Microwave-driven two-hole spin qubits

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Group IV spin qubits are promising candidates for realizing quantum processors due to their scalability, CMOS compatibility, and long coherence times. In particular, Ge has become a very attractive platform because of the low effective mass and low hyperfine interaction. In addition, strong spin-orbit interaction allows the spin to be driven electrically. From 2018 and within a few years, a Loss-DiVincenzo [1], a singlet-triplet hole spin qubit [2], a two-qubit [3], and a four-qubit Ge quantum processor [4] have been realized, demonstrating the potential of Ge for quantum information.

Manipulation of spin qubits can be achieved via multiple driving mechanisms: Electron Spin Resonance [5], Electron Dipole Spin Resonance [6], g-tensor modulation [7], or exchange interaction [8]. Owing to the low effective mass of holes in Ge, exchange interaction can have a much stronger effect compared to Silicon [9], thereby warranting the study of its effects.

Here, we show a spin qubit in a double quantum dot hosted in Ge/SiGe heterostructure operated in a regime where the exchange interaction dominates over the Zeeman energy difference. We measure three microwave-driven transitions of two-hole spin states that can be coherently manipulated. To investigate the impact of exchange on the driving mechanism, we study the Rabi frequency dependence as a function of magnetic field, B, and detuning, ϵ.

References

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Figures

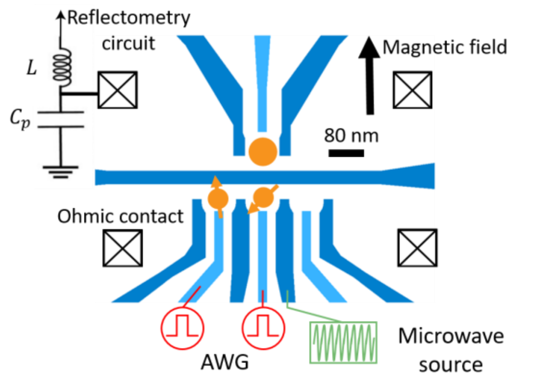

Figure 1: Computer-aided design of the gate layout of the device under study.

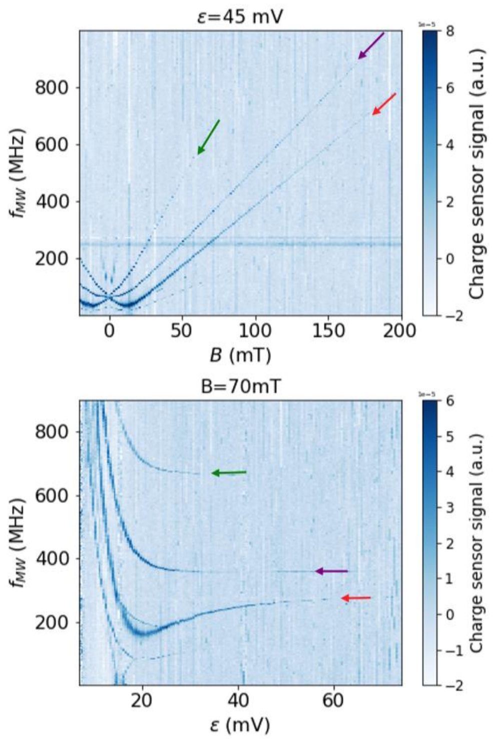

Figure 2: Spectroscopy of the three spin transitions as a function of magnetic field and detuning.