FOM-Institute for Plasma Physics Rijnhuizen
Association EURATOM-FOM

# Student project: Development of a full wave code for electron cyclotron wave propagation and absorption.

The FOM-Institute for Plasma Physics Rijnhuizen carries out research towards the realization of thermonuclear fusion as a virtually inexhaustible, environmentally friendly source of energy. This research is carried out under the auspices of EURATOM, which is one of the partners in the ITER project. The aim of ITER is to demonstrate the scientific and technological feasibility of fusion energy. The research of FOM-Rijnhuizen is focused on the R&D needs for the successful exploration of ITER. The Fusion Physics Department aims to develop an understanding of the physics of burning plasma and to develop techniques for its control. In particular, the use of high-power microwaves for the control of magnetohydrodynamic (MHD) instabilities is investigated. The interaction of these microwaves and the plasma occurs at the electron cyclotron resonance, and the localized nature of the ensuing heating and non-inductive current drive provides an ideal tool for control of plasma instabilities. This work is carried out in close collaboration with various national (TU/e, TNO, ITER-NL, …) and international (Max-Planck Institute for Plasma Physics, EFDA Taskforces on MHD, and on Integrated Tokamak Modeling, …) partners.

The Computational Plasma Physics – High Temperature group supports this research by developing the relevant theory and the necessary tools for numerical simulation of fusion plasmas.

## The student project

This particular project aims to develop a numerical code for the solution of 3D Maxwell's equations describing the propagation and absorption of electron cyclotron waves in hot plasmas. Because of the relatively short wave lengths of these waves this is a quite challenging problem. Moreover, a specific problem is posed by the kinetic plasma response to the waves, which is known only in Fourier space. A number of codes have been developed and used to simulate wave propagation in relatively small and low magnetic field devices, but no code has been able yet to treat the problem on a scale relevant to present day large tokamak experiments. We want to explore new techniques making use of the localized nature of the electron cyclotron wave beams obviating the need for "whole device simulations". It is intended to use the code to study the importance of physics effects, like mode conversion and mode purity, that are not described by reduced models such as geometric optics ray-tracing or quasi-optical beam tracing.

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