17 - Small Satellites for Aerodynamics

Current orbital trajectory simulations for satellites in low earth orbit (LEO) suffer from significant uncertainties in their atmospheric drag modelling methods. This is due to a lack of understanding on how air particles collide with spacecraft surfaces, especially at altitudes where helium concentrations become significant. Uncertainty in these gas-surface interactions (GSI) leads to a need for high safety margins in collision probability estimations, resulting in a large number of collision warnings in densely populated orbits. As the mitigation procedure for these warnings is costly both in time and resources, there is a need for increased accuracy measurements of the atmospheric composition at an altitude range between 150 and 600km and, more importantly, how this impacts the modelling of atmospheric drag.

Mission Objective

Project "Surface-gas Collision with Aerodynamic Twins for Thermospheric Experimental Research" (SCATTER) is the proposed mission to address the need outlined above. The main objective of this mission is to measure the difference in drag coefficient between two satellites with different frontal surface areas. This difference must be sensitive to chemical composition and temperature, as this will reveal the nature of the GSI which are present at various orbital altitudes. Throughout the mission, temperature and particle number density will also be measured to verify current atmospheric models, such as NRL-MSISE00. The launch date of the mission shall be on January 1st, 2035 at the latest, with a development and production cost of at most €10M. Furthermore, the designs shall comply with the latest sustainability regulations by using sustainable propellants, non-radioactive materials, and complete burn-up upon re-entry.

System Design

The design of project SCATTER consists of two CubeSAT spacecraft flying in close proximity at orbital altitudes ranging from 600 km until re-entry. Both spacecraft contain a payload of a mass spectrometer, an accelerometer and a GNSS receiver, which allows for accurate measurements of atmospheric composition and the kinematic features of the spacecraft themselves. To ensure that the satellite's drag properties are sensitive to GSI parameters, the team considered the aerodynamic features of a wide range of satellite shapes. Through a detailed trade-off process, a 12U CubeSAT body with four shallow deploying panels was selected. Communications with a ground station will be done using an S-band transceiver so that scientific measurements can be done with a frequency of at least 0.1Hz. Finally, to regulate the lifetime of the mission and to guarantee a means for collision avoidance, two mono-propellant thrusters were included in each satellite design. At the moment of writing, the team is currently in the final iteration of the detailed design. The internal layout of the subsystems has been carefully selected to maximize the available internal space. Furthermore, detailed electrical, data handling and mechanical integration is taking place, resulting in an assembled system design. In the next couple of weeks of the project, the group will focus on the manufacturing and operational aspects of the mission, including production plans and an outline of the steps which need to be taken should the project be continued after the Design Synthesis Exercise. Following from this, the results will be documented in the final report in preparation for the the final review and the symposium.