Observing quantum effects in the motion of a millimeter-scale object

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One of the major challenges in physics is to understand how the classical behavior of macroscopic objects emerges from constituents whose behavior is fundamentally quantum mechanical. The field of optomechanics attempts to address this issue by studying the quantum behavior of devices in which a macroscopic object's motion is coupled to the photons stored in an optical cavity. In the past few years, experiments have demonstrated a number of quantum effects in these devices, including ground-state cooling, entanglement, and the quantum back-action of displacement measurements. In this talk, I will give an overview of our group's recent work in this area. I will also describe results from an optomechanical device that exploits the unique properties of superfluid helium. Lastly, I will discuss the prospects for using superfluids to reach previously inaccessible regimes of quantum optomechanics.