero dimensions it has discrete energy levels. Whenever one of the levels is aligned with the source and drain, a peak shaped conductance across the device can be measured. These conductance peaks are called Coulomb resonances and their exact position on a gate voltage axis depends on the surrounding electrostatics, hence also the charge state of a neighboring dot. The potential change due to single-electron charging causes a step-like change in the current through the charge detector. This detection signal allows us to confirm and investigate the dynamics of last electron\hole quantum dots. Furthermore, we can tune the tunnel barriers individually, such that the tunnel rates get low enough for time-resolved measurements of telegraph noise (see Fig. 1). In a multi-dot regime [4], the charge detection enables us to determine the number of charge carriers in each of the dots.

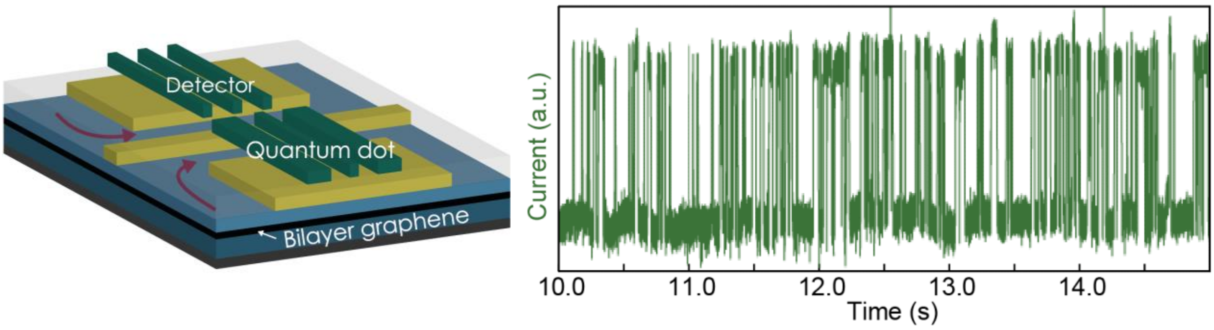

Fig. 1.: Left: Schematic of the different layers in the bilayer graphene device and an exemplary gate structure on top. Right: Time trace of the current measured through the detector corresponding to fluctuations of the charge of the dot between N and N + 1 electrons.