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Probing Multiphoton Dressed States of a Superconducting Qubit
C.M. WILSON, T. DUTY, F. PERSSON, M. SANDBERG, G. JOHANSSON, L. TORNBERG, P. DELSING, Chalmers University — There has been great interest in the new field of circuit QED, where the interaction of photons and matter are studied in the context of superconducting qubits. In this work, we create dressed states of a superconducting qubit, the single Cooper-pair box (SCB), with an intense microwave ($\sim$7 GHz) drive. The dressed states represent the hybridization of the qubit and photon degrees of freedom, and appear as avoided level crossings (ALC) in the combined qubit-photon energy diagram. The ALC occur when the energy of n photons is resonant with the charging energy of the SCB. By embedding the circuit in an rf resonator ($\sim$650 MHz), we can directly probe the dressed states. When the dressed states are off resonance, we see a purely reactive response, analogous to the quantum capacitance. On resonance, we see that the dressed qubit absorbs energy from the resonator. For some conditions, we also see evidence of population inversion in the dressed states, indicated by amplification of the reflected rf field and a negative quantum capacitance. All these effects can be explained by including relaxation in the dressed state picture.

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