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Mechanical Oscillators in Non-Equilibrium Thermodynamics (MONET)

To reach higher sensitivities in the frequency band below 10 Hz in third generation terrestrial gravitational wave detectors, such as the Einstein Telescope, the individual noise sources must be addressed and their impact on the system reduced. One of these noise sources is thermal noise, to be addressed through operating ET at cryogenic temperatures.

The cooling of the detector will introduce a temperature gradient along the suspensions at which the optical components are located. It is crucial to understand and characterise any effect of this thermal gradient onto heat dissipation and therefore the mechanical behavior of the suspensions. This behavior is complex, and current models, based on the fluctuation-dissipation theorem, do not capture all aspects of it creating the need for experimental work toward understand these effects.

The "Mechanical Oscillators in Non-Equilibrium Thermodynamics (MONET)" project aims to investigate, define and quantify the changes in mechanical properties of a suspension when a temperature gradient is introduced to a system along the suspension. To explore this, we use an experimental setup, where a mirror is suspended on thin wires, along which we create a temperature gradient of up to 60 K. To monitor the changes to the mechanical properties of the suspension, we used a high dynamic range interferometer, based on homodyne quadrature interferometry.

In this contribution, we will present the results of the experimental work, its conclusions and limitations, outlining the next steps towards better understanding of thermal noise is such systems, and through this reaching higher sensitivities in cryogenic detectors.

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