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SYMPOSIUM ON FUTURE SPACE ASTRONOMY AND SOLAR-SYSTEM SCIENCE MISSIONS (A7)
Science Goals and Drivers for Future Exoplanet, Space Astronomy, Physics, and Outer Solar System Science Missions (2)

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MISSION AND SYSTEM DESIGN CHALLENGES OF ESA'S TURBULENCE HEATING OBSERVER (THOR) SCIENCE MISSION

Abstract

Energetic, hot plasmas in different states of turbulence are omnipresent throughout the universe and make up most of the observable matter. In fact, plasmas are considered the main origin of electromagnetic radiation, such as X-rays or visible light, which are emitted by stellar objects such as stars. Despite the cosmic omnipresence of plasmas, many of the underlying mechanisms are still poorly understood. Two of the most important outstanding areas of fundamental plasma physics are turbulent energy dissipation and particle energization. To advance our knowledge of these processes, *in-situ* measurements would be game-changing. Therefore, the Turbulence Heating Observer (THOR) is being proposed as a candidate for ESA's fourth medium-class science mission (M4) in scope of the Cosmic Vision 2015-2025 programme. THOR would be the first mission ever dedicated to measuring plasma turbulence in the actual space environment, and would do so with an instrument suite with the highest resolution ever flown.

The scientific objectives of THOR have been flown down to mission requirements that lead to unusual technical challenges. This paper will outline the resulting mission- and spacecraft-design drivers. The three most important drivers are: i) the requirement to access three "Top Priority Regions (TPR)" for extended periods of time in different regimes of the plasma environment, ranging from 15 Earth radii to 45 Earth radii altitude; ii) the need for a Sun-pointing spin-stabilized spacecraft as required by several of the ten payloads; and iii) the Electromagnetic Cleanliness (EMC) to achieve the measurement performances for particles, electric fields, and magnetic fields. This combination of drivers is unique to THOR. For instance, the need to access different TPRs requires large orbital changes and necessitates a bi-propellant system. However, such a system has not been used on a spin-stabilized satellite with similar requirements yet. Moreover, THOR will be equipped with fifty-meter long wire-booms, leading to an overall span width of more than 100 m that complicates the attitude dynamics and slewing strategy.

This paper will present technical concepts to address these challenges, which have been elaborated by OHB System and its industrial partners Thales Alenia Space, SENER, and OHB Sweden in a Phase A study. THOR is currently undergoing the mission selection review in competition with two other M4 candidates. If selected, the mission is planned for launch in June 2026.