Quantum micro-mechanics with ultracold atoms

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Isolated atoms and ions have been inserted into high-finesse optical resonators for the study of fundamental quantum optics and quantum information. Here, I will introduce another application of such a system, as the realization of cavity optomechanics where the collective motion of an atomic ensemble serves the role of a moveable optical element in an optical resonator. Compared with other optomechanical systems, such as those incorporating nanofabricated cantilevers or the large cavity mirrors of gravitational observatories, our cold-atom realization offers immediate access to the quantum regime. Experimental investigations of optomechanical effects, such as the bistability of collective atomic motion and the first quantification of measurement backaction for a macroscopic object, will be presented, along with recent progress in this nascent field.

This work was performed in collaboration with group members T. Botter, D. Brooks, S. Gupta, Z.-Y. Ma, K.L. Moore, K.W. Murch and T. Purdy, and is supported by the NSF and AFOSR.

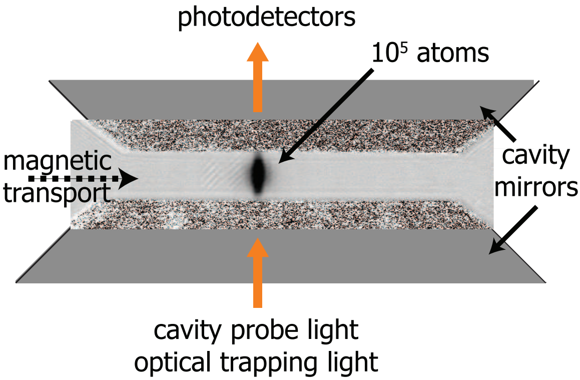

Figure 1: *The paradigmatic system of a mechanical oscillator coupled to a single mode of light is realized at a macroscopic level by trapping a large atomic ensemble within a high-finesse optical resonator. A single mode of collective atomic motion is actuated by the cavity field and measured by its optical properties. Establishing this connection allows us to explore issues related to weak force sensing by micromechanical cantilevers and by gravity-wave observatories.*