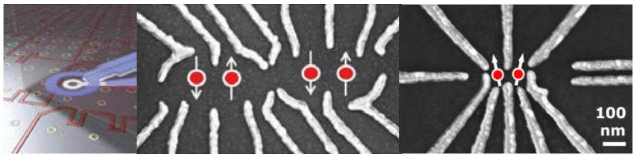
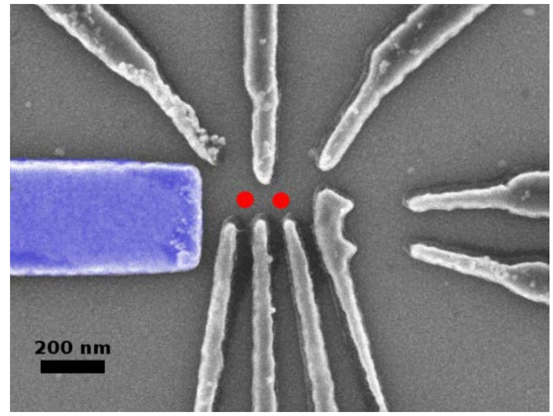


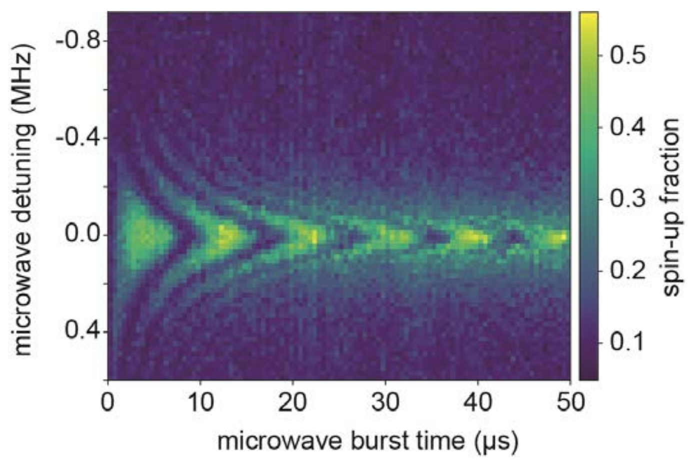
High-fidelity manipulation and detection of a qubit in silicon

Master's project starting WS 2018/19



Scientific background The electron spin confined to a Si/SiGe heterostructure is an ideal platform for the implementation of a long-lived and precisely controlled quantum bit (qubit). Single electron manipulation using electron spin resonance and single spin read-out using state-dependent tunneling was already observed. Maximizing the fidelity of both processes facilitates quantum-error correction schemes.

Research goal We are going to improve electrostatically defined tunnel-coupled double quantum dots (DQDs) formed in Si/SiGe heterostructures. These DQDs can host up to two electron spin qubits. Firstly, by using heterostructures with isotopically purified ^{28}Si coupling to nuclear spins and thus the spin coherence is reduced. Secondly, using and asymmetric single electron transistor for charge read-out, the output swing of the charge detector is maximized. Both measures improve qubit manipulation and detection.



Top: Scanning electron micro-graph of the metallic gates on top of a double quantum dot sample. The position of the trapped electrons is indicated. Bottom: Chevron pattern showing Rabi-oscillations of the electron spin for different driving frequencies.

Your task

You will learn working with a sophisticated low-temperature measurement set-up. You will confine single electrons by tuning the voltage on metallic gates, manipulate the spin by electric dipole spin resonance and measure and optimize the quantum gate fidelity.

You will gain experience in

- Low temperature physics at 10 mK
- High-frequency, low-noise electrical measurement techniques
- Developing and improving measurement schemes/software
- Data analysis
- Numerical simulations

Furthermore, you will attend group seminars and journal clubs to learn about new developments in quantum computing.

Cooperation partners: Helmholtz Nano Facility in Jülich, University of Regensburg

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