ID de Contribution: **11** Type: **Non spécifié**

Reduction of flexing-filtering noise in TDI

mardi 10 juin 2025 15:00 (20 minutes)

In early 2024, ESA formally adopted the Laser Interferometer Space Antenna (LISA) space mission – with the aim of measuring gravitational waves emitted in the millihertz range. The constellation employs three spacecrafts that exchange laser beams to make interferometric measurements over a distance of 2.5 million kms. The measurements will then telemetered down to Earth at a lower sampling frequency. Anti-aliasing filters will be used on board to limit spectral folding of out-of-band laser noise. The primary noise concern in these measurements is laser frequency noise, caused by the variability in the arm-length of the constellation via the disproportionate movement of the spacecrafts and the Doppler effect. Minimization of this noise requires virtual time-shifting of the data using delay operators to build a beam path that simulates equal-arm interferometers. The non-commutativity of these delay operators and on-board filters manifests as a noise (flexing-filtering) that significantly contributes to the noise budget. This non-commutativity is a consequence of the non-flatness of the filter in-band. Attenuation of this noise requires high-order and computationally expensive filters, putting additional demands on the spacecraft.

My presentation will explore an alternative method to reduce this flexing filtering noise via the introduction of a modified delay operator – accounting for the non-commutativity with the filter in the delay operation itself. This approach allows us to reduce the flexing-filtering noise by over three orders of magnitude whilst reducing the dependency on the flatness of the filter. The work is supplemented by numerical simulations of the data processing chain that compare the results with those of the standard approach

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Classification de Session: Contributions (15’ + 5’ de questions)