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Phase-space theory for nonlinear detectors of superconducting qubits IOANA SERBAN, Ludwig-Maximilians-Universitaet, Munich, FRANK WILHELM, University of Waterloo, Waterloo, ON — Superconducting circuits are envisioned as quantum bits and demonstrate quantum-coherent features i.e. Rabi oscillations and Ramsey fringes. The detector (e.g. a superconducting quantum interference device, SQUID) can itself be described by a Hamiltonian and treated quantum-mechanically.This allows more insights into the measurement process. Several experimental groups have recently realized good detectors with strong coupling to the measured system, where nonlinear dynamics plays a significant role. Motivated by the recent experiment [1], we study a nonlinear detector where the qubit couples to the square amplitude of a driven oscillator, which can be used for dispersive detection. We use a complex-environment approach treating the qubit and the oscillator exactly, expressing their full Floquet-state master equations in phase space. We investigate the backaction of the environment on the measured qubit and explore the resolution of measurement. We discuss the possibility for using the squeezing capability of the nonlinear interaction for beating the standard quantum limit and emphasize the resulting role of non-Gaussian and non-Markovian effects in the backaction including significant non-exponential shape of the coherence decay.
[1] A. Lupascu et al. PRL 93 177006 (2004)

Ioana Serban
Ludwig-Maximilians-Universitaet, Munich

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