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Room temperature optomechanical squeezing

Quantum fluctuations of light impose a fundamental limit precision optical measurements, laser interferometric detection of gravitational waves (GWs), for example. Current generation GW detectors are limited by quantum noise and plan to improve their sensitivity by injecting squeezed states of light generated by non-linear optical materials. We present an alternative technology for producing squeeze states of light using the radiation pressure interaction of light with a mechanical oscillator. Such optomechanical (OM) squeezed light sources would be widely applicable for future precision measurements because their non-linearity is independent of the laser wavelength. Previously, OM squeezers were limited to cryogenic temperatures. I will present our recent measurement of squeezed light from an OM system at room temperature [1]. Operation of a quantum OM system at room temperature not only makes its integration into complex interferometers more feasible, it also provides a resource for exploring quantum light-matter interactions in a human-perceivable environment.

[1]: https://arxiv.org/abs/1812.09942

Measurement of quantum back action in the audio band at room temperature

The Heisenberg uncertainty principle dictates that as the precision of a measurement of an observable (e.g. position) increases, back action creates increased uncertainty in the conjugate variable (e.g. momentum). In interferometric gravitational-wave (GW) detectors, higher laser powers reduce the position uncertainty created by shot noise but necessarily do so at the expense of back action in the form of quantum radiation pressure noise (QRPN). There exist several proposals to improve the sensitivity of GW detectors by mitigating QRPN, but until now no platform has allowed for experimental tests of these ideas. Here we present a broadband measurement of QRPN at room temperature at frequencies relevant to GW detectors [2]. The obtained noise spectrum shows effects due to QRPN between about 2 kHz to 100 kHz, and the measured magnitude of QRPN agrees with our model. We now have a testbed for studying techniques to mitigate quantum back action, such as variational readout and squeezed light injection, with the aim to improve the sensitivity of future GW detectors.

[2] https://arxiv.org/abs/1802.10069