Superconducting Circuits and Quantum Computation

Personnel

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Introduction

Superconducting circuits are being used as components for quantum computing and as model systems for non-linear dynamics. Quantum computers are devices that store information on quantum variables and process that information by making those variables interact in a way that preserves quantum coherence. Typically, these variables consist of two quantum states, and the quantum device is called a quantum bit or qubit. Superconducting quantum circuits have been proposed as qubits, in which circulating currents of opposite polarity characterize the two quantum states. The goal of the present research is to use superconducting quantum circuits to perform the measurement process, to model the sources of decoherence, and to develop scalable algorithms. A particularly promising feature of using superconducting technology is the potential of developing high-speed, on-chip control circuitry with classical, high-speed superconducting electronics. The picosecond time scales of this electronics means that the superconducting qubits can be controlled rapidly on the time scale and the qubits remain phase-coherent.

Superconducting circuits are also model systems for collections of coupled classical non-linear oscillators. Recently we have demonstrated a ratchet potential using arrays of Josephson junctions as well as the existence of a novel non-linear mode, known as a discrete breather. In addition to their classical behavior, as the circuits are made smaller and with less damping, these non-linear circuits will go from the classical to the quantum regime. In this way, we can study the classical-to-quantum transition of non-linear systems.