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Modelling Newtonian noise of acoustic origin in the caverns of the ET gravitational wave detector

Among the noises affecting GW detectors, Newtonian noise of seismic or acoustic origin could limit sensitivity at low frequencies, below a few tens of Hz. This presentation focuses on modeling Newtonian noise of acoustic origin, resulting from technical noises in caverns and experimental halls. A significant contribution to this technical noise is specifically linked to the operation of the air conditioning system (HVAC), which is essential to ensure the thermal stability and cleanliness of these rooms. The acoustic pressure present in the environment is responsible for small fluctuations in density. The fluctuating gravitational field that is induced directly causes random forces on sensitive optical elements, such as the interferometer's test masses. Acoustic Newtonian Noise is quantified using a numerical model of the acoustic field in an arm-end cavern. This model describes the modal response of the room under the effect of acoustic sources equivalent to the vents of the ventilation system, which allows the calculation of Newtonian noise based on equipment parameters (rotation speed, vent position). The criticality of this noise source for the detector is demonstated, given the sensitivity targeted by ET in the low frequency range. Possible solutions for reducing Newtonian acoustic noise (room geometry, tower position, position of HVAC system inlets and outlets) are discussed based on the proposed physical model.

Author: GAUTIER, François (Laboratoire d'Acoustique de l'Université du Mans, UMR CNRS 6613)

Co-authors: MAURIN, Lionel; BARSUGLIA, Matteo; TERRIEN, Soizic (LAUM)

Presenter: GAUTIER, François (Laboratoire d'Acoustique de l'Université du Mans, UMR CNRS 6613)

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