Effect of biasing on plasma equlibrium

PhD position

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 – In this PhD project we propose 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 plan will be to start with a simple academic plasma configuration in which models and simulations can be confronted straightforwardly, before progressively moving towards more complex configurations, an eventually confronting results with experimental data. The proposed PhD position is indeed offered as part of the ANR project Cantaloupe gathering colleagues in Lyon (LPENSL), Marseille (PIIM) and Toulouse (Laplace & IRAP), which will offer opportunities to confront results with data from the VKP and Mistral experiments. This broader project, studying centrifugal instabilities as driven for instance in the lab through biasing, will also offer a particularly stimulating environment for the student to work in.

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.

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[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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