Abstract Submitted
for the MAR11 Meeting of
The American Physical Society

Circuit QED without selection rules: the dispersive regime of the fluxonium qubit GUANYU ZHU, JENS KOCH, Northwestern University — Manipulation and readout of superconducting qubits with microwave photons, as realized in circuit QED, commonly employ the dispersive regime. In this regime, the qubit-photon interaction strength is small compared to the relative detuning Δ, and manifests itself only in the dispersive energy shifts χ, crucial for dispersive readout and spectroscopy of the qubit. For Cooper Pair Box and transmon, these shifts are known to scale like $1/\Delta$ and $1/\Delta^2$, respectively, making readout at very large detuning challenging. We show that the relation between χ and Δ is mainly dictated by selection rules, and derive general expressions describing the dispersive regime of a multi-level qubit with arbitrary matrix elements. This generalization turns out essential for describing the dispersive regime of the fluxonium qubit, where no simple selection rules exist. We show that this lack of selection rules explains the suprising magnitude of disperse shifts, at detunings as large as $\sim$8GHz, and also causes peculiarities observed in the fluxonium spectroscopy.

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Date submitted: 23 Nov 2010 Electronic form version 1.4