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Quantum Noise and Opto-mechanics in Advanced Gravitational-wave Detectors

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The Laser Interferometer Gravitational-wave Observatory (LIGO) project and other international efforts aim to directly observe gravitational waves. In this pursuit, extremely precise measurements require that the sensitivities of the measurement devices be lowered to quantum limits inherent to the measurement process. This limit is manifested as shot and radiation pressure noise, and I will review strategies for their reduction. I will also describe the opto-mechanical coupling that arises from the very high levels of laser power used in the measurement, and which has a profound impact on the operation and sensitivity of the detectors. Finally, I will present results from a series of prototype experiments designed to explore these effects in preparation for advanced detectors, and discuss how these devices may also be interesting to fundamental quantum mechanics research.