Characterization of electromechanically induced absorption and transparency in microwave optomechanical device

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Microwave optomechanical circuitry is attractive for both fundamental research and quantum engineering as it gives microwave photons an ability to interact with mechanical phonons through radiation pressure [1]. In this scheme, a mechanical oscillator, a weak nonlinear component, also allows microwave signals to have frequency up/down conversion. When the system is side-band pumped by a microwave tone, the up/down converted photons will affect the interference of the input signal around the resonance frequency of the resonator, causing an electromechanically induced transparency/absorption (EMIT/EMIA) [2]. Here, we present a two-tone measurement performed with a microwave optomechanical scheme, a Si_3N_4 mechanical oscillator capacitively couples with a lumped element superconducting microwave resonator [3]. This experiment concentrated on investigating effects of the thermal phonon/photon and the input photon numbers on EMIT and EMIA efficiencies, especially on the transition from absorption to amplification. One of the typical measurement results is shown in Fig.1. We will also show quantitative fits of these experimental results based on our analytical calculations. Characterizations of the two-tone operation scheme in microwave optomechanical circuits are essential for developing mechanical microwave amplifications and filters in quantum engineering.

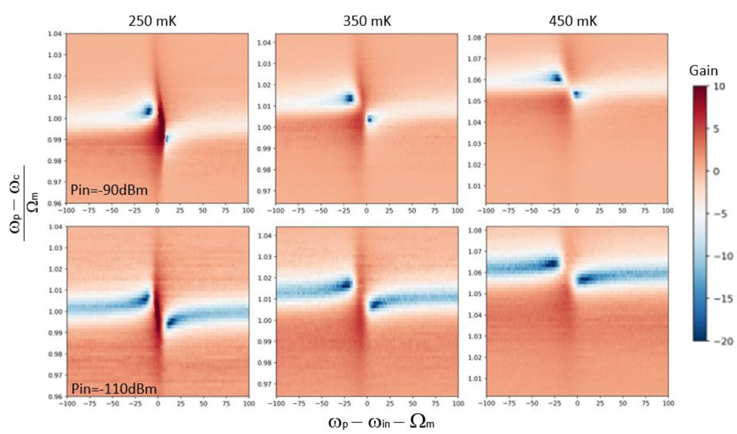

Figure 1. 2D plot of the signal gain with different input power when the microwave resonator is the sideband pumped with a power of -40dBm, measured at different temperatures. Here, ω_c, ω_p, ω_{in}, Ω_m correspond to resonator resonance frequency, pump frequency, input signal frequency and resonance frequency of mechanical oscillator.

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[2] F. Hocke, et al, New J. Phys. 14, 123037 (2012)
[3] X. Zhou, et al, arXiv:1903.04992