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Laser Cooling of Gram Scale Objects

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Laser cooling of macroscopic mechanical oscillators is a rapidly growing field with applications in high precision measurements, gravitational wave detectors, and exploration of the classical-quantum transition. Here I will describe a series of cooling experiments, which are inspired by gravitational wave detectors, to trap and cool gram scale mirror oscillators. To approach quantum limits of oscillators with such a high mass requires the use of a variety of cooling techniques. The techinques employ non-mechanical forces both to trap the mirror by increasing its effective mechanical resonant frequency, and to cool the mirror by damping its motion within the trap. The non-mechanical forces are created from either radiation pressure in a detuned optical resonator, or from electronic feedback forces in an active servo. As the experiments approach the quantum regime, an assortment of non-classical behavior and effects should become evident, such as quantum radiation pressure noise, and squeezing and entanglement of the light and mirror states. I will discuss the prospects for observation of these effects, in light of current performance and expected upgrades.