A Programmable Two-Qubit Quantum Processor In Silicon

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Electron spins confined to silicon quantum dots are promising qubits for quantum information processing as they offer long coherence times and lend themselves well to scaling up. In this talk, I will discuss experiments where we have demonstrated the initialization, read-out, and universal control of two single-electron spin qubits confined to a Si/SiGe double quantum dot. Single-qubit gates are achieved by using electric-dipole spin resonance mediated by micromagnets[1] and two-qubit gates are implemented by making use of the exchange interaction[2]. Randomized benchmarking gives single-qubit gate fidelities of 98-99% and quantum state tomography yields Bell state fidelities of about 90%. Integrated control of the complete two-qubit system allows us to program it to successfully run the Deutsch-Jozsa and Grover quantum algorithms.

References

[1] E. Kawakami et al. "Electrical control of a long-lived spin qubit in a Si/SiGe quantum dot". In: *Nature Nano* 9.9 (Sept. 2014), pp. 666–670.

[2] M. Veldhorst et al. "A two-qubit logic gate in silicon". In: *Nature* 526.7573 (Oct. 2015), pp. 410–414.