Superconducting Circuits Algorithms

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Abstract

Using quantum systems for computations can provide a big improvement over classical methods by exploiting quantum effects like entanglement and superposition of states. Two-level quantum systems (Qubits) can be emulated using superconducting integrated circuits which allows for a high degree of control over the parameters compared to natural quantum systems.
In our presentation, we present the work of DiCarlo et al. who demonstrated the implementation of Grover's algorithm with superconducting circuits [1] which constitutes a great breakthrough in quantum information technology. Grover's algorithm can be used to perform search tasks in an unstructured set of N elements. The time necessary scales as $\mathcal{O}(\sqrt{N})$, which is a significant speed-up compared to the limit of the classical analogue which is $\mathcal{O}(N)$. The experimental implementation uses two transmon qubits coupled by a cavity which allows for entanglement of states on demand. We will present the experimental setup that was used by the group. Furthermore we will discuss how they could control the circuit to be able to realise single- and two-qubit gates such that they could successfully realise Grover's algorithm.

1 L. DiCarlo, J. M. Chow, J. M. Gambetta, Lev S. Bishop, B. R. Johnson, D. I. Schuster, J. Majer, A. Blais, L. Frunzio, S. M. Girvin & R. J. Schoelkopf *Demonstration of two-qubit algorithms with a superconducting quantum processor*
Nature 460, 7252 (2009)