Thermal noise in Gravitational Wave mirror coatings: relaxations in SiO2 and Ta2O5 films.

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Abstract

The direct detection of Gravitational Waves has been one of the main discoveries of the century: it finally proved the correctness of the General Relativity and it opened a completely new way to observe the Universe. The main limitation to the detector future developments is given by the thermal noise generated inside the coatings deposited on the optical cavities mirrors of the interferometers.
Such coatings are Bragg reflectors made of glasses with two different refractive indices: SiO2 and Ta2O5. These materials have been selected and optimized for the current detectors considering the optical and mechanical properties. Thermal noise of these materials changes with deposition parameters, annealing or mixing with other oxides and there is no explanation of these behaviours. To understand the origin of thermal noise in glass films a specific investigation has started and developed in collaboration between the vibrational spectroscopy group Soprano at the ILM and the laboratory LMA that delivered the mirrors for all the GW detectors.
In this presentation preliminary results on the correlation between structural properties and thermal noise will be given for the two materials SiO2 and Ta2O5. In particular it will be shown how and why the noise in silica are correlated with the population of the 3-member rings associated with the D2 Raman line and how, in opposite, the tantala structure does not evolve significantly until the onset of crystallization making this glass the true limiting material in the GW detection.

Keywords: Relaxations, thermal noise, gravitational waves, films, internal friction, Raman

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