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THE METHOD AND RESULT OF THE CENTER OF MASS CALIBRATION OF "TAIJI-1" DURING ITS EXTENDED TASKS

Abstract

"Taiji-1"is China's first in-orbit technology validating project related to spaceborne gravitational wave (GW) detection, it is the first step of the "three-step plan" launching the final "Taiji" at 2030s. The satellite was launched at a 600km sun synchronized orbit on Aug.31st in 2019. It has accomplished all its initial missions, including the validation of the optical metrology system (OMS), gravitational reference sensor (GRS), single degree of drag-free control (DFC), thermal control subsystem, high-quality microgravity satellite platform and so on. The test mass (TM) of GRS is made of titanium alloy and with size 40mm40mm10mm. The designed measurement resolution of X axis direction is about 310-8m/s2/Hz1/2, and the Y and Z axes resolution are 310-9 m/s2/Hz1/2. The satellite is ground orientation in normal mode, and the +X axis of the TM is parallel with the -Zb axis of the body frame. The GRS, gyroscope and star tracker are the core sensors to calibrate the center of mass (CoM). Before the experiment, the satellite attitude is controlled to zero in the LVLH coordinate around the magnetic equator, and then all the actors are shut down. In the next 200 seconds, the satellite is slowly rotated by the earth magnetic force, the gyroscope and star tracker will measure the angular velocity and Euler angle of the satellite in time, repeat this process several times aroud the ascending and descending magnetic equator. After that, extracting the Euler angle and angular velocity from the star tracker and gyroscope respectively, receiving the effective signal after outlier removal, deviation correction, interpolation and down sampling filtering, a second-order polynomial fitting method is adopted to get the angular accelerations from the gyroscope measurement. The relationship between the change of the measurement of GRS and the attitude maneuver is obtained by the acceleration model, and finally a minimal variance estimator is adopted to estimate the deviation of the CoM. The experiment results show that the best calibration accuracy of rx is 0.02mm, while ry is 0.04mm and rz is 0.23mm. The identification accuracy of rx and ry is betten than that of rz, which is the reason that the noise resolution of GRS's y and z axis is one order better than x axis.