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A GRAVIMETER FOR SOLAR SYSTEM SMALL BODIES IN THE FIRST EUROPEAN SPACE AGENCY PLANETARY DEFENCE MISSION

Abstract

The measurement of the gravitational field, together with the measurement of the magnetic field, allows planetary scientists to make a first model of the internal composition of a body in the Solar System. That is why the proposal from the Royal Observatory of Belgium and the Spanish company Embedded Instruments and Systems was very well received to participate in the European Space Agency's first planetary defence mission to the moon of the asteroid Didymos (recently christened Dimorphos) onboard GomSpace Juventas Cubesat, bound to land on it after being released by the Hera spacecraft. However, the characteristics of the mission, the available space, mass and power budgets, and the low gravitational accelerations to be measured (Dimorphos gravity field amounts to 3.6mgal, or expressed in the mks system of units to $36\mu\text{m}\cdot s^{-2}$) requires a new gravimeter concept, the engineering model of which has passed qualification tests.

The gravimeter consists of a flexible copper beryllium metal sheet, fixed at one end and weighed down by a cylindrical mass at the other, located inside a rotating piece with electrodes opposing each of its faces. The measurement of the differential capacity as the whole piece rotates, and the sheet bends, provides a direct estimation of the gravity while eliminating offset effects. Statistical processing combining multiple capacity samples and the angular position of the rotating piece removes other artefacts and provides valuable scientific measurements.

The paper will describe the design of the sensing element by using the Fenix finite elements software to produce a capacitance variation conditioned by electronics amplifiers with enough signal to noise ratio to provide the required accuracy. The final instrument fits within less than 1U of GomSpace's Juventas Cubesat and measures gravitational fields up to 5mgal with a resolution of 1% by resolving capacitance variations of less that 80aF ($10^{-18} Farads$).