Experimental validation of LISA interferometric performances

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Abstract

The Laser Interferometer Space Antenna (LISA) is a space-based mission to detect low frequency gravitational waves. These signals are produced by various events like inspiralling supermassives black holes binaries. Gravitational waves are very small variations of space-time metric which can be detected with high precision laser interferometry. The LISA method consist of measuring distance fluctuations between free-falling test masses.

As with any detector, signal to noise ratio has to be optimised. In actual ground-based interferometers like LIGO/VIRGO experiment, sensitivity is limited by sismic and quantum noises. In the LISA case, the raw measurements are burried within the laser frequency noise Acutally, due to the LISA constellation geometry, the phase fluctuations due to the laser instabilities dominate by 8 orders of magnitude the gravitational wave signal.
A noise reduction method named Time Delay Interferometry (TDI) was developped in the 90's to remove in post-processing the laser frequency noise of future LISA data. This algorithm is crucial for the success of the LISA mission and needs to be tested with simulated data before launch.
For several years and with the support of CNES, an electro-optical bench for metrological demonstration named LOT (for "LISA On Table") has been set up at APC. The objective of this bench is to demonstrate experimentally several aspects of TDI, characterize its frequency response and assess the noise residuals.

The main goal of my thesis is to validate experimentally key aspects of LISA noise reduction techniques by improving the LOT test bench to be compliant with the latest developments of TDI.

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