

## Excitation of elliptical and toroidal AE modes by 3 He - ions of the MeV energy range in hydrogen - rich JET plasma

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Excitation of Elliptical AEs (EAEs) and TAEs has been observed in hydrogen-rich (nH/nH+nD ~70-90%) JET discharges of so-called "three-ion scenario", i.e.D-(3He)-H three ion ICRH scenario [1]. This scenario is characterized by a strong absorption of radio frequency waves at very low concentrations of the resonant 3He-ions. In the experiments, core localized TAEs with frequency  $f_{TAE} \approx 280$  kHz were observed. Following the phase with the TAE excitation, EAEs at higher frequencies,  $f_{EAE} \approx 550-580$  kHz, and with mode numbers  $n = \pm 1, \pm 3, \pm 5$  were seen. These high frequency modes indicate that a MeV range population of trapped energetic ions was present in the plasma interacting with the modes via the trapped particle resonances. The experimental evidence of the existence of the MeV-energy 3He-ions able to excite the AEs is provided by neutron and gamma-ray diagnostics as well as fast ion loss (FILD) measurements. It was found that the anomalous DD neutron rate in the ICRF-only heated plasma is provided by population of energetic deuterons formed via elastic head-on scattering of the MeV 3He-ions on deuterium (the knock-on effect):  $D(3He,3He)D$  knock-on  $\Rightarrow D(D_{knock-on},n)3He$ . Gamma-ray diagnostics [2] show that some neutrons are also generated in the nuclear reaction  $9Be(3He,n)11C$ , which takes place with 3He-ions in the MeV-range. The fast ion loss detector [3] indicates that the MeV-range 3He-ion losses related to the core localized TAEs ended with a spike associated with a monster sawtooth, after which the losses correlated to the EAE modes were observed. Analysis of FILD data indicates that the lost 3He-ion energies exceed 2 MeV. The back-in-time orbit analysis of the FILD data shows that the TAE-induced losses of 3He-ions are localised in the plasma centre ( $R \approx 3.0$  m). However, the losses of 3He-ions associated with the EAEs are coming from  $R \approx 3.2-3.4$  m. Results of MHD analysis are consistent with the experimental data showing that the MeV 3He ions are resonant when interacting with TAEs and EAEs.

References

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