Spacecraft Doppler Tracking as a Narrow-Band Detector of Gravitational Waves

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Abstract

We discuss spacecraft Doppler tracking for detecting gravitational waves in which Doppler data recorded on the ground are linearly combined with Doppler measurements made on board a spacecraft. By using the four-link radio system first proposed by Vessot and Levine [1], we derive a new method for removing from the combined data the frequency fluctuations due to the Earth troposphere, *ionosphere,* and mechanical vibrations of the antenna on the ground. This method also reduces the frequency fluctuations of the clock on board the spacecraft by several orders of magnitude at selected Fourier components, making Doppler tracking a narrow-band detector of gravitational radiation [2]. In the assumption of calibrating the frequency fluctuations induced by the interplanetary plasma, a strain sensitivity equal to 4.7×10^{-18} at 10^{-3} Hz is estimated.

The experimental technique presented in this paper could be extended to other tests of the theory of relativity, to radio science experiments that rely on high-precision Doppler measurements, and to a configuration with two spacecraft tracking each other through a microwave or a laser link.

[1] R.F. C. Vessot and M.W. Levine, *Gen. Relativ. Gravit.* 10, 1S1 (1979).
[2] M. Tinto, *Phys. Rev. D*, 53, 5354 (1996)

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