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Reaching the quantum limit with a gravitational-wave telescope

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Abstract

Gravitational waves are ripples in the spacetime. A massive astronomical even like a black hole merger can generate gravitational waves that are observable by an interferometric detector on Earth. Gravitational-wave detectors can measure a tiny displacement of a 10kg-scale test mass and its sensitivity is about to reach and exceed the standard quantum limit. Our quantum limit comes from quantum fluctuation of light. Phase fluctuation of light makes shot noise and amplitude fluctuation of light makes radiation pressure noise. A number of proposals have been made to reduce the quantum noise and the current telescopes implement the optical squeeze injection technique. A recent study has revealed that the quantum noise level in LIGO detector with the squeezing technique has already exceeded the standard quantum limit. In my talk, I will review the fundamental noise sources of a gravitational-wave telescope and then move on to the discussion about the quantum limit and the zero-point fluctuation of the test mass.