Two-electron interactions in bilayer graphene single and double quantum dots

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Graphene quantum dots (QDs) are considered promising candidates for spin and valley-based quantum computing [1]. Here, we report on finite bias spectroscopy measurements of the two-electron spectrum in gate defined bilayer graphene (BLG) single and double QDs for varying magnetic fields. The spin and valley degree of freedom in BLG give rise to a rich magnetic field dependent spectrum. In a single QD, we find that the two-electron states are split into multiplets of 6 orbital symmetric and 10 orbital anti-symmetric states, which are separated by 0.4 – 0.8 meV [2]. The symmetric multiplet exhibits an additional splitting due to short- range lattice scale interactions. With the help of detailed calculations, we are able to determine that inter-valley scattering and 'current-current' interaction constants are of the same magnitude in BLG [3, 4]. We are able to confirm these findings in finite bias measurements of the (1,1) → (0,2) triple point of an electron-electron double QD. There the short-range interaction gives rise to either valley- or spin-blockade, depending on the applied magnetic field.

References

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Figures

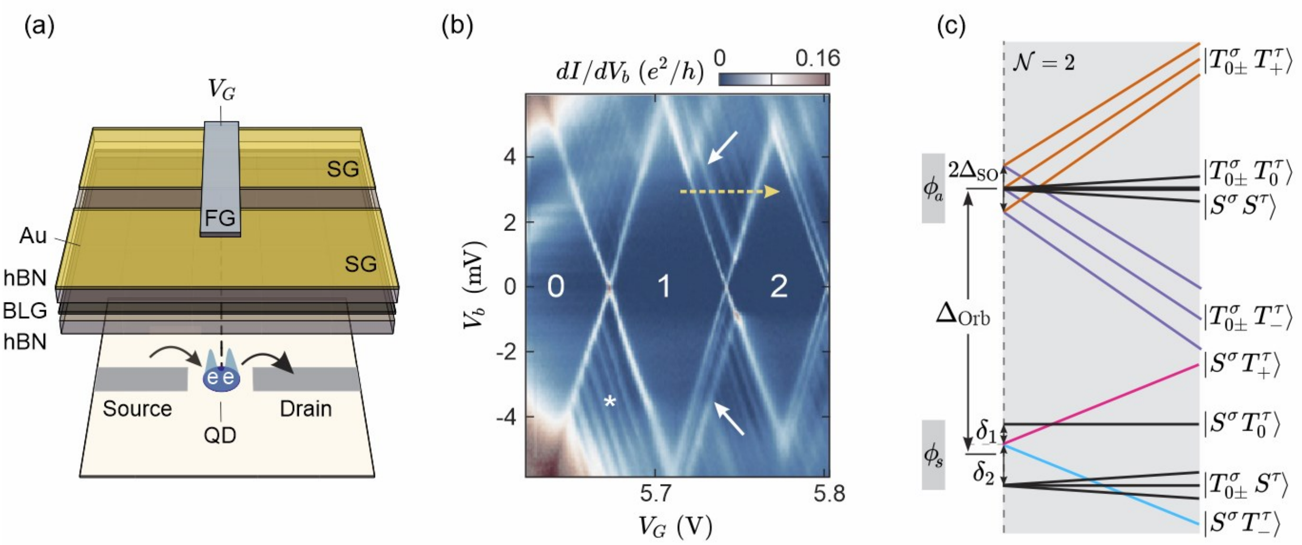

Figure 1: (a) Device schematic illustrating the formation of a QD via soft-confinement. **(b)** Coulomb diamonds for N = 0, 1, 2 electrons in the QD. White arrows highlight excited states. **(c)** Two-particle spectrum in a BLG QD as a function of perpendicular magnetic field.