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Prospects of superconducting qubits for quantum computation

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Superconducting qubits are solid state electrical circuits fabricated using techniques adapted from those of conventional integrated microprocessor fabrication. They are based on the Josephson tunnel junction, the only non-dissipative, strongly non-linear circuit element compatible with low temperature operation. In contrast to microscopic entities such as spins, atoms or ions, superconducting qubits can be well coupled to each other, an appealing feature for 2-qubit gate implementation. Very recently, new circuit architectures have greatly improved the isolation of qubits from unwanted noise, yielding coherence quality factors well in excess of 100,000. Entanglement, the key property that distinguishes a quantum processor from a classical one, has been produced and measured for up to 3 qubits.[1,2] Current experiments are addressing the problem of whether the Preskill criterion of 10,000 coherent 1- and 2-qubit gate operations can be met to enable quantum error correction.

[1]DiCarlo, L. et al. Nature 467, 574-578 (2010);
[2]Neeley, M. et al. Nature 467, 570-573 (2010).