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Quantum measurement with atomic cavity optomechanics

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A cloud of ultracold atoms trapped within the confines of a high-finesse optical cavity shakes from the pressure of the light that probes it. This radiation pressure is a form of quantum backaction, a disruptive consequence of quantum measurement that imposes fundamental limits on measurement precision. The existence of these limits has long been an underlying tenet of quantum mechanical theory, though experimental validation has only been recent. In this talk, I will describe experiments enlisting the collective motion of ultracold atoms as the mechanical degree of freedom in a cavity optomechanical system to reach settings cold and quiet enough to allow the effects of measurement backaction to manifest. Recounting observations of quantum-limited force measurement, ponderomotive squeezing, and a new understanding of complex quantum correlations, I focus on experiments that emphasize the nature of measurement backaction: how it can be detected, tuned, and perhaps, through careful accounting, avoided.