Abstract Submitted
for the MAR17 Meeting of
The American Physical Society

**Keldysh meets Lindblad: Correlated Gain and Loss in Higher Order Perturbation Theory** TOM STACE, CLEMENS MUELLER, University of Queensland — Motivated by correlated decay processes driving gain, loss and lasing in driven artificial quantum systems, we develop a theoretical technique using Keldysh diagrammatic perturbation theory to derive a Lindblad master equation that goes beyond the usual second order perturbation theory. We demonstrate the method on the driven dissipative Rabi model, including terms up to fourth order in the interaction between the qubit and both the resonator and environment. This results in a large class of Lindblad dissipators and associated rates which go beyond the terms that have previously been proposed to describe similar systems. All of the additional terms contribute to the system behaviour at the same order of perturbation theory. We then apply these results to analyse the phonon-assisted steady-state gain of a microwave field driving a double quantum-dot in a resonator. We show that resonator gain and loss are substantially affected by dephasing- assisted dissipative processes in the quantum-dot system. These additional processes, which go beyond recently proposed polaronic theories, are in good quantitative agreement with experimental observations.

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Date submitted: 11 Nov 2016 Electronic form version 1.4