



INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
PhD-17 SHORT ABSTRACT OF THESIS

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SHORT ABSTRACT

Cavity optomechanical systems have established themselves as powerful platforms for high precision measurements of weak forces, displacements, and fields, with prominent applications in gravitational wave detection, quantum metrology, nanoscale sensing, and emerging quantum technologies. In these systems, the interaction between an optical cavity field and a mechanical oscillator enables the transduction of minute mechanical motion into measurable optical signals. Despite remarkable experimental and theoretical progress, the ultimate sensitivity of optomechanical measurements is fundamentally constrained by quantum measurement noise. Overcoming the Standard Quantum Limit (SQL) represents a long-standing challenge in precision measurement and has motivated extensive research into finding effective strategies. In this thesis, we have come up with a set of experimentally feasible schemes to beat the SQL. Our schemes are primarily based on the so-called coherent quantum noise cancellation technique. The main contributions of this thesis lie in demonstrating that coherent quantum noise cancellation can be systematically realized across a broad class of hybrid optomechanical systems, leading to complete elimination of radiation-pressure back-action and force sensitivities beyond the Standard Quantum Limit.