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Cavity Optomechanics: Generating Mechanical Interference Fringes and Brillouin Optomechanical Strong Coupling

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Cavity quantum optomechanics utilizes electromagnetic fields to generate and study quantum states of motion of macroscopic mechanical oscillators. The field has undergone significant growth recently owing to its significant promise for both quantum technology development and to test the foundations of physics. Our new team at Imperial College London - the Quantum Measurement Lab - pursue a combination of experiment and theory in these directions with key interests including quantum-state engineering of mechanical systems and exploring the quantum-to-classical transition. In this talk, results from two of our research programs will be presented. Firstly, our work towards creating a mechanical superposition state will be described including experimentally generating interference fringes in the motion of a mechanical oscillator using single-photon detection [1], and theoretical work proposing how to grow a mechanical superposition state using a sequence of pulsed interactions and single-photon measurements [2]. Secondly, our experimental work on Brillouin optomechanics with high-frequency phonons (~10 GHz) will be presented including the first observation of Brillouin optomechanical strong coupling [3]. This observation provides a powerful new direction that unites several favorable properties for mechanical quantum state engineering including very low optical loss and absorption, and back-scatter operation to allow the signal to be easily separated from the pump.

[1] Ringbauer et al, New J. Phys. 20, 053042 (2018).
[2] Clarke and Vanner, Quantum Sci. Technol. 4, 014003 (2019).
[3] Enzian et al, Optica 6, 7 (2019).
https://groups.physics.ox.ac.uk/QMLab/

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