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The Free-fall Experiment Results: measuring subfemto-g acceleration noise in LISA Pathfinder and fN force variations on ground with torsion pendulum, in intermittent control mode

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The relative acceleration between two test masses free falling in orbit is perturbed by the presence of a larger constant relative acceleration that must be actively compensated in order to keep the test bodies centered inside the orbiting apparatus. The actuation force applied to compensate this effect can be applied continuously or can be limited to brief impulses, with test masses in a parabolic free fall in between two “kicks”. The actuation-free motion is then analyzed for the remaining sources of acceleration noise.

We report on the implementation and results of the on-board free-fall experiment that allows to test a LISA-like actuation configuration, free from the actuator noise and its force calibration, achieving the measurement of the residual acceleration at the subfemto-g level. The challenging data analysis method of the experiment and its reliability have been also tested with an on-ground torsion pendulum test bench, measuring fN force variation at level nearing the subfemto-g/Hz^{1/2} performance required for LISA Pathfinder.

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