Towards spin and valley qubits in graphene

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Graphene and bilayer graphene (BLG) are attractive platforms for quantum circuits with potential applications in the area of quantum information. This has motivated substantial efforts in studying quantum dot devices based on graphene and bilayer graphene. A major challenge in this context is the missing band-gap in graphene, which does not allow to confine electrons by means of electrostatics making displacement field-gapped BLG particularly interesting.

Here we present gate-controlled single and double quantum dots in electrostatically gaped BLG [1-5]. We show a remarkable degree of control of our devices, which allow realizing electron-hole and electron-electron double quantum dot systems with single-electron occupation. In both, the single and double quantum dot devices, we reach the very few electron/hole regime, we are able to extract excited state energies and investigate their evolution in a parallel and perpendicular magnetic field. Finally, I will show data on BLG quantum dots allowing investigating the spin-valley coupling in bilayer graphene [4] as well as spin lifetimes [5]. Our work paves the way for the implementation of spin and valley-qubits in graphene.

References

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Figure

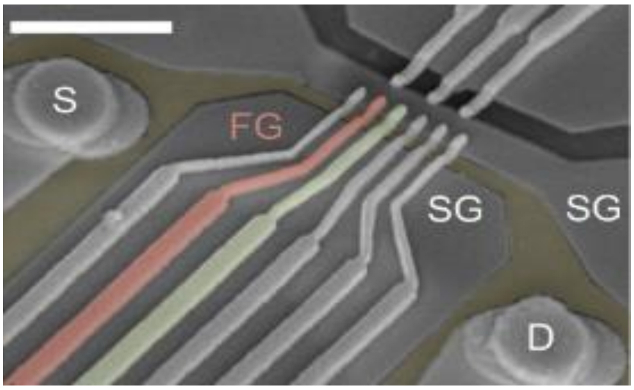

Figure 1: False-color scanning electron image of a bilayer graphene quantum dot device. The scale bar corresponds to 1 micrometer.