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Continuous and Pulsed Cavity Quantum Optomechanics
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ABSTRACT

Quantum optomechanics utilises the tools of quantum optics and the radiation-pressure interaction to manipulate and precisely measure the motion of mechanical resonators. The field is currently receiving a surge of interest for its potential to contribute to weak force sensing, non-classical state preparation of macroscopic objects, and studies of quantum decoherence. During this thesis, we proposed a pulsed approach to quantum optomechanics that allows the preparation of mechanical squeezed states of motion by a back-action-evading position measurement an d addresses the important problem of how to perform mechanical quantum state reconstruction. This scheme was experimentally implemented that performed “cooling-by-measurement” and conditional preparation of a thermomechanical squeezed state with a position uncertainty below 20 picometers, which was limited by the quantum optical phase noise of the measurement. A pulsed, or time-domain, approach also allows for experiments that utilise multiple interactions and this presentation will also describe two experimental proposals that exploit a geometric phase to probe potential quantum-gravitational modifications to the mechanical canonical commutator and for deterministic quantum state engineering of mechanical motion.