DRF: Thesis SL-DRF-20-0794

RESEARCH FIELD

Plasma physics and laser-matter interactions / Corpuscular physics and outer space

TITLE

Kinetic physics of the scrape-off layer and its interplay with the edge in fusion tokamak plasmas

ABSTRACT

Turbulence has long been identified as the transport mechanism limiting the performance of fusion plasmas. The transport of heat is from this point of view one of the main issues of the ITER project. To study this problem in all its complexity, our team developed the code GYSELA. Plasma is characterized by its function of distribution depending on the appropriate dimensions of the phase space. The code includes a module for heating the plasma under conditions comparable to those of experiences. This already very complete tool allows fundamental numerical experiments of the physics of turbulence and its impact on transport. Many elements Innovators have been studied as aspects of self-organization, development of large scale flows similar to those of oceans and planetary atmospheres, the confrontation with measurements of turbulent fluctuations and recently an important step in to study transport bifurcations has been crossed by recent improvements in boundary conditions, between the plasma and its material environment.

It is proposed for this PhD work to study heat, mass and momentum transport in the plasma edge boundary layer and in the transition zone between the closed field lines of the confined plasma and the open field lines region where the plasma interacts with the solid boundaries. It will be necessary to begin to explore the analytical and numerical bases to treat these peripheral regions in a kinetic framework, both for the ions and for the electrons that make up the plasma. The thermonuclear plasma being weakly collisional, it is expected that significant departures from Fourier's law may exist, which is commonly referred to as "non-local" transport. In order to become familiar with a problem that is complex, new and important for the community, many aspects can be addressed via a reduced kinetic model, called "VOICE". This model addresses the important aspects of the problem in a simplified geometry and allows for a detailed study of the kinetic response of plasma, such as the generation of coupling to sound waves as well as the trapping of electrons in parallel structures of electrical potential. Finally, the transport in the radial direction will bring into play the self-organization of plasma turbulence and possible competitions / synergies between transport of heat and matter.

LOCATION

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