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Entangled Squeezed Light for Quantum Noise Reduction in Small-Scale suspended Interferometers

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Title: Entangled Squeezed Light for Quantum Noise Reduction in Small-Scale suspended Interferometers

Presentation type: SIPS

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Abstract

Gravitational wave (GW) detectors are fundamentally limited by quantum noise, affecting sensitivity across their detection bandwidth (10–10,000 Hz). Quantum shot noise dominates at high frequencies, while quantum radiation-pressure noise limits performance at low frequencies. To overcome these constraints, modern interferometers utilize Frequency-Dependent Squeezing (FDS) with a detuned filter cavity (300m), reducing quantum noise dynamically. However, an alternative approach using Einstein-Podolsky-Rosen (EPR) entanglement offers a promising method for broadband noise suppression. The Suspended Interferometer for Ponderomotive Squeezing (SIPS) serves as a small-scale experimental platform to explore these noise reduction techniques. Designed with a Michelson configuration and high-finesse Fabry-Perot arm cavities, SIPS investigates ponderomotive squeezing, where quantum correlations are induced between the light field and suspended optics. SIPS will operate with a double-pendulum and monolithic suspension system made of fused silica fibers for reducing thermal noise and providing stable optical alignment. The high-precision local control system, based on PXI-based data acquisition and position-sensitive detectors (PSDs), continuously monitors angular (pitch, yaw) and linear (z-pendulum) displacements. Real-time feedback through LabVIEW-based control enables corrective actuation, achieving angular stability. The talk will give an overview of the SIPS status, from simulation and setup point of view.

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