INTERNSHIP PROPOSAL

Internship proposal: yes **PhD thesis proposal:** yes

SUPERVISOR

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PROPOSAL

Title	Numerical study of wave turbulence in partially-magnetized plasmas for electric propulsion

Type of subject	Theory / simulation
Financial support for the internship	Yes
Financial support for the PhD thesis	Yes

SUMMARY

Partially-magnetized plasmas are characterized by electrons that are magnetized whereas the ion Larmor radius remains larger than the typical length of the domain. These plasmas are widely used in technological applications such as Hall thrusters, ion sources for neutral beam injection for fusion, or Penning and magnetron discharges. In these applications, the electric and magnetic fields are mostly perpendicular to each other, hence called ExB configurations, where the electrons form a Hall current in the ExB direction and the ions are mostly accelerated by the electric field.

Partially-magnetized ExB plasmas can host a wide variety of electrostatic instabilities, such as gradient-drift, lower-hybrid, electron cyclotron drift, modified two-stream, etc (See [1, 2] for a recent review). These instabilities can lead to wave turbulence, which modifies the macroscopic properties of the discharge (e.g., the electric current, plasma density, etc). For this reason, a better understanding of the wave turbulence is fundamental for the characterization of ExB plasmas.

This project is developed in the frame of the ERC grant HiMomPlas on the theoretical study of electric propulsion plasmas. In this project, we propose to study wave turbulence transport in plasmas. The goal of the project is to extend a pseudo-spectral solver [3], currently developed at LPP to study turbulence in fusion plasmas. Based on the model proposed by previous works [4, 5], this project aims at analyzing the reasons for the observed tendency of formation of large structures as well as studying the impact of the different discharge parameters (e.g., gradients, boundaries, ions flows, etc). Comparison with kinetic simulations will be done. Similarly, the candidate will assess the impact of the turbulent transport into macroscopic quantities as compared to experiments of electric propulsion thrusters.

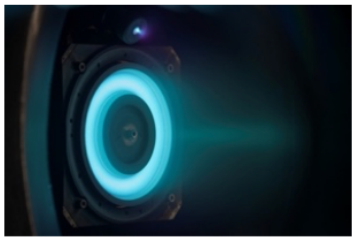

Figure 1: Hall thruster

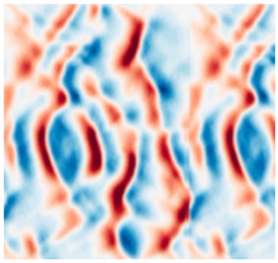

Figure 2: kinetic simulation of the non-linear evolution of the MTSI [1]

[1] Petronio et al. *Phys. Plasmas 30, 012104 (2023)*
[2] Boeuf & Smolyakov. Phys. Plasmas 30, 050901 (2023)
[3] Guillon & Gürcan *Phys. Plasmas* 32, 012306 (2025)
[4] Koshkarov *Phys. Rev. Lett. 122, 185001* (2019)
[5] Smolyakov et al. *Plasma Phys. Control. Fusion* 59 014041 (2017)