# Effect of biasing on plasma equlibrium

## M2 Internship

Laboratoire Plasma et Conversion d'Energie (Laplace)
CNRS - Université Paul Sabatier – Toulouse

**Context –** The ability to control the profile of the plasma potential in the direction perpendicular to the magnetic field in a magnetized plasma opens the way to controlling the cross-field drift. In cylindrical and toroidal devices, this notably opens a way to controlling respectively the azimuthal and poloidal plasma rotation. For these reasons, the question of electric field control in magnetized plasma is of importance both to understand basic physics processes, including rotating instabilities, and for a number of applications, such as magnetic confinement fusion, electric space propulsion and plasma mass separation [1].

One long-proposed option to affect the plasma potential is to use electrically biased electrodes positioned at the edge of the plasma. Although conceptually simple, there are a number of effects which can limit the effectiveness of this control scheme [2]. One key element is the formation of a sheath in front of the biased electrode, which in turn controls the current reaching the biased electrode. Another is the plasma perpendicular conductivity, which sets an upper limit on the perpendicular voltage drop the plasma can support. Simple models have been proposed to capture these effects, with encouraging results, but also clear limitations [3]. Meanwhile, kinetic modelling via particle in cell simulations have confirmed certain trends in particular plasma regimes and plasma configurations [4].

**Objectives –** The goal of this internship is to take advantage of the complementing tools developed at Laplace, namely analytical models and particle in cell codes, to examine the physics of electrode biasing in more detail. The proposed scope of work is to start with a simple academic plasma configuration in which models and simulations can be confronted straightforwardly, before progressively evolving towards more complex configurations. It is indeed expected that the results of this internship will be later continued in the form of a PhD project (ideally as a continuation of this internship), as part of the ANR project Cantaloupe to start in Jan. 2025. An objective of this larger project will be to study biasing with the goal of improving plasma rotation control for the study of rotating instabilities, in collaboration with colleagues in Lyon (LPENSL), Marseille (PIIM) and Toulouse (Laplace & IRAP).

**Candidate education -** M2 Physics / plasma / astrophysics.

**Candidate profile**: Analytical skills, good physical intuition, curiosity and resourcefulness are essential assets for this project. Some coding experience and an interest for numerical modelling will be an advantage.

**Keywords -** Plasma physics.

**Supervisors & contacts -** Renaud Gueroult & Gwenael Fubiani – renaud.gueroult@laplace.univ-tlse.fr, gwenael.fubiani@laplace.univ-tlse.fr

**Preferred start date –** March 1st, 2025.

**Possibility to continue as a PhD project -** Yes, as part of the ANR-funded project Cantaloupe.

[1] I. Kaganovich *et al.* (2019), Phys. Plasmas, **27**, 120601

[2] R. Gueroult, J.-M. Rax and N. J. Fisch (2019), Phys. Plasmas, **26**, 122106
[3] B. Trotabas and R. Gueroult (2022), Plasma Sources Sci. Technol., **31**, 025001
[4] G. Fubiani e*t al.* (2021), Phys. Plasmas, **28**, 063503

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