Coherent Oscillations in a Bilayer Graphene Charge Qubit

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Semiconductor quantum dots (QDs) serve as hosts for charge and spin qubits. Charge qubits are a straight-forward realization of qubits in double quantum dots (DQDs), where quantum information is encoded in the position of an excess electron within the DQD [1]. Bilayer graphene (BLG) has proven particularly suitable for realizing highly tunable QDs [2], and its potential to host qubits is currently explored. However, no coherent manipulation of charge or spin states in BLG has been reported so far. We demonstrate coherent oscillations of a charge qubit in a BLG DQD. We operate the device in the few-electron regime and tune the interdot tunnel coupling to the low GHz regime, which we verify by photon-assisted tunnelling spectroscopy. The charge qubit is controlled by square voltage pulses that allow to non-adiabatically transfer the system from the initialization regime of high detuning to the vicinity of zero detuning, where we observe free charge oscillations. The oscillation frequency shows a strong dependency on the detuning. From the damping of the charge oscillations, we determine the decoherence time T^*_2 which exceeds 200 ps.

References

[1] K. D. Petersson, J. R. Petta, H. Lu, and A. C. Gossard, Phys. Rev. Lett. 105, 246804 (2010)
[2] L. Banszerus, B. Frohn, A. Epping, D. Neumaier, K. Watanabe, T. Taniguchi, and C. Stampfer, Nano Lett. 18, 4785 (2018)

Figures

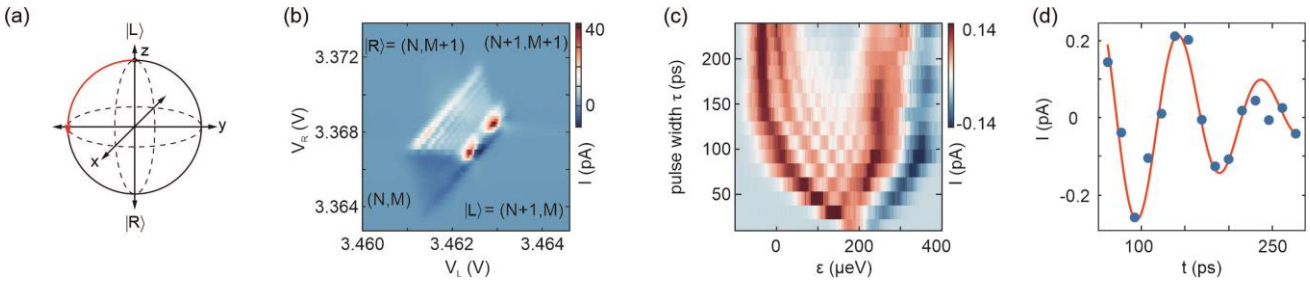

Figure 1: (a) Bloch sphere representation of charge oscillations. (b) Charge stability diagram in the presence of a square voltage pulse, showing multiple features of charge oscillations. (c) Charge oscillations in the time domain as function of detuning. (d) Line cut along the time axis in (c). The red line is a fit to the data.