On-Chip Microwave Frequency Combs in a Superconducting Niobium electromechanical Device

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ABSTRACT:

Nanomechanical resonators coupled to microwave cavities can be excited, measured and controlled using electromechanical back-action. Examples of these effects include sideband cooling and amplification, which are commonly described by linear optomechanical equations of motion. However, this linear equation becomes invalid when the pump-induced cavity microwave field is large enough to trigger optomechanical nonlinearities, resulting in phenomena like frequency combs. Here, we employ a niobium-based superconducting electromechanical device to study the generation of microwave frequency combs. We observe the frequency combs around a microwave resonant frequency (3.78 GHz) with 8-MHz frequency spacing, equal to the mechanical resonant frequency. We investigate their dynamics for different optomechanical parameters, including pump detuning, pump powers and cavity decay rates. Our experimental results show excellent agreement with numerical analysis. These electromechanical frequency combs can be beneficial in nanomechanical sensing applications which require precise electrical tracking of mechanical resonant frequencies.