

Squeezed Light in Fibered Optomechanical Cavities

Amin Lakhali,^{1,*} Pierre-Edouard Jacquet,¹ and Pierre-François Cohadon¹

¹Laboratoire Kastler Brossel, 75005 Paris, France

Interferometric measurements of mechanical displacements are nowadays limited by quantum noises in both tabletop optomechanics experiments and gravitational interferometers : quantum shot noise (QSN) related to the laser's phase noise and quantum back action (QBA) arising from the mechanical response to fluctuating radiation pressure. Together, they enforce the Standard Quantum Limit (SQL) — the ultimate noise floor for displacement measurements with a coherent laser field. Our project targets broadband subSQL displacement spectra at cryogenic temperatures of a ng-scale SiN membrane, by injecting squeezed light into a fiber-based cavity hosting a membrane at the edge (MATE). This light source must feature a frequency-dependent squeezing angle to minimize QSN outside the resonator's bandwidth while simultaneously reducing QBA at resonance. A filter cavity placed after the optical parametric oscillator generating bright squeezing uses its phase response to induce that frequency-dependent angle.

Progress has also been made in the quantum engineering of the optomechanical system. Optical fiber end facets are shaped and, once coated with high-reflectivity dielectric layers, assembled into a fully fiber-based cavity . A membrane will be mounted and thermally anchored at cryogenic temperatures by placing the cavity inside a cryostat. The constituent fibers of the cavity will be spliced in-situ to external fibers, connecting the system to the homodyne detection probing the displacement and to the squeezed-light source.

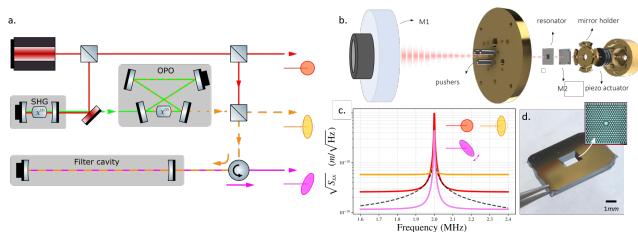


FIG. 1. a) Optical setup. b) MATE system diagram where all elements have been designed to be fixed to the cold plate of a cryostat. c) Theoretical displacement noises of a 10ng membrane for sensitive experimental parameters i.e. 1mW of IR light, 6dB of squeezing, $T = 10\text{mK}$, $Q = 10^6$ and $\mathcal{F} = 20000$. d) 1mm² square membrane.

* amin.lakhali@lkb.upmc.fr