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Wavefront Sensing with a Coupled Cavity for Torsion-Bar Antenna

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Torsion-Bar Antenna (TOBA) is a ground-based gravitational wave detector using a torsion pendulum. The resonant frequency of torsional motion is ~1 mHz, therefore TOBA has good design sensitivity of $10^{-19}/\sqrt{\mathrm{Hz}}$ at 0.1 Hz in low frequencies (0.1 Hz –10 Hz). TOBA can detect intermediate mass black hole binary mergers, Newtonian noise, and so on. A prototype detector Phase-III TOBA with a 35 cm-scale pendulum is under development to demonstrate noise reduction. The target sensitivity is set to $10^{-15}/\sqrt{\mathrm{Hz}}$ at 0.1 Hz. To achieve our target sensitivity, we need to measure the pendulum rotation precisely. We propose a new scheme of wavefront sensing with a coupled cavity for Phase-III TOBA. In our method, an auxiliary cavity is used to compensate Gouy phase of a main cavity and enhance the first-order TEM modes in the main cavity. The simulation with FINESSE and the experimental demonstration were successfully performed in 2021. In this symposium, we will show the principle of angular signal amplification with a coupled cavity and the results of simulation and demonstration.

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