University of Stuttgart
Institute of Space Systems

Flow Field Analysis for Characterizing the Aerodynamics of Novel Rocket Upper Stage Recovery Concepts

Master Thesis Opportunity

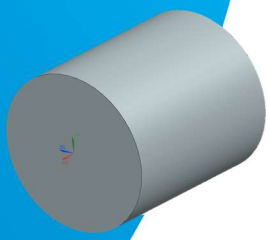
Background:
The sustainability of spaceflight is a growing concern, and novel concepts for the recovery of rocket upper stages are being developed to enable their reuse or recycling. These innovative designs aim to reduce space debris and enhance the efficiency of launch systems. Existing analytical methods to assess aerodynamics of blunt bodies in an early project phase have good comparison with traditional re-entry capsules, but come to their limits for stability assessment, and aerodynamics of deviating geometries. To better understand their aerodynamic behaviour, detailed flow field analyses are required, particularly in the transition regime and hypersonic flight conditions.

Objective:
This Master's thesis focuses on the aerodynamic characterization of various recovery concepts for rocket upper stages for selected trajectory points. The study will involve:

- **Transition Flow Analysis:** Using Particle-in-Cell (PIC) method solver to study the aerodynamic properties of different geometries in the transition regime.
- **Hypersonic Flow Analysis:** Using Bhatnagar-Gross-Krook (BGK) model tools to analyse the aerodynamic behaviour of these geometries in the hypersonic regime at continuum flow.
- **Comparative Assessment:** Evaluating how different designs perform in terms of stability, drag, lift, and other aerodynamic parameters.

Scope of Work:

- Literature review on numerical assessment of aerodynamic properties and re-entry physics.
- Familiarisation with the IRS simulation code PICLas
- Computational simulation of flow fields in the transition/continuum regime
- Interpretation of results and recommendations for design improvements



The thesis aims to provide valuable insights into the aerodynamic characteristics of novel upper-stage recovery concepts, contributing to the advancement of sustainable spaceflight technologies.

Start at any time, by arrangement.

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