Valley and Spin Blockade in Graphene Quantum Dots

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The Pauli blockade effect manifests itself in coupled quantum dots by forbidding transitions between states with non-matching quantum numbers, conserved in inter-dot tunneling processes. The prohibition of transitions between spin singlet and triplet states [1] is the foundation of successful manipulation of spin qubits [2]. In our bilayer graphene quantum dots, we observe robust Pauli spin blockade at high perpendicular magnetic field B > 600mT rather than at zero magnetic field, and valley blockade at low field. This unusual behaviour arises from the peculiar two-particle spin-triplet ground state of a single quantum dot, at low magnetic field [3]. The spin blockade leakage current is more than 50 times, and the valley blockade leakage current five times smaller than the non-blockaded current. This advancement prepares graphene quantum dots for spin (and valley) qubits [2]. The observation of blockade demonstrates the superb quality that the graphene quantum dots have reached, brought about by recent progress in fabrication technology.

REFERENCES

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FIGURES

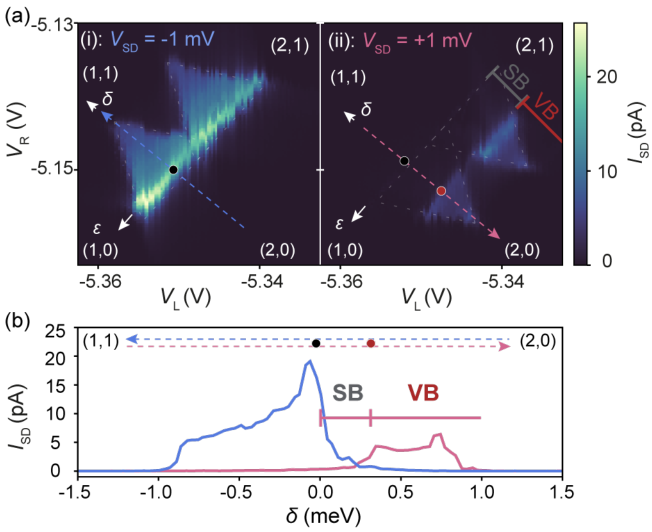

Figure 1: (a) DC current maps of finite-bias triangles at B = 800mT with (i) negative bias V_{SD} = -1mV [electron transport (2,0) → (1,1)], and (ii) positive bias V_{SD} = +1mV [electron transport (1,1)→(2,0)], with the same gate voltage window. (b) Line-cuts along the δ-axis, at ε=0 where current peaks are labeled by circles. Valley blockade (VB) and spin blockade (SB) effects suppress the current in the negative bias direction. Here the VB leakage current is five times smaller than the current in the non-blockaded bias direction. The SB leakage current is masked by measurement noise ~300fA, and is therefore more than 50 times smaller than the non-blockaded current.