Four-state discrimination for a pair of spin qubits via gate reflectometry

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Abstract

Single-electron spin qubits defined in quantum dots are used as building blocks of a semiconductor-based quantum computer. Readout in a scaled-up version of such a quantum computer is expected to rely on the Pauli Spin Blockade (PSB) mechanism.

A desired functionality of PSB readout is that it reveals two bits of information on the two spin qubits [1] that are involved in the process, e.g., such that the four computational basis states can be discriminated. In this work, we propose and quantitatively analyse an experimental procedure, based on gate reflectometry [2,3], which enables this four-state discrimination in a single measurement [5]. We provide an intuitive recipe to maximize the contrast between the quantum capacitances of the four basis states. Focusing on silicon double quantum dots equipped with a micromagnet [4], we quantify how amplifier noise and phonon-mediated relaxation influences readout fidelity. Our results highlight a realistic opportunity to mitigate the overhead of readout ancilla qubits in a spin-based quantum computer.

References

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Figures

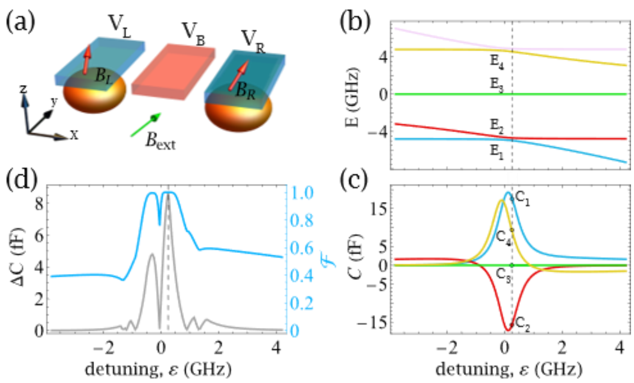

Figure 1: (a) Schematics of the double quantum dot (DQD) in the presence of an inhomogeneous magnetic field. (b) Energy spectrum of the DQD. (c) Quantum capacitances of the energy eigenstates of panel (b). (d) Capacitance contrast ΔC (grey), and four-state discrimination fidelity (blue), the latter shown in the presence of amplifier noise.