A two-qubit logic gate in silicon

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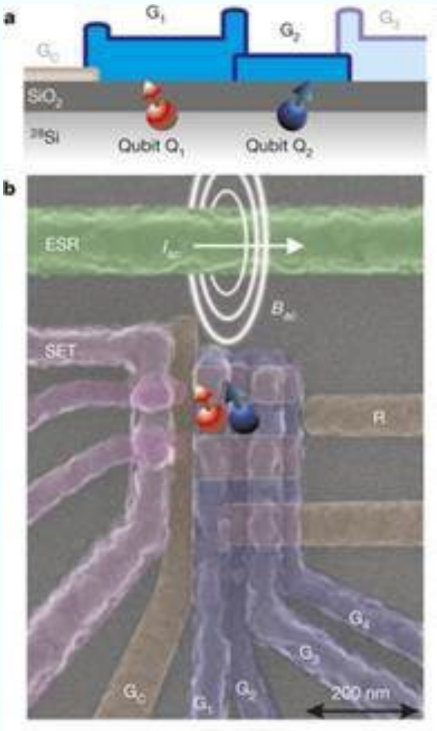

Schematic (**a**) and scanning electron microscope coloured image (**b**) of the device.

Quantum computation requires qubits that can be coupled in a scalable manner, together with universal and high-fidelity one- and two-qubit logic gates. Many physical realizations of qubits exist, including single photons, trapped ions, superconducting circuits, single defects or atoms in diamond and silicon and semiconductor quantum dots with single-qubit fidelities that exceed the stringent thresholds required for fault-tolerant quantum computing. Despite this, high-fidelity two-qubit gates in the solid state that can be manufactured using standard lithographic techniques have so far been limited to superconducting qubits, owing to the difficulties of coupling qubits and dephasing in semiconductor. Here we present a two-qubit logic gate, which uses single spins in isotopically enriched silicon and is realized by performing single- and two-qubit operations in a quantum dot system using the exchange ,interaction, as envisaged in the Loss–DiVincenzo proposal. We realize CNOT gates via controlled-phase operations combined with single-qubit operations. Direct gate-voltage control provides single-qubit addressability, together with a switchable exchange interaction that is used in the two-qubit controlled-phase gate. By independently reading out both qubits, we measure clear anticorrelations in the two-spin probabilities of the CNOT gate.

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