

# Amplification without Population Inversion from a Strongly Driven Superconducting Qubit

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Amplification of EM fields is often achieved by strongly driving a medium to induce population inversion such that a weak probe can be amplified through stimulated emission. Here we strongly couple a superconducting qubit to the field in a semi-infinite waveguide. When driving the qubit strongly on resonance such that a Mollow profile appears, we observe a few percent amplitude gain for a weak probe at frequencies in between the Mollow profile. This amplification is not due to population inversion, neither in the bare qubit basis nor in the dressed-state basis, but instead results from a four-photon process that converts energy from the strong drive to the weak probe [1]. We find excellent agreement between the experimental results and numerical simulations without any free fitting parameters. Since our device consists of a single two-level artificial atom, the simplest possible quantum system, it can be viewed as the most fundamental version of a four-wave-mixing parametric amplifier.

[1] P. Y. Wen, A. F. Kockum, H. Ian, J. C. Chen, F. Nori and I.-C. Hoi  
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