The performance of the data processing

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Abstract

The signal of interest in the MICROSCOPE space mission is the difference of the accelerations of two test-masses made with different materials. These accelerations are measured by an ultra-sensitive electrostatic accelerometer onboard a micro-satellite equipped with a drag-free system. The challenge of the data processing is to find a violation signal around a well-dened frequency in data samples disrupted by deterministic perturbations and colored noise. To achieve this objective, we perform a regression analysis to estimate the WEP violation as well as instrument parameters. A long integration period corresponding to several orbits is needed to reach a sucient signal-to-noise ratio. However, in flight, the measurement may suffer from numerous interruptions due to various causes: saturation events due to crackles of the thrusters tank or the multilayer insulation coating, micrometeorite impacts, and telemetry losses. We investigate the effect of these gaps on the performance of the WEP test and show that they cause a signicant frequency leakage of the noise power. We present a regression method which cancels this effect and enables us to estimate the parameters of interest with a precision comparable to the complete data case, even if the noise power spectral density is not known a priori. The method is based on an autoregressive fit of the noise, which allows us to build a general least squares estimator approaching the minimal variance bound. We apply this method to simulated measurements of the instrument in orbit, and show that it increases the precision by a factor 60 with respect to ordinary least squares estimators. This analysis validates the integration times, the mission scenario and the processing tools to be implemented in the Scientic Mission Center. In addition, the outputs of the algorithm are used to faithfully reconstruct the signal in the missing intervals.

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