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Observation of a beam-driven low-frequency mode in Heliotron J

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In magnetically confined fusion plasmas, energetic ions with energies significantly larger than the bulk ion temperature are used to heat the plasmas. Energetic ion populations created by fusion reactions, neutral beam injection (NBI) or radiofrequency (RF) heating are usually concentrated in the center of the plasma [1]. In theory, discrete Alfven eigenmodes (AEs) existing in the frequency gap of the Alfven continuum can be destabilized by tapping the free energy source associated with the energetic particle (EP) pressure gradient through wave-particle resonant interactions.

A low-frequency electromagnetic mode (LF-mode) has been observed in a stellarator / heliotron (S/H) device, Heliotron J [2]. The LF-mode is observed only in neutral beam heated plasmas with a co-current, which increases the rotational transform. The observed LF-mode peaks at rho = 0.86–0.91, where rho = r/a is the normalized minor radius. The LF-mode propagates in the ion diamagnetic drift direction, and the poloidal mode number is m ~ 6–8, determined with a combination of Mirnov coil arrays and a perpendicularly viewed fast imaging system (Figure 1 (a) and (b)). A high m number induces significant Doppler shift from the background ion flow. The frequency is corrected with both E × B rotation and the ion diamagnetic flow. The corrected frequency is almost consistent with the beta-induced Alfven eigenmode (BAE) gap evaluated with the STELLGAP code, although very close to the accumulation point. The mode could also be a global Alfven eigenmode (GAE).

References

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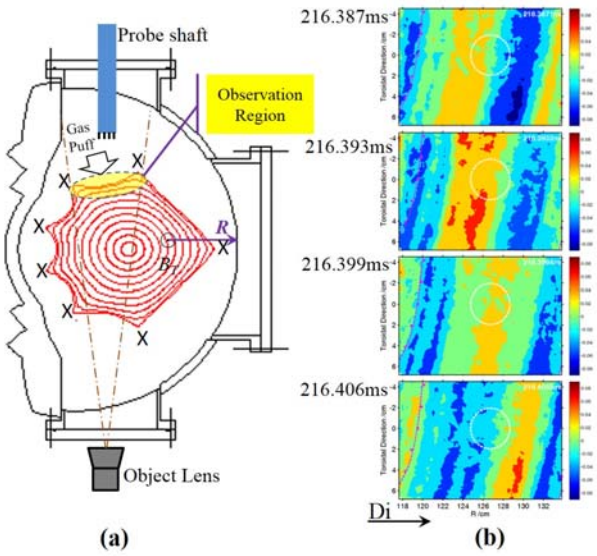

Figure 1 (a) fast imaging system on Heliotron J; (b) wave structure of the LF-mode, taken with the fast imaging system.