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PROPOSITION DE STAGE 2013-2014

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Niveau du stage : MASTER
Durée du stage : 6 months

Sujet du stage :

Titre : Analysis of non-linear effects near the plasma edge during radiofrequency heating in tokamaks

Contexte et objectifs :
The goal of magnetic fusion research is to demonstrate the scientific and technological feasibility of fusion power as a mean to provide a clean energy source for the future. To achieve this, hot plasma with temperature exceeding 100 million degrees must be generated and sustained for long durations. Additional heating methods, using neutral beam injection or radiofrequency (RF) waves, are commonly used for this purpose. During the RF heating, multi-MW waves are launched by antennas in the vacuum chamber and absorbed by the plasma. Study of the interaction between the RF waves and the plasma edge in tokamaks is an essential topic for several reasons, such as the risk of metallic impurity production from the antennas which degrades the fusion performance. On the other hand, the RF waves modify the turbulence naturally occurring in the plasma edge region, which could possibly have a beneficial effect on fusion performance.
The interplay between the edge plasma turbulence and the RF heating in the ion cyclotron range of frequencies (ICRF at 57 MHz) and in the Lower Hybrid range (LH at 3.7 GHz) have been studied on the Tore Supra tokamak in France, using probes located near the plasma edge measuring density fluctuations with an acquisition frequency of 1 MHz [1, 2, 3]. Recently, a novel diagnostic was installed allowing us to measure with an acquisition rate of 200 MHz. This opens up the possibility to study new plasma wave phenomena never observed in a tokamak before. Preliminary results show the appearance of a peak in the frequency spectrum at about 2 MHz [3, 4], but its origin and its underlying physics mechanism are yet unknown.

Nature du travail à réaliser par l'étudiant :
In this work, it is proposed to analyze the experimental data obtained from this new diagnostic measuring the density fluctuations with an acquisition frequency of 200 MHz. We shall focus on the origins of the peak in the frequency spectrum observed at about 2 MHz with the goal to establish the main parameters responsible for its amplitude. Statistical analyses tools using programs in Matlab will have to be written by the student in order to characterize this wave experimentally. Then, a thorough investigation of the parametric dependencies found from the experimental data will be done in presence of the ICRF and LH sources at 57 MHz and 3.7 GHz, respectively. This work will finally study the possible theoretical mechanisms of the plasma wave generation and the onset of parametric decay instabilities as available in literature.

References :
[1] G Antar et al., Nucl. Fusion **52** (2012) 103005
[2] T Oosako et al., AIP Conf. Proc. **1406** (2011) 230
[3] M Goniche et al., Nucl. Fusion **53** (2013) 033010
[4] G Antar et al, submitted to PRL (2013)

Domaine de spécialité, compétences : Physics, plasma physics
Prolongement possible thèse : No