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Quantum noise reduction in Gravitational Wave Interferometers

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The sensitivity of gravitational wave detectors is ultimately limited by
the quantum noise, which arises from the quantum nature of light and it is driven by vacuum fluctuations of the optical field entering from the dark port of the interferometer.

Quantum noise has two complementary features: the shot noise, which depends on phase fluctuations of the optical field disturbing the detector at high frequencies, and radiation pressure noise, which depends on amplitude fluctuations of the optical field perturbing the position of suspended mirrors at low frequencies. One way to improve the sensitivity is to inject squeezed vacuum into the dark port, with reduced phase fluctuations (frequency-independent squeezing). At the same time, due to the Heisenberg's uncertainty principle, the amplitude fluctuations are larger and we need to produce frequency-dependent squeezing to achieve a broadband mitigation of quantum noise.

I will present quantum noise reduction methods that have already been implemented in current interferometers and those that will be introduced in future gravitational wave detectors.

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