

Microwave Quantum Optics with Superconducting Circuits

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The generation and manipulation of complex quantum states of light is central to quantum technologies. I will introduce our research on generating and controlling squeezed states of microwave photons using superconducting quantum circuits, particularly Josephson metamaterials

I will present our last experimental results on near quantum-limited amplification and squeezing generation in a flux tunable Josephson traveling-wave parametric amplifiers (J-TWPAs) [1] based on SNAIL (superconducting nonlinear asymmetric element) [2] unit cells with inverted flux polarity.

Such a device was first introduced in the literature as a four-wave-mixing (4WM) amplifier [3], and squeezer [4]. Subsequent investigations have shown that flux tunability can be used to activate residual three-wave-mixing (3WM) non-linearity, enabling second harmonic generation and amplification [5].

I will present experimental results aiming at exploiting flux-tunability to investigate the effect of residual 3WM on both amplification and generation of squeezing. The outcomes of our investigation could help in defining new operational configurations for generating multi-mode squeezing in TWPAs, possibly extending the range of applications in the framework of microwave photonics.

[1] Aumentado IEEE Microwave Magazine 21, 8 (2020)

[2] Frattini et al. Phys. Rev. Appl. 10, 5 (2018)

[3] Ranadive et al. en. Nature Communications 13,1 (2022)

[4] Esposito et al. Phys. Rev. Lett. 128 153603 (2022)

[5] Levchikina et al. Superconductor Science and Technology 37, 11 (2024)