Contribution ID: **31** Type: **Invited Talk**

Scalable superconducting circuit optomechanics with millisecond quantum coherence

Thursday, 11 December 2025 13:30 (50 minutes)

Superconducting circuit optomechanics based on vacuum-gap capacitors offers a versatile platform for controlling mechanical oscillators in the quantum regime, yet achieving long coherence and scalability has remained a major challenge. We address these limitations by developing a silicon-etched-trench fabrication technique that reproducibly forms vacuum-gap capacitors incorporating high-stress, high-Q superconducting membranes with strong optomechanical coupling. Using this platform, we achieve mechanical quality factors exceeding 40 million, corresponding to mechanical quantum coherence times beyond 10 milliseconds. We further demonstrate multimode optomechanical lattices with more than 20 sites, which not only exhibit basic optomechanical operation but also enable on-site optomechanical interactions to map microwave mode distributions in the lattices. Finally, we observe collective ground-state motion among degenerate mechanical modes, confirming access to the quantum regime in multimode optomechanical systems. These results establish a new regime of long-lived, controllable, and scalable optomechanics, opening new opportunities for studying quantum thermodynamics with mechanical oscillators.

Presenter: KONO, Shingo (Niels Bohr Institute)

Session Classification: Thursday