Quantum optomechanics

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Quantum optomechanics is the study of the quantum nature of interactions between light and matter. In recent years, much progress has been made in the field using cavity optomechanical systems, where the motion of a macroscopic mechanical oscillator, such as a cantilever or beam, is controlled and measured via a resonantly enhanced optical field. Some important examples include, cooling to near the quantum ground state where only the zero-point motion of the oscillator remains; strong optomechanical coupling where energy is resonantly exchanged between light and mechanics at a rate faster than all dissipative rates, and even faster than the quantum decoherence rate, the generation of macroscopic quantum entanglement between a microwave field and a mechanical oscillator; optical squeezing via radiation pressure forces; and the observation of the effect of radiation pressure shot noise on the motion of a mechanical oscillator.

Quantum optomechanical systems are particularly interesting due to their prospect to test the transition from quantum to classical physics at new size scales and in new parameter regimes, and perhaps even contribute towards reconciling quantum mechanics and general relativity. Furthermore, devices developed for quantum optomechanics are beginning to be spun-off into precision sensing applications, with state-of-the-art sensitivity realized in areas such as accelerometry, magnetometry, and force sensing; and potential applications in chronometry (measurements of time) and quantum information science amongst other areas.

In this talk I will give an overview of the field discussing some of the recent major results, and describe work in my group on optomechanics with superfluids, applications in biophysics, and progress towards the generation of macroscopic non-classical states of matter.

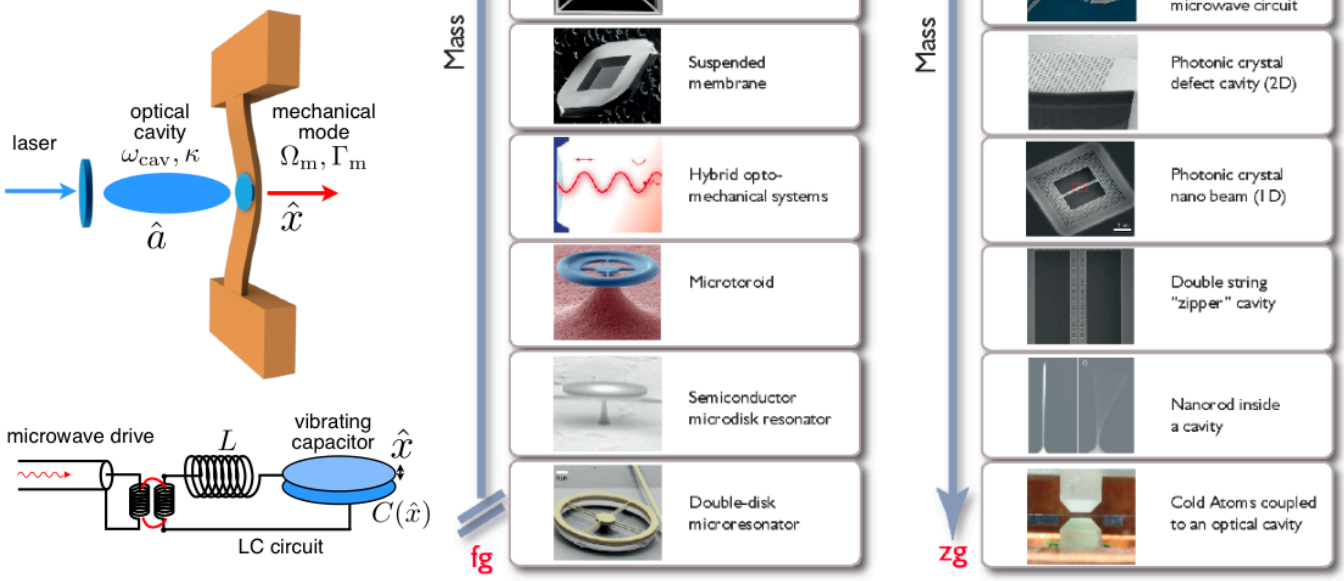

Figure 1: *Left:* canonical cavity optomechanical systems. *Right:* diverse range of architectures. Images from M. Aspelmeyer, T. J. Kippenberg, and F. Marquardt, *Cavity Optomechanics* arXiv:1303.0733 (2013).