Study of Wave-Plasma Interaction and Plasma Heating in the Ion Cyclotron Frequency Range

Abstract

Abstract:
The interaction between electromagnetic (EM) waves and plasma plays a crucial role in heating magnetically confined plasmas, particularly in the ion cyclotron (IC) frequency range. In this frequency regime, externally launched EM waves couple to the plasma and propagate primarily as fast magneto-sonic waves, commonly referred to as "fast waves." When the polarization of the rotating electric field in these fast waves aligns favorably with the gyrating motion of ions and matches their cyclotron frequency, the wave energy is effectively absorbed by the ions. This frequency is known as the ion cyclotron resonance frequency (ICRF), and the spatial location where this absorption takes place within a tokamak plasma is termed the ion cyclotron resonance layer.

Scope of Work:
As part of this project, the student will be expected to develop a strong theoretical and computational foundation in Ion Cyclotron Resonance Heating (ICRH) of magnetically confined plasmas. This will involve studying the fundamental principles of:
• Excitation of fast magneto-sonic waves in a plasma environment
• Coupling of these waves at the plasma edge via ion cyclotron (IC) antennas and launchers (including the role of parallel wave-number shaping, k? shaping)
• Various ion cyclotron heating mechanisms, such as:
? Second harmonic heating
? Minority ion heating
? Direct electron heating
? Mode conversion heating

Computational Studies and Methodology:
The student will be trained in the use of advanced numerical tools for wave-plasma interaction studies. These include:
• Wave coupling and propagation
• Tokamak equilibrium solvers
• Fokker-Planck solvers for studying particle distribution effects

Expected Outcomes
The project aims to provide a comprehensive understanding of ICRF heating physics and develop computational methodologies for predicting and optimizing wave-plasma interactions.

Academic Project Requirements:

1) Required No. of student(s) for academic project: 2

2) Name of course with branch/discipline: M.Sc. Physics

3) Academic Project duration:

(a) Total academic project duration: 26 Weeks
(b) Student's presence at IPR for academic project work: 5 Full working Days per week

Email to: amit.singh@iterindia.in[Guide's e-mail address] and
project_phy@ipr.res.in [Academic Project Coordinator's e-mail address]

Phone Number: 079 -07923269619 [Guide's phone number]