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Qubit Measurement with a Nonlinear Cavity Detector Beyond Linear Response CATHERINE LAFLAMME, AASHISH CLERK, McGill University — We consider theoretically the use of a driven, nonlinear superconducting microwave cavity to measure a coupled superconducting qubit. This is similar to setups studied in recent experiments.[1,2] In a previous work, we demonstrated that for weak coupling (where linear response theory holds) one misses the quantum limit on QND detection in this system by a large factor proportional to the parametric gain.[3] Here we calculate measurement backaction beyond linear response by using an approximate mapping to a detuned degenerate parametric amplifier having both linear and dispersive couplings to the qubit. We find surprisingly that the backaction dephasing rate is far more sensitive to corrections beyond linear response than the detector response. Thus, increasing the coupling strength can significantly increase the efficiency of the measurement. We interpret this behavior in terms of the non-Gaussian photon number fluctuations of the nonlinear cavity. Our results have applications to quantum information processing and quantum amplification with superconducting microwave circuits.

[1]M. Hatridge *et al.* Phys.Rev.B, 83,134501 (2011)
[2]F.R. Ong *et al.* PRL 106,167002 (2011)
[3]C. Laflamme and A.A. Clerk, Phys. Rev. A 83, 033803 (2011)

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