MAR07-2006-020085

Abstract for an Invited Paper
for the MAR07 Meeting of
the American Physical Society

Flux qubits: quantum nondemolition readout and controlled-not gate[1]

HANS MOOIJ, Delft University of Technology

Superconducting flux qubits have of a loop with three Josephson junctions, biased at about half a flux quantum. Basic states have opposite persistent currents, readout is by inductive coupling to a SQUID magnetometer. The following results have been obtained in a bias flux regime where the qubit energy states closely resemble the current states. Coherence was significantly lower than for the best samples. A dispersive method for readout was developed, where the inductance of the SQUID is measured rather than the critical current. The SQUID together with an on-chip capacitance forms a nonlinear oscillator where the resonant frequency depends on the flux in the SQUID, in turn influenced by the qubit. For high driving, two oscillation modes exist with low and high amplitude with a hysteretic transition. A short microwave pulse is applied and the probability that the oscillator switches to the high-amplitude mode is determined. This readout method yields a fidelity of 87% without any corrections for relaxation. We have performed series of two consecutive measurements on a qubit in various superposition states and correlations between the outcomes were determined. Between the first measurement and the second a Rabi pulse was applied. Results were consistent with fully projective measurement, with a quantum nondemolition fidelity of 88% without corrections. We have also studied a system of two permanently coupled flux qubits. For each qubit, the energy splitting is shifted by the other qubit to plus or minus 200 MHz. When a suitable pulse is applied to a target qubit, it acts as a pi-pulse when the control qubit is in one state, and does nothing in the opposite case. This controlled-not operation that consists of a single microwave pulse has been performed for arbitrary superposition states of the two qubits. We have determined the phase reliability of the operation as well as its amplitude response.

[1]In collaboration with Adrian Lupascu (present address Ecole Normale Paris), Jelle Plantenberg, Thomas Picot, Pieter De Groot, and Kees Harmans, Delft University of Technology.