Quantum Measurement in an Optomechanical System

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We rarely consider the more exotic effects of quantum mechanics in objects on the scale of our everyday existence. However, recent progress in the field of cavity optomechanics (where light is used to both make precise position measurements and actuate mechanical motion) has demonstrated collective quantum behavior in objects large enough to easily be seen with the naked eye. For instance, macroscopic mechanical resonators have been laser cooled near to their quantum mechanical ground state, and have been shown to obey the Heisenberg uncertainty limit for position measurement. Here I will present experimental results, akin to a macroscopic continuous measurement version of the famous Heisenberg microscope thought experiment. We clearly see the necessary increase in momentum uncertainty dictated by the Heisenberg uncertainty limit, as our position measurement uncertainty becomes smaller. I will also discuss the reverse quantum measurement process, where a mechanical object is used to non-destructively measure the quantized nature of light. Here, the recoil of the movable object acts as a sensitive meter of the many individual photons reflecting off its surface. One of the useful consequences of this process is the generation of squeezed light.