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Ion cyclotron emission (ICE) from energetic ions in fusion plasmas

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Ion cyclotron emission (ICE) is a primary source of information on the physics of energetic ions in magnetically confined fusion plasmas. It comprises intense radiofrequency signals that are driven by the collective relaxation of energetic ion populations. These energetic ions are either born in fusion reactions, or created within the plasma by external methods, such as particle beam injection or radiofrequency heating. Working in collaboration with Culham Centre for Fusion Energy (CCFE), the CFSA team is the partner-of-choice of experimental teams studying ICE worldwide, for modelling and interpretation. This year CFSA PhD students have published with us on ICE from:

-KSTAR (Korea) fusion-born protons, B. Chapman *et al.* Nucl. Fusion 58 096027 (2018)

-ASDEX-U (Germany) fusion-born protons, R. Ochoukov *et al*. Rev. Sci. Inst. 89 10J101 (2018)

-JET (Eurofusion) minority helium-3 ions, K. McClements *et al*. Nucl. Fusion 58 096020 (2018)

-LHD (Japan) fusion-born and beam ions, R. Dendy *et al*., APS 2018 Conference

To continue this success, a PhD student is sought to develop and apply first principles kinetic modelling at a level that can capture ion cyclotron resonant physics in realistic plasma parameter regimes. The PhD student skill set developed by this project combines: first principles plasma physics; the analytical theory of ICE-relevant plasma instabilities; high performance computation (HPC), through learning and using the EPOCH particle-in-cell code; and the quantitative techniques needed to relate simulation outputs to experimental datasets in strongly nonlinear regimes.

The project will focus on interpreting observations reported during 2018, both from the U.S. and from our collaboration with ASDEX-U, of ICE originating from the core plasma. This strengthens the prospects of ICE as potential diagnostic for the next step fusion experiment ITER. In addition we anticipate ICE measurements from imminent deuterium-tritium plasmas in JET – where ICE was first detected from fusion-born alpha-particles in 1991.

There is considerable fundamental physics interest to this phenomenon. It involves arguably the three most distinctive features of magnetic fusion plasmas: cyclotron motion in the confining magnetic field; excitation of a “signature” oscillation, namely the Alfvén wave; and the central role of fusion-born ions.

The student will be based primarily at CFSA, with short-duration working visits to fusion laboratories worldwide and close collaboration with CCFE. Enquiries and applications from interested students are welcome, with detailed information about the studentship scheme to follow.

For further details on the group see go.warwick.ac.uk/CFSA, and for how to apply please see go.warwick.ac.uk/PhysicsPG.