Investigation of suprathermal electron transport induced by Electron-Cyclotron waves in tokamak plasmas

J. Cazabonne[1], P. Donnel[2], S. Coda[1], J. Decker[1], Y. Peysson[2]

[1] *EPFL, Swiss Plasma Center (SPC), CH-1015 Lausanne, Switzerland*

[2] *CEA, IRFM, F-13108 Saint-Paul-lez-Durance, France*

Electron-Cyclotron (EC) waves are routinely injected in tokamak plasmas to increase electron temperature and drive current. The resonant absorption of EC waves occurs in a narrow region of real and velocity space, allowing for very accurate power deposition. For this reason, it is foreseen as the main tool for MHD mode control or mitigation in future large devices such as ITER. However, it has been observed that the suprathermal electron distribution is broader than the power deposition calculated by numerical simulations with linear ray-tracing and quasi-linear drift-kinetic codes [1, 2] ; the experimental driven current is also smaller than calculated. This may potentially hamper the efficiency of MHD mode mitigation by driving current outside magnetic islands, and the underlying mechanisms need to be understood. A possible explanation being explored, both numerically and experimentally, is the broadening of the EC beam before its absorption by density fluctuations [3]. The other main possibility, on which this contribution focuses, is the transport of the accelerated electrons outside the absorption area due to local turbulent transport enhancement. This has been suggested by previous studies performed at TCV, using drift-kinetic models augmented by ad-hoc radial transport of fast electrons [2]. Indeed, the transport model that most successfully recovers the experimental data from Hard X-Ray Spectroscopy (HXRS) is a model proportional to the local deposited power in phase space. This has motivated the development of a realistic EC source in a gyro-kinetic code, enabling turbulent transport studies from first principles [4]. This new tool, implemented in ORB5, has been tested and compared to drift-kinetic simulations performed with LUKE/C3PO, by disabling turbulent transport effects which are specific to gyro-kinetic codes. A good agreement is found between both codes, confirming that the model is correctly implemented in ORB5. It is planned to experimentally study transport induced by EC waves, using power-modulated EC beam and HXRS-constrained LUKE modeling, extending the work performed in [2]. It will be the opportunity for testing the new EC source module of ORB5 in actual experimental situations.

References

[1] S. Coda et al, Nuclear Fusion **43** (2003)

[2] D. Choi et al, Plasma Physics and Controlled Fusion **62** (2020)

[3] O. Chellaï, Nuclear Fusion **61** (2021)

[4] P. Donnel et al, Plasma Physics and Controlled Fusion **63** (2021)