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Optomechanics with superfluid He4 thin films CHRISTOPHER BAKER, GLEN HARRIS, DAVID MCAUSLAN, YAUHEN SACHKOU, XIN HE, EOIN SHERIDAN, WARWICK BOWEN, Univ of Queensland — Cavity optomechanics focuses on the interaction between confined light and a mechanical degree of freedom. Vibrational modes of superfluid helium-4 have recently been identified as an attractive mechanical element for cavity optomechanics, thanks to their ultra-low dissipation arising from superfluids viscosity free flow. Here we propose and demonstrate an approach to superfluid optomechanics based on femtogram thin films of superfluid helium condensed on the surface of a microscale microtoroid optical whispering gallery mode resonator. Excitations within the film, known as third sound, manifest as surface waves with a restoring force provided by the van der Waals interaction. We experimentally probe the thermodynamics of these superfluid excitations in real-time, and demonstrate both laser cooling and amplification of the thermal motion. In addition, we propose and demonstrate an entirely new approach to optical forcing based on the atomic recoil of superfluid helium-4. This technique utilizes the thermomechanical effect of superfluids, whereby frictionless fluid flow is generated in response to a local heat source. Using this technique, we achieve superfluid forces on a microtoroid mechanical mode an order of magnitude greater than the equivalent radiation pressure force.

Christopher Baker
Univ of Queensland

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