Time-delay interferometry for space-based gravitational wave detectors

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ABSTRACT

A generalization of the previously treated time-delay gravitational wave interferometry [1, 2] with three spacecraft is presented. In our previous work the three spacecraft were each idealized as moving almost inertially, and each rigidly carrying a laser, beam splitters and analyzer photo detectors. Each spacecraft was capable of transmitting laser signals to the other two and, using its laser as a local oscillator, measures the frequencies of the laser beams received from the other two. In references [1,2] we presented and analyzed time-delay combinations of these data streams that eliminated the laser frequency fluctuations, while retaining the gravitational wave signal.

In this work we extend those results by presenting time-delay equations for data from actual drag-free configuration envisaged for the LISA mission. We show that there exist suitable linear combinations of the set of data measured onboard the three spacecraft (twelve data streams in total) which recover all the results of reference [2]. Now not only the phase noise of the six lasers is removed, but also the non-inertial motions of the spacecraft is eliminated.

It is noteworthy that adjacent optical benches need not be rigidly connected and that no phase locking of their lasers [3] is required.

Reference

[1] Tinto, M., & Armstrong, J.W. 1999, Phys. Rev. D., 59, 102003
[2] Armstrong, J.W., Estabrook, F.B., & Tinto, M. 1999, Ap.J., 527, 814
[3] Peterseim, M., Robertson, D.I., Danzman, K., Welling, H., & Bender, P. 1999, *LISA interferometer Sensitivity to Spacecraft Motion.*