

Centre for Fusion, Space and Astrophysics

PhD Project: Inferring energetic ion physics from ion cyclotron emission from fusion plasmas

Joint supervisors: Professors Richard Dendy (also at UKAEA Culham) and Sandra Chapman

Ion cyclotron emission (ICE) is an intense suprathermal electromagnetic signal which is generated by fusion-born ion populations in magnetically confined plasmas. Understanding the physics of fusion-born ions, notably the 3.5 MeV alpha-particles that are produced in deuterium-tritium plasmas, is crucial if these ions are to be exploited to sustain the thermonuclear burn. ICE provides unique insights into this – always provided that the physics underlying ICE is well understood. This presents an intellectual challenge which is underpinned by the interplay of three fundamental characteristics of plasma physics: the signature Alfvén wave; the gyromotion of fusion-born ions in the confining magnetic field; and the collective effects that arise from the long-range nature of the Maxwell-Lorentz system of equations. This project will involve a mix of: state-of-art high performance computation (HPC), using the widely adopted EPOCH kinetic code; analytical theory; and determining the linkages between current ICE observations and simulation outputs. The PhD student may choose to be based at the UKAEA fusion research centre at CCFE Culham, near Oxford, from the second year onwards. Joint supervision will be provided by Professors Sandra Chapman and Richard Dendy, who have an extensive track record in this area. There is a team-based working environment at CCFE, with several Warwick/CCFE alumni within the “home team” for the ICE topic. CFSA has a record of several dozen successful joint PhD projects with CCFE. The timing of this PhD project is optimal in relation to:

- Imminent ICE measurements from deuterium-tritium plasmas in JET (“DTE2”) at Culham
- The current high level of interest in ICE at major fusion facilities worldwide
- The CFSA-CCFE team's role as a partner in international experiments on ICE. In 2019 and 2020 we have already published on ICE in the IAEA journal *Nuclear Fusion* with the flagship facilities in Germany (Max Planck Institute for Plasma Physics), Japan (National Institute for Fusion Science) and Korea (National Fusion Research Institute). We are partners in an invited paper with the US team from General Atomics at this autumn's IAEA Fusion Energy Conference. These collaborations continue, and in addition to future JET DTE2 data will generate interesting and rewarding challenges for the PhD student.

In the longer term, ICE is under consideration as a diagnostic for fusion-born ions in the Next Step fusion experiment, ITER.

We welcome informal enquiries to richard.dendy@ukaea.uk and s.c.chapman@warwick.ac.uk and encourage full applications through the Warwick Graduate School website.