# QSIT Seminar

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Host:  Jonathan Home

## Quantum optomechanics with superfluid helium density waves

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The field of optomechanics deals with the interaction between light and mechanical objects. One of the goals in this field is to gain ability to coherently manipulate mechanical states with single-quantum precision and to interface these states with electromagnetic radiation without loss. Recent achievements enabled by this power include cooling of the mechanical oscillator to its quantum ground state, generating optical or mechanical squeezing, or entangling mechanical and optical degrees of freedom. To accomplish these goals, one generally aims to create a system with strong optomechanical coupling, while maintaining low optical and mechanical losses and low temperature. Superfluid helium is a liquid which is uniquely well-suited to meet these requirements.

In this talk I will describe the cavity optomechanics systems in which we couple infrared light to a standing acoustic wave in superfluid helium. With this system, we used light to coherently excite acoustic vibrations and manipulate their frequency and damping rate using the dynamic back-action effect. In addition, we measured thermal fluctuations of the mechanical mode corresponding to mean phonon number of five. These measurements had sufficient precision to reveal quantum signatures in the motion of the acoustic waves and in their interaction with light. Specifically, we observed the expected one-phonon difference between the Stokes and anti-Stokes mechanical sidebands, and indirectly measured the action of the optical shot noise on the mechanical object by investigating the correlations between these sidebands.