High-frequency reversed-shear Alfvén eigenmodes in fast-ion experiments on JET

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A broad range of Alfvén eigenmodes (AEs) was destabilized by fast ions in JET D-^{3}He plasmas heated with the three-ion ICRF scenario [1, 2], see Fig. 1. The observed modes include the toroidicity-induced AEs (TAEs), ellipticity-induced AEs (EAEs), as well as reversed-shear AEs (RSAEs), originating from the presence of a local minimum of the safety factor $q_{\min}$. Two different types of centrally localized RSAEs were regularly observed during the long-period sawtooth phases in this series of JET experiments [3]. In addition to the low-frequency RSAEs with frequencies below the TAE frequency ($f \approx$ 80-180 kHz), also RSAEs with frequencies above the TAE frequency ($f \approx$ 330-450 kHz) were destabilized. The high-frequency RSAEs feature the temporal decrease of their frequency as the value of $q_{\min}$ decreases (cf. Fig. 1), opposite to the dynamics of the more often observed low-frequency RSAEs. Such high-frequency RSAEs were previously reported in reversed-shear plasmas in JT-60U heated with negative-ion-based NBI, injecting a large number of passing ions with energies ~400 keV [4].

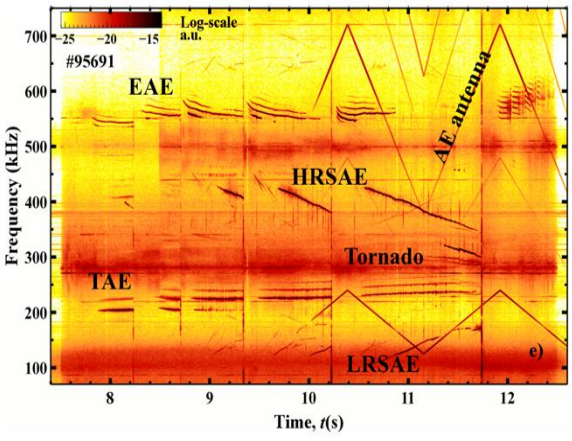

Fig. 1. The magnetic spectrogram in JET pulse #95691, featuring the destabilization of the high-frequency RSAEs ($f \approx$ 330-450 kHz).

In this contribution, we report the characteristics of the high-frequency RSAEs in JET experiments, investigated in detail using HELENA, CSCAS and MISHKA codes. The computed radial mode structure is consistent with the experimental mode measurements, using an X-mode reflectometer, a multiline interferometer and soft X-ray diagnostics. Our analysis also shows that the high-frequency RSAE destabilization is mostly caused by passing fast ions with energies of several hundred keV [3]. Although the high-frequency RSAEs are not often seen on JET, these modes could be highly relevant for future ITER and fusion reactors dominated by ~MeV-range energetic ions, including a significant population of passing fast ions.

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