Abstract Submitted
for the MAR17 Meeting of
The American Physical Society

Multimode phase-locking in a Josephson parametric oscillator ANDREAS BENGTSSON, Chalmers University of Technology, WALTRAUT WUSTMANN, Laboratory for Physical Sciences, VITALY SHUMEIKO, PER DELSING, JONAS BYLANDER, Chalmers University of Technology — Frequency-tunable resonators are versatile tools for microwave amplification at the quantum limit of sensitivity, interaction between qubits and radiation in the circuit-QED architecture, and strong-coupling microwave quantum optics. We investigated non-degenerate parametric resonance in multimode microwave superconducting resonators. Pumping is realized by modulating magnetic flux through the SQUID attached to the cavity. Pumping at the sum-frequency of two modes provides parametric amplification. For low pumping strength, we observe the generation of two-mode squeezed states, i.e., entangled modes when the input is the vacuum. For high pumping strength, exceeding a parametric instability threshold, self-sustained parametric oscillations are observed in each mode. The sum of the phases of the mode fields is fixed, while the difference is uncertain in the classical limit, and undergoes diffusion under the effect of quantum noise. This phenomenon significantly changes the statistics of entangled modes in the oscillator state.

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Date submitted: 11 Nov 2016 Electronic form version 1.4