Seminarankündigung

Freitag, 2. August 2019
12:30 Uhr

WSI, Seminarraum S 101

“Silicon quantum processor unit cell operation above one Kelvin”

Quantum computers are expected to outperform conventional computers for a range of important problems, from molecular simulation to search algorithms, once they can be scaled-up to very large numbers of quantum bits (qubits), typically many millions. For most solid-state qubit architectures, e.g. those using superconducting circuits or semiconductor spins, scaling poses a significant challenge as every additional qubit increases the heat generated, while the cooling power of dilution refrigerators is severely limited at their normal operating temperature below 100 mK.

Here we demonstrate operation of a scalable silicon quantum processor unit cell, comprising two qubits, at a device temperature of ~1.45 Kelvin [1] – the temperature of pumped ^4He. We achieve this by isolating the quantum dots (QDs) which contain the qubits from the electron reservoir, initialising and reading them solely via tunnelling of electrons between the two QDs [2]. We coherently control the qubits using electrically-driven spin resonance (EDSR) [3,4] in isotopically enriched silicon ^{28}Si [5], attaining single-qubit gate fidelities of 98.6 % and Ramsey coherence times of $T_2^* = 2$ ⍰s during “hot” operation [1], comparable to those of spin qubits in natural silicon at millikelvin temperatures.

Furthermore, we show that the unit cell can be operated at magnetic fields as low as 0.1 T, corresponding to a qubit control frequency $f_{qubit} = 3.5$ GHz, where the qubit energy hf_{qubit} is much smaller than the thermal energy k_BT. The quantum processor unit cell constitutes the core building block of a full-scale silicon quantum computer and satisfies physical layout constraints required by error correction architectures. Our work indicates that a spin-based quantum computer could be operated at elevated temperatures in a simple pumped ^4He system, offering orders of magnitude higher cooling power than dilution refrigerator systems.

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