Characterisation of anomalous energy and momentum transfer from electrons to ions in ECCD discharges on TCV

Ch. Schlatter, A. N. Karpushov, B. P. Duval
S. Coda, E. Fable, T. P. Goodman, O. Sauter, V. S. Udintsev
Ecole Polytechnique Fédérale de Lausanne (EPFL)
Centre de Recherches en Physique des Plasmas
Association Euratom-Confédération Suisse
CH-1015 Lausanne, Switzerland

The signature of suprathermal ion populations in ECH and ECCD experiments on the TCV tokamak was previously observed in NPA measurements [1]. The appearance of these ions cannot result from simple Coulomb collisions, as the observed timescales are much shorter than the collision time.

New experiments with a Compact Neutral Particle Analyser (CNPA) covering a broader energy range with higher temporal resolution were undertaken with the aim of assessing the mechanism responsible for the ion heating. Scans of the electron density, ECCD efficiency, toroidal microwave injection angle, ECH power deposition, plasma current and position were performed. Suprathermal ion tails are strongest at low current, low density and high electron temperature, thus also at high power and high ECCD efficiency. These measurements are currently being validated against neutron emission measurements.

It is also found that the suprathermal population only appears when the ratio of the parallel electric field to the Dreicer (runaway) electric field is below a finite limit value. These results suggest a similarity to the anomalous electron to ion energy transfer invoked by Coppi et al to explain suprathermal ion generation in the Alcator device [2]. Modes around the ion plasma frequency excited by the current-carrying part of the electron distribution can resonate with the ions and transfer a significant amount of energy from the electrons to the ions. This paper attempts to examine whether this candidate mechanism is effective in the specific case of an ECH-driven, perpendicularly heated electron distribution function.

References

[1] A. N. Karpushov, S. Coda, B. P. Duval, Proc. 30th EPS Conf. on Cont. Fus. and Plasma Physics, St Petersburg, Russia, July 2003, ECA Vol. 27A, P-3.123

[2] B. Coppi, F. Pegoraro, R. Pozzoli and G. Rewoldt, Nucl. Fusion 16, 2: 309-328 (1976).