Spin and Valley Blockade and Leakage Current in Graphene Quantum Dots

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The Pauli blockade effect in coupled double quantum dots is the foundation of successful characterization and manipulation of spin qubits [1,2]. Pauli spin blockade is well established for systems where the single-dot two-particle ground state is a spin-singlet [1,2,3]. In our bilayer graphene quantum dots, however, the additional valley degree of freedom provides us with a spin-triplet-valley-singlet single-dot two-particle ground state [4,5,6], altering the canonical picture where Pauli spin blockade shows up at alternating even-odd triple-points, to one that is more complex with a four-by-four grid [7]. With good understanding and control [3,4,5] of our few-carrier spin and valley states by gate voltages and magnetic field, we study at different magnetic fields the type of Pauli blockade (valley, spin, or mixed) at electron numbers between zero and four, and the relevant blocked transitions involved. At triple points where we observe Pauli spin blockade at zero magnetic field, we study the dependence of spin blockade leakage current on magnetic field. We gain insight into spin-mixing mechanisms which lift the spin-blockade, in particular into hyperfine interaction and spin-orbit interaction effects in bilayer graphene quantum dots [7].

References

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Figures

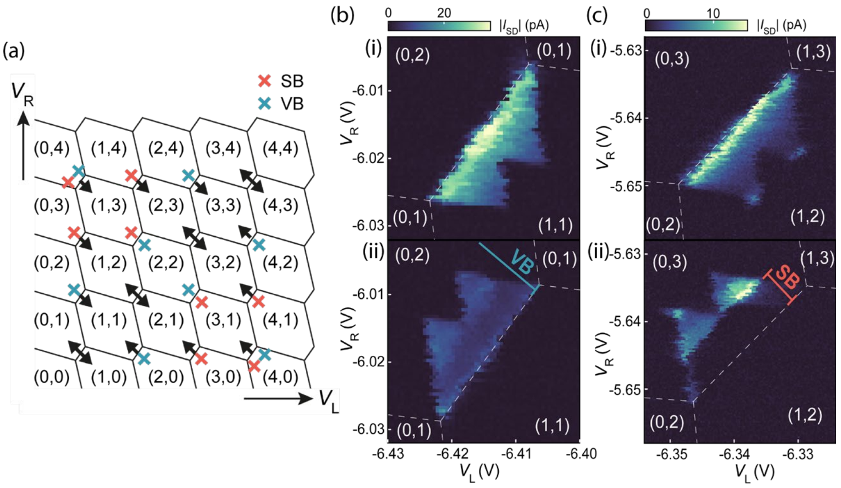

Figure 1: (a) Schematic charge-stability diagram for bilayer graphene double quantum dots at zero magnetic field, where blue and red crosses at triple points label valley and spin blocked transitions. (b, and c) Finite-bias triangles at zero magnetic field with (i) positive, and (ii) negative source–drain bias V_{SD}, around triple points with carrier occupancy (b): (0,2)↔(1,1) showing valley blockade, and (c): (0,3)↔(1,2) showing spin blockade.