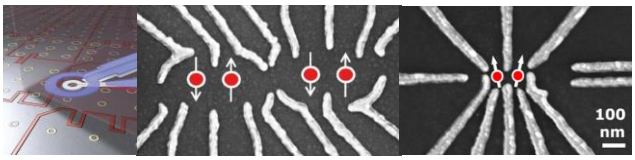
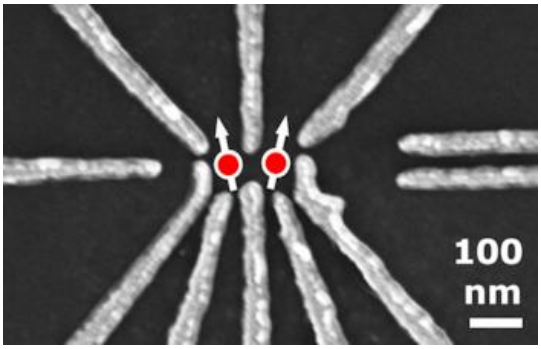


Quantum Technology Group | RWTH AACHEN UNIVERSITY

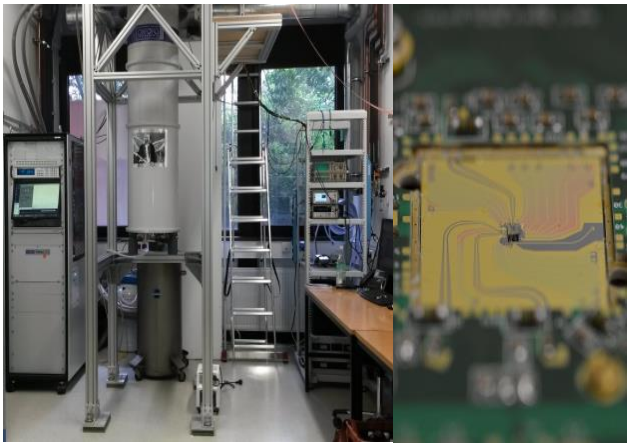
High-fidelity manipulation and detection of a qubit in silicon

Master's project starting WS 2017/18

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 improves qubits manipulation and detection.



Top: Scanning electron micro-graph of the metallic gates on top of a double quantum dot sample. The position of two trapped electrons is indicated. Bottom: 10 mK cryostat set-up and PCB board with quantum chip at the center.

Your task You will learn the complex gate fabrication of double quantum dots including cobalt micromagnets in the high-tech clean room facility in FZ Jülich. Cooling down the samples in a dilution refrigerator at our institute, you have to tune the voltages on the metallic gates in order to create quantum dots and characterize capacitive coupling of the the single-electron transistor to its source and drain reservoirs. You will gain experience in

- Optical lithography and cutting edge electron-beam-lithography at the technical limit
- Low temperature physics at 10 mK
- High-frequency, low-noise electrical measurement techniques
- 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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