Coherent Dynamics of a Josephson Charge Qubit

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Although a large number of physical systems have been suggested as potential implementations of qubits, solid state systems are attractive in that they offer a realistic possibility of scaling to a large number of interacting qubits. Recently there has been considerable experimental progress using superconducting microelectronic circuits to construct artificial two-level systems. A variety of relative Josephson and Coloumb energy scales have been used to construct qubits based upon a single-Cooper-pair box and flux qubits based upon a 3-junction loop. The experimental systems reported so far can also be distinguished by the readout method, and the manner of performing single qubit rotations.

We have fabricated a Josephson charge qubit by capacitatively coupling a single-Cooper-pair box (SCB) to an electrometer based upon a single-electron transistor configured for radio-frequency readout (RF-SET). Charge quantization of $2e$ is observed and microwave spectroscopy is used to extract the Josephson and charging energies of the box. We demonstrate coherent manipulation of the SCB by using very fast DC pulses, and observe quantum oscillations in time of the charge that persist to a few ns.

The next challenging step will be to fabricate and measure a 2-qubit system with controlled inter-qubit coupling. We will present several ideas for reaching this goal using coupled single-Cooper-pair boxes and RF-SET readout.

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