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THERMAL DESIGN OF CASSTOR, A NANOSATELLITE FOR HIGH-RESOLUTION UV SPECTROPOLARIMETRY

Abstract

CASSTOR is a 16U nanosatellite proposed by the Paris Observatory that will serve both as a technological and scientific demonstrator for high-resolution UV spectropolarimetry in space. In particular, it will allow the study of the magnetic field and environment of hot stars. Existing ground-based high-resolution spectropolarimeters only work in the Visible or IR light, as UV light gets absorbed in the Earth's atmosphere. Several space mission projects with UV spectropolarimetry payload onboard are proposed for the coming decades, such as Arago (ESA) and Pollux on LUVOIR (NASA). Therefore, we have been developing and testing the first prototypes of UV spectropolarimeters, and will test one of them onboard CASSTOR. This project is funded by CNES and CASSTOR is currently in phase 0/A. It is planned to be launched in 2026.

In this paper, the thermal design and simulation results of CASSTOR are discussed. Thermal management plays an important role for the success of the mission. The aim of the thermal design is to keep the temperature of the CMOS detector under 260K, and maintain the temperature stable. It is critical as the dark current is highly affected by temperature. Moreover, thermal elasticity has an impact on the optics, and especially on the objective mirror, which impacts the stability of the spectrum on the CMOS detector. This spectrum stability is required at sub-pixel level during a spectropolarimetric measurement.

For the passive thermal design, a radiator, thermal strap, and outside coatings were studied. The radiator is attached on the side of the nanosatellite pointing at the star as it has the smallest view factor from both the Earth and Sun. Furthermore, outside coatings are chosen according to the orbits to achieve the desired performance. In the simulation, the solar flux, albedo, Earth infrared, and internal heat were considered as input heat sources, while radiation to outer space is considered as output as a thermal environment. In addition, SSO 6:00 and SSO 10:30 orbits are compared.

Our results show that it is possible to maintain the detector temperature below 260K by selecting the appropriate multi layered insulation (MLI).For thermal stability, SSO 6:00 is much preferred as it keeps the stability of approximately 0 degree for one orbit, and about 4 degrees for a year as heat input is constant throughout the observations. SSO 10:30 and 13:30 have about 8 degrees per orbit and approximately 11 degrees for a year due to eclipses.