CANCELLATION OF LASER NOISE IN SPACE-BASED INTERFEROMETER DETECTORS OF GRAVITATIONAL RADIATION

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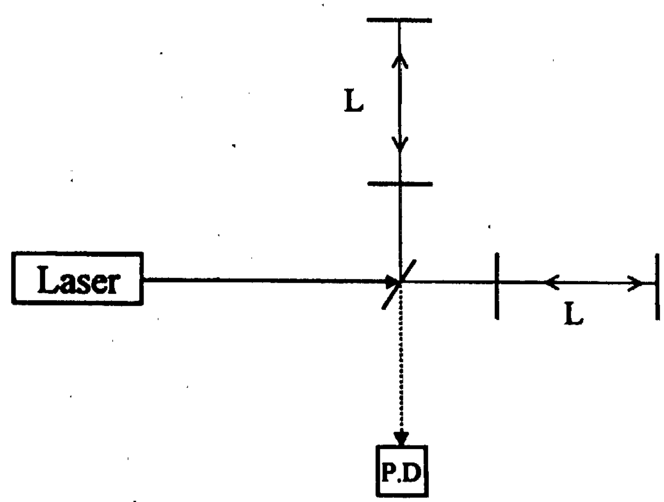
STATEMENT OF THE PROBLEM

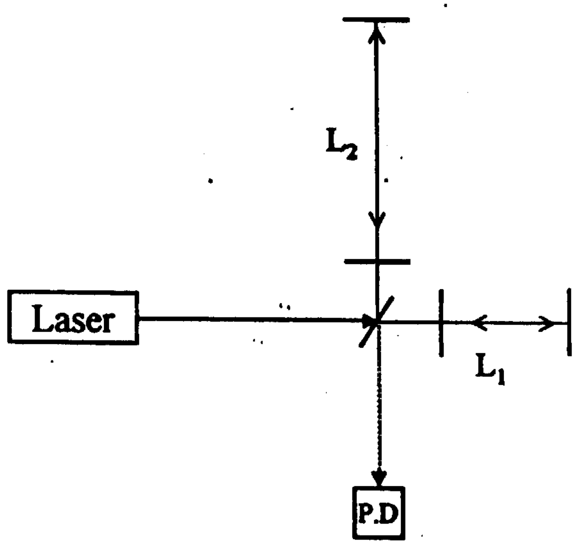
- In an equal-arms interferometer, the frequency fluctuations of the laser are delayed by the same amount of time in the two equal-arms, and therefore they cancel-out at the photo detector.

- In an unequal-arms interferometer instead, the jitters from the laser are delayed by a different amount of time in the two arms, and they do not cancel out at the phase detector.

(**M.Tinto & J.W. Armstrong,** *Phys. Rev. D*: submitted for publication.)

STATEMENT OF THE PROBLEM (Cont.)





$$C(t - 2L_1) - C(t - 2L_2) \simeq 2\dot{C}(t - 2L_1)\epsilon L_1$$

THE TIME-DOMAIN TECHNIQUE

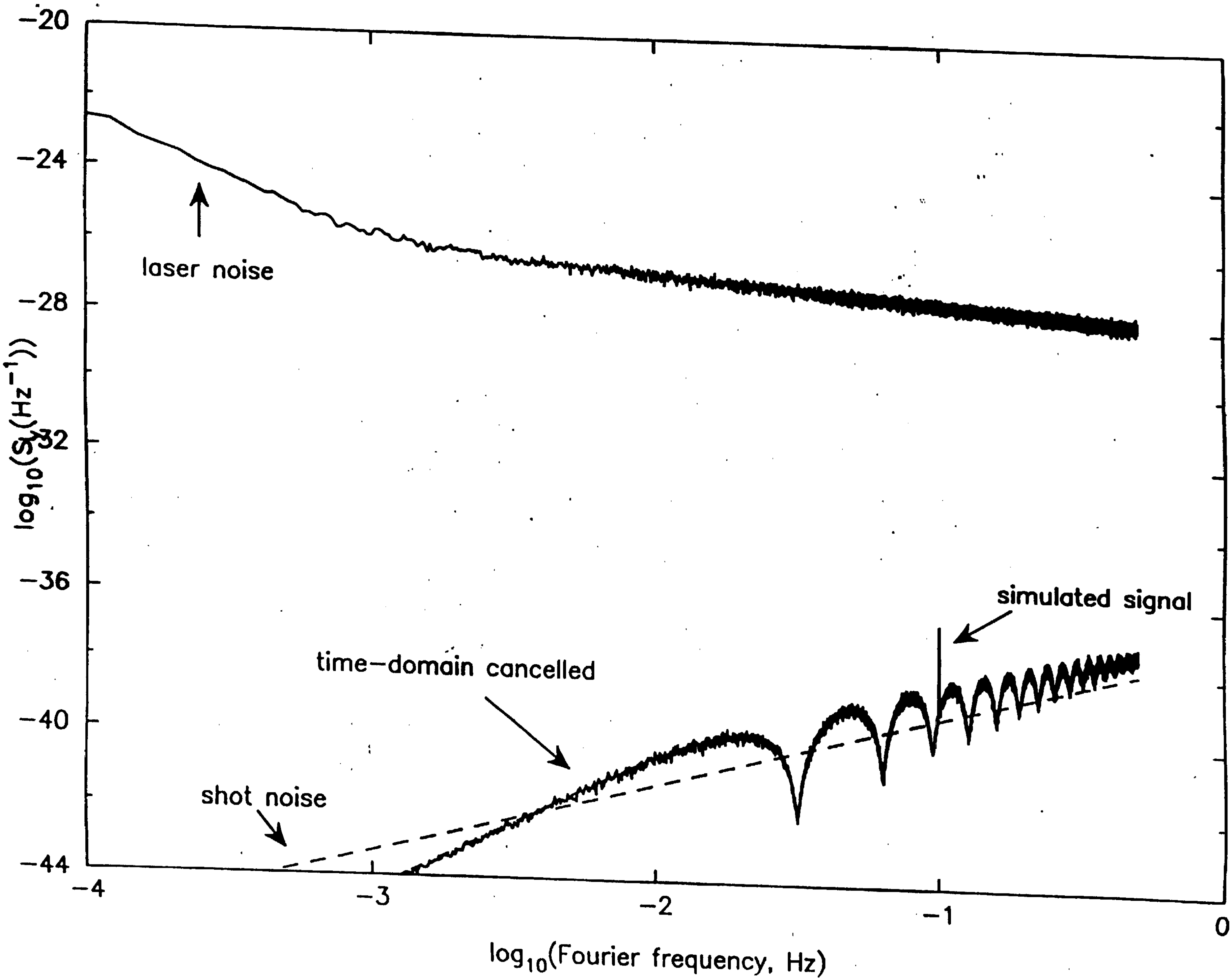
$$\left(\frac{\Delta\nu(t)}{\nu_0}\right)_1 \equiv y_1(t) = h_1(t) + C(t - 2L_1(t)) \; - \; C(t) \; + \; n_1(t)$$

$$\left(\frac{\Delta\nu(t)}{\nu_0}\right)_2 \equiv y_2(t) = h_2(t) + C(t - 2L_2(t)) \; - \; C(t) \; + \; n_2(t)$$

$$\begin{aligned} \Lambda_1(t) \equiv y_1(t) - y_2(t) &= h_1(t) - h_2(t) + C(t - 2L_1) - C(t - 2L_2) \\ &+ n_1(t) - n_2(t) \, . \end{aligned}$$

$$\begin{aligned} \Lambda_2(t) \equiv y_1(t - 2L_2) - y_2(t - 2L_1) &= h_1(t - 2L_2) - h_2(t - 2L_1) + C(t - 2L_1) \\ &- C(t - 2L_2) + n_1(t - 2L_2) - n_2(t - 2L_1) \end{aligned}$$

$$\begin{aligned} \Sigma(t) \equiv \Lambda_2(t) - \Lambda_1(t) &= h_1(t - 2L_2) - h_1(t) - h_2(t - 2L_1) + h_2(t) \\ &+ n_1(t - 2L_2) - n_1(t) - n_2(t - 2L_1) + n_2(t) \end{aligned}$$


laser noise
simulated signal
time−domain cancelled
shot noise
log10(Fourier frequency, Hz)
log10(Sy(Hz−1))
−20
−24
−28
−32
−36
−40
−44
−4
−3
−2
−1
0

CONCLUSIONS

- We presented a time-domain procedure for accurately cancelling laser noise fluctuations in an unequal-arm Michelson interferometer. The method involves separately measuring the phase of the returning light relative to the phase of the transmitted light in each arm. By suitable offsetting and differencing of these two time series, the common laser noise is cancelled exactly
- The technique presented in this paper is general, in such that it can be implemented with any (Earth as well as space-based) unequal-arms Michelson interferometers.