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ONERA
THE FRENCH AEROSPACE LAB

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PROPOSITION DE STAGE EN COURS D'ETUDES

Référence : **DPHY-2025-24**
(à rappeler dans toute correspondance)

Lieu : Palaiseau

Département/Dir./Serv. : DPHY/FPA

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Responsable(s) du stage : Benjamin Khiar

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DESCRIPTION DU STAGE

Thématique(s) : Plasma, magnetohydrodynamics, hypersonics, atmospheric reentry

Type de stage : ☒ Fin d'études bac+5 ☐ Master 2 ☐ Bac+2 à bac+4 ☐ Autres

Intitulé : Magnetohydrodynamic modeling of experiments in hypersonic atmospheric re-entry conditions

Sujet: In the context of atmospheric re-entry, magnetohydrodynamics (MHD) offers promising solutions to challenges such as deceleration, trajectory control, thermal protection of vehicles, and the mitigation of the radio blackout phenomenon. Indeed, in a highly hypersonic regime (v >~ 4 km/s), the air encountered by the re-entering vehicle is naturally ionized by the strong shock created in front of it. The electrical conductivity of this plasma can thus be exploited by applying a magnetic field to modify the flow, and consequently, the aerodynamic forces and thermal fluxes acting on the vehicle.

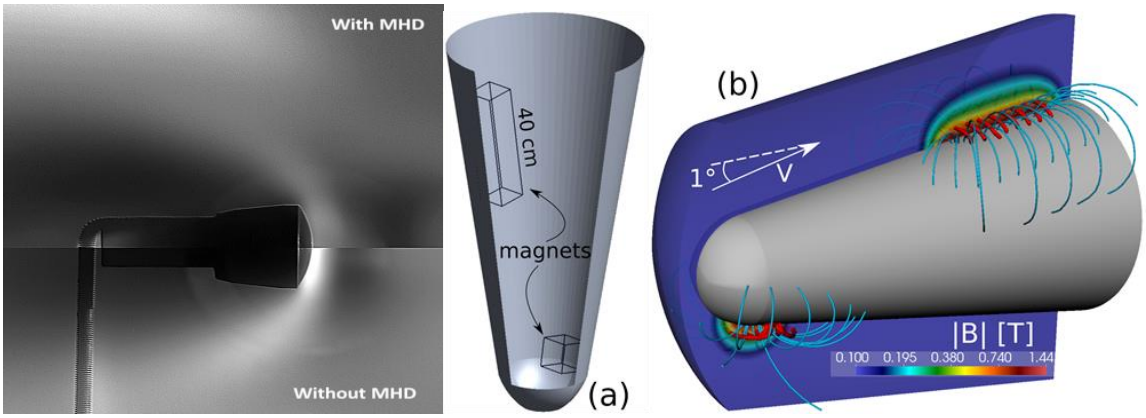

Figure 1 : On the left: Example of an MHD experiment at the ICARE laboratory. On the right: Example of 3D modeling (TARANIS) of a re-entry object assisted by MHD actuators.

ONERA, particularly the FPA team (Lightning, Plasmas, and Applications), has been interested in this topic for several years, notably through the development of numerical modeling tools for MHD. The validation of these tools by comparing them with MHD experiments conducted in wind tunnels or shock tubes is a crucial aspect of this research effort. To this end, we have recently obtained ANR funding (including a future PhD position) aimed at addressing this need through experimental campaigns in facilities that can reproduce hypersonic flows (in collaboration with CNRS/ICARE). The student's work will be part of this project and will consist of:

1. Becoming familiar with the fluid-MHD modeling tools developed at ONERA (CEDRE, TARANIS).
2. Initially modeling "academic" 2D geometries (sphere, cylinder, etc.) under the conditions of the CNRS wind tunnels PHEDRA and MARHY, but without the presence of a magnetic field.
3. Modeling these same configurations, but with the application of a magnetic field.

The goal is to contribute to the design of MHD experiments that will be conducted following the internship, during the PhD. This work will be carried out within the FPA team at the ONERA center in Palaiseau, with possibly a stay at the CNRS ICARE laboratory in Orléans.

Est-il possible d'envisager un travail en binôme ? Non

Méthodes à mettre en oeuvre :

☒ Recherche théorique	☐ Travail de synthèse
☒ Recherche appliquée	☒ Travail de documentation
☐ Recherche expérimentale	☐ Participation à une réalisation

Possibilité de prolongation en thèse : Oui

Durée du stage : Minimum : 4 months Maximum : 6 months

Période souhaitée : Sprint 2024

PROFIL DU STAGIAIRE

Connaissances et niveau requis :	Ecoles ou établissements souhaités :
Plasma physics, fluid mechanics	Master 2 or engineering school