Abstract Submitted
for the MAR07 Meeting of
The American Physical Society

Cavity QED with a Josephson Phase Qubit E. M. WEIG, M. ANSMANN, R. BIALCZAK, N. KATZ, E. LUCERO, R. MCDERMOTT, M. NEELEY, A. D. O'CONNELL, M. STEFFEN, J. M. MARTINIS, A. N. CLELAND, California NanoSystems Institute & Department of Physics, UC Santa Barbara, M. R. GELLER, Department of Physics and Astronomy, University of Georgia — A superconducting qubit coupled to a microwave resonator is a solid state implementation of cavity quantum electrodynamics. This system allows a study of the coherent interaction of a macroscopic two-level system with a single photon in the strong coupling limit. We have investigated a Josephson phase qubit capacitively coupled to a superconducting coplanar waveguide resonator (CPW). The phase qubit is tunable over a wide frequency range and can thus be brought in and out of resonance with the CPW. Vacuum Rabi oscillations and cavity quantization can be probed spectroscopically as well as in the time domain. An arbitrary quantum state can be initialized in the phase qubit and transferred to the CPW. Using the qubit as sensitive probe of the resonator the relaxation time T_1 as well as the dephasing time T_2 of the resonator can be measured directly. With lifetimes of the order of several microseconds, high Q resonators are envisioned to act as storage elements for the quantum state of a qubit or as inter-qubit communication bus.

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Date submitted: 17 Nov 2006 Electronic form version 1.4