Scientific Assistant (HiWi)

Support for magnetohydrodynamic (MHD) numerical simulations and documentation within the EU project MEESST

Motivation:
The goal of the EU project MEESST (Magnetohydrodynamic Enhanced Entry System for Space Transportation, https://meesst.eu) is to exploit MHD effects using a first demonstrator of an active magnetic shielding device, by means of both experiments and numerical simulations. This demonstrator is based on a superconductive coil system and is currently under development within MEESST. When a spacecraft enters the Earth’s atmosphere on a hyperbolic trajectory, the air flowing around the spacecraft is ionized due to friction and creates a plasma sheath on the surface. Moreover, the spacecraft travels at hypersonic speeds such that a plasma shock is formed. This subjects the spacecraft to high heat flux loads that need to be mitigated. Since the particles in a plasma are negatively and positively charged, the flux can be controlled by an adequately strong magnetic field. The goal is to use superconductive coils in order to increase the shock standoff distance and to respectively decrease the heat flux loads. Powerful numerical tools are required to simulate such a complex phenomenon, which includes aerodynamics, electromagnetism and thermochemical non-equilibrium. The numerical codes will support the design of the magnetic shielding device providing predictions of the behavior of the plasma around the spacecraft. Different codes from different institutions will be used within the MEESST consortium. The actual capabilities of the IRS in-house C++ code SAMSA will be assessed via verification activities against previously performed Argon test cases. Then, it will be extended in order to simulate the air plasma chemistry and the implemented model will be verified against the experimental activities as well as the other simulations performed within the consortium. The candidate has to support the documentation in English and the rebuild of relevant test cases. This includes both pre-processing and post-processing of the simulations. Possibly but not necessarily the activity can lead to a Master Thesis as well as a respective doctoral thesis.

Description of the tasks of the research work:

- Introduction to SAMSA and documentation in English;
- Literature review of simplified MHD test cases and of air plasma thermo-chemical models;
- Pre-processing of simulations:
  - Rebuilding of coil configurations to match the required magnetic field (software FEMM)
- Post-processing of simulations:
  - Heat flux calculations
  - Comparison plots

Notes:

- Contract for at least 30 hours a month, starting as soon as possible
- Good knowledge of English is required, experience with coding is recommended

My contact (please write in English):

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