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The quantum limit and beyond in gravitational wave detection

NERGIS MAVALVALA, Massachusetts Institute of Technology

The sensitivity of current and next generation interferometric gravitational wave detectors is limited by quantum mechanics. We will explore this quantum limit, one aspect of which arises from the radiation pressure that laser light exerts on the movable mirrors of the interferometer. I will describe experiments in which the light force dominates the mechanical forces to such an extent that the mirror oscillators are optically trapped and cooled. Laser cooling of macroscopic mechanical oscillators has applications in high precision force and position measurements, gravitational wave detection, and exploration of the classical-quantum boundary. I will discuss the status of a variety of experimental efforts worldwide are working to approach the quantum regime, with the goal of observing non-classical effects such as quantum back-action, squeezing and entanglement of the light and mirror states, and conclude with an outlook on prospects for observation of quantum effects in macroscopic human-scale objects.