Dispersively Probed Microwave Spectroscopy of a Silicon Hole Double Quantum Dot

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Owing to ever increasing gate fidelities and to a potential transferability to industrial CMOS technology, silicon spin qubits have become a compelling option in the strive for quantum computation. In a scalable architecture, each spin qubit will have to be finely tuned and its operating conditions accurately determined. In view of this, spectroscopic tools compatible with a scalable device layout are of primary importance.
Here we report on a two-tone spectroscopy technique providing access to the spin-dependent energy-level spectrum of a hole double quantum dot defined in a split-gate silicon device, see Figure 1. A first gigahertz-frequency tone drives electric dipole spin resonance enabled by the valence-band spin-orbit coupling. A second lower-frequency tone (approximately 500 MHz) allows for dispersive readout via rf-gate reflectometry, see Figure 2. We compare the measured dispersive response to the linear response calculated in an extended Jaynes-Cummings model and we obtain characteristic parameters such as g factors and tunnel and spin-orbit couplings for both even and odd charge occupation.

References

Ezzouch et al. Phys. Rev. Applied 16, 034031 (2021)

Figures

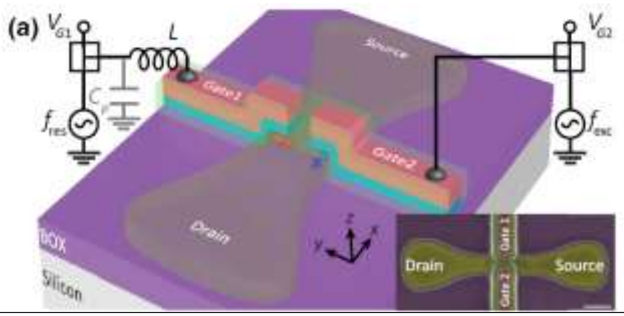

Figure 1: (a) Simplified 3D schematic of a split-gate, silicon-on-insulator field-effect transistor. An LC resonator wired to gate 1 is used for reflectometry readout while a spectroscopy tone in the GHz range is applied to gate 2 (f_{exc}). The inset shows a false color scanning electron micrograph of the device (scale bar is 100 nm)

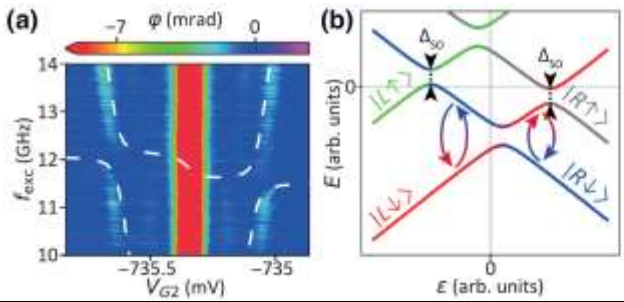

Figure 2: (a) Photon assisted spectroscopy at finite magnetic field for an odd-parity interdot charge transition. The dispersive shift of an LC resonator as a function of DQD detuning and spectroscopy tone (f_{exc}) is plotted. (b) Energy diagram of an odd charge configuration in a DQD at finite magnetic field.