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

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

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]. The Coulomb resonances in the detecting dot are sensitive to individual charging events another on quantum dot nearby. The potential change due to single-electron charging causes a step-like change in the current through the charge detector which matches in signal to noise ratio the traditional semiconductors Si and GaAs. This high-quality 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. In a multi-dot regime [4], the charge detection enables us to determine the number of charge carriers in each of the dots.

We demonstrate time resolved measurements in graphene quantum dots, which may allow us to investigate the spin-lifetime in graphene.

References

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Figures

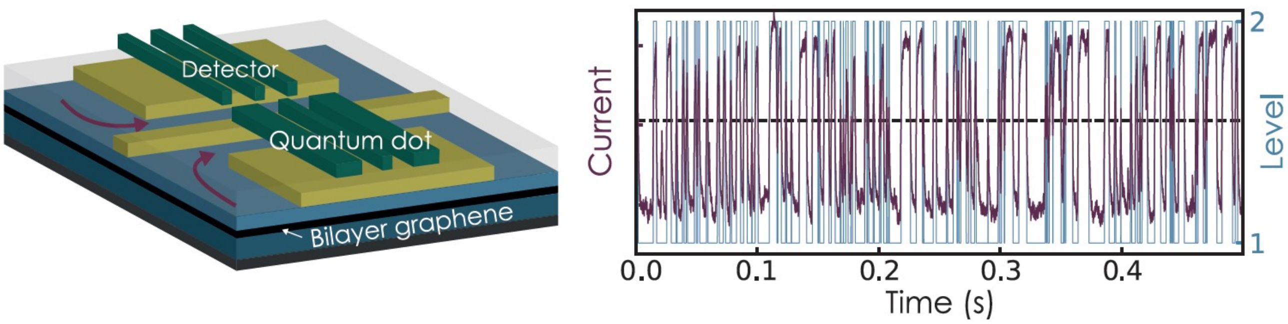

Figure 1: Left: Schematic of the different layers in the bilayer graphene device and an exemplary gate structure on top. Right: Time trace of the current measured through the detector corresponding to fluctuations of the charge of the dot between N and N + 1 electrons.