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Optical resonator-based precision displacement sensing using GHz phasemeters

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Knowledge of changes in distance, known as displacement sensing, is crucial for detecting gravitational waves. In addition to detecting test-mass motion in inertial sensors, we also want to monitor unwanted displacements in suspension systems to increase detector sensitivity.

This poster presents the idea of using optical cavities for displacement sensing, and introduces a heterodyne cavity-tracking scheme in combination with GHz frequency measurements that is capable of reaching noise levels below $10^{-16} \text{ m}/\sqrt{\text{Hz}}$ at low frequencies with reasonable cavity and readout configurations. We discuss the main sources of noise and provide a preliminary noise budget. To use this scheme as a displacement sensor, one tracks the heterodyne frequency and retrieves the displacement information. We are currently developing a high-dynamic range frequency tracking system called the 'GHz Phasemeter', and we present our initial results.

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