Contribution ID: **30** Type: **poster**

Optomechanical cavity methods to measure mechanical and optical coating losses in cryogenic conditions

One of the most critical components of gravitational wave interferometers is their mirror test masses, as coating thermal noise is a primary limiting factor in the 20–2000 Hz frequency range. For this reason, one of the two nested interferometers composing the Einstein Telescope (ET-LF) is designed to operate at cryogenic temperatures. However, characterizing both mechanical and optical losses in mirror coatings under realistic conditions is challenging, especially at cryogenic temperatures, when thermo-elastic interactions between the coating and the substrate makes very hard to use standard characterization methods based on the measurements of mechanical Q factors of substrates coated with the materials to be characterized.

To overcome these limitations, we are developing a novel experimental setup to probe both optical losses and mechanical dissipation using freestanding coating membranes across a broad temperature range. Suspending the coating as a thin membrane strongly suppresses substrate–coating coupling, enabling direct and precise evaluation of the coating's properties from room temperature down to a few kelvins.

The experimental apparatus features a low-vibration cryostat housing a high finesse optical cavity and piezo actuators for precise membrane positioning and alignment. The measurement consists in placing the membrane inside the resonator so that it couples with the stationary electromagnetic field circulating inside the cavity. The optical losses are determined by monitoring the finesse of the Fabry-Perot cavity as a function of membrane position along the optical axis. The mechanical dissipations are instead measured using the cavity as a sensitive transducer of the membrane vibration spectrum, with dissipation values extracted through a dedicated data analysis procedure.

Preliminary tests on low-stress silicon nitride (SiN) membranes confirm the functionality of the setup. To test sensitivity and expand the range of testable materials, we have also begun the fabrication process of our own SiN membranes, and we are preparing to test coatings with lower optical absorption than SiN. These developments will help in optimizing the apparatus and expanding instrumentation to enable more comprehensive studies.

Authors: SKLIAROVA, Hanna (University of Padova - Department of Physics and Astronomy & Istituto Nazionale di Fisica Nucleare - Sezione di Padova); ZENDRI, Jean-Pierre (Istituto Nazionale di Fisica Nucleare - Sezione di Padova); CONTI, Livia (Istituto Nazionale di Fisica Nucleare, Sezione di Padova); BAZZAN, Marco; BUSDON, Nicole; MARCHETTI, Simone; MILOTTI, Valeria (University of Padova - Department of Physics and Astronomy & Istituto Nazionale di Fisica Nucleare - Sezione di Padova)

Presenter: BUSDON, Nicole

Session Classification: Poster Session

Track Classification: ISB: Optics