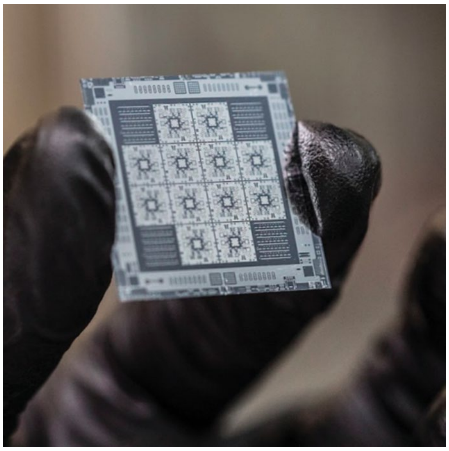
ON-CHIP QUBITS

Quantum gates scale up

Sci. Adv. **4**, eaao3603 (2018)



Credit: Rigetti Quantum Computing

Building a quantum computer faces two serious challenges: scaling up the number of qubits that store and manipulate information, and improving the fidelity of quantum logic operations. Building quantum logic gates relies, in particular, on entanglement, which requires strong interaction between qubits. At the same time, unwanted interaction with neighbouring qubits can introduce errors in the calculation, a problem that becomes more significant as the system grows and more qubits are added to the circuits. Matthew Reagor and colleagues have now developed an approach to generate selective entangling interactions in multi-qubit processors and demonstrated quantum computations on a superconducting processor with eight qubits.

The researchers used eight transmon qubits — a common type of superconducting qubit that consists of a Josephson junction in parallel with a capacitor — in a ring arrangement. Building on earlier work from the team, they combined an improved circuit fabrication approach with an entangling scheme that helps with the issue of on-chip cross-talk and qubit decoherence. Under this scheme, the transmon qubit frequencies can be tuned so that only selected qubits interfere during an entangling gate operation, and interaction with the other qubits is minimized.

For their experiments, the team — who are based at Rigetti Computing, a quantum computing start-up in Berkeley, California — ran quantum algorithms on sets of two or more qubits of the eight-qubit register. To test the performance of the quantum gate, they measured the fidelity of the entangled state (a standard assessment of their quality), which was as high as 95% for neighbouring pairs of qubits and 79% for four qubits. In addition, they tested the effect of decoherence across the whole chip and found limited cross-coupling between a two-qubit gate and the remaining qubits. As a next step, the team aims to run quantum algorithms with all eight qubits of the processor.

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Published online: 9 March 2018
https://doi.org/10.1038/s41928-018-0051-y