HIGH-FREQUENCY MODES EXCITED IN SCENARIO WITH ALPHA-PARTICLE BUMP-ON-TAIL DISTRIBUTION IN DTE2 PLASMAS ON JET

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Excitation of high-frequency modes via resonant interaction with fusion-born α-particles is one of the most important problems for burning deuterium-tritium (DT) plasma operation, such as ITER [1]. During DTE2 campaign on JET, a novel scenario was found of exciting high-frequency modes by α-particles aiming at establishing a bump-on-tail (BOT) distribution. JET baseline discharges with q(0)~1 and NBI only were used so fusion-born α-particles were the only ions present in the MeV energy range in these DT plasmas. For the α-particle BOT scenario, a modulation of α-particle source was used via modulating NBI power. A Fokker-Plank FIDIT model [2] was employed before the experiment for optimising the NBI modulation required for sustaining a BOT in the α-particle distribution. Five DT pulses (##99500-99503 plus contingency pulse #99627) were performed in this scenario with B_T = 3.7 T, I_P = 2.5 MA and with modulated NBI power up to P_{NBI}= 10-15 MW delivering up to R_{DT} = 0.65x10^{18} s^{-1}[3]. Both D and T beams were used and Tritium concentration in the discharges was varied from D:T = 33:67 (T-rich plasmas) to D:T = 55:45 (D-rich plasmas). A strong high-frequency mode activity was detected in these discharges over a wide frequency range from ≅100 kHz to ≅400 kHz, with no correlation to the characteristic frequencies of TAEs or EAEs. The modes observe were multiple and most of them were short-lived. The mode detection with interferometry, soft X-ray cameras, and reflectometry established that the modes observed were localised close to the magnetic axis. These modes were not seen in the Mirnov coils thus making their toroidal mode numbers n's undetermined. Interpretation of these modes was given in terms of the on-axis kinetic Alfvén eigenmodes described by Rosenbluth and Rutherford in [4] (so we can call these as RR-modes). These are eigenmodes of kinetic Alfvén waves (KAW) having their reflection points surrounding the magnetic axis. These RR-modes in the first order finite Larmor radius approximation were modelled with complex resistivity CASTOR code [3]. In this presentation, the peculiar temporal evolution of the RR frequencies is explained via the q(0) temporal evolution combined with the drive from transient BOT in the α-particle distribution assessed from the TRANSP [5] modelling. The first experimental observation of RR-modes reported here allow to validate the codes used for predicting excitation of high-frequency modes by α-particles velocity distribution function and pave the way to possible MHD spectroscopy of q(0) -evolution and/ or BOT characteristics of α-particles in burning plasmas.

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