Observation of MHD mode transition and core toroidal rotation variation in EAST long-pulse discharges

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Spontaneous MHD mode transition and core toroidal rotation variation were observed in EAST long-pulse discharges.A m/n = 3/2 tearing mode (TM) persisted for ~ 42 s, and was eventually damped as a result of current profile evolution. The resistive diffusion time τ_R was ~ 10 s, shorter than the TM duration. A m/n = 1/1 long-live mode (LLM) co-existed with the TM, but transformed into a higher frequency kink mode when the normalized electron temperature gradient R/L_{Te} near q=1 surface was larger than 8.5. The LLM and the kink mode could be derived from the resistive MHD equations modified by drift wave frequency effects. The frequency of the kink mode was ~ 3.3 kHz higher than that of the LLM, close to the electron drift wave frequency ω_{*e} (also called electron diamagnetic frequency), which was ~ 3.7 kHz. After the TM disappeared, the core electron temperature increased and the temperature gradient driven kink mode persisted. The kink mode was believed to facilitate the sustainment of the T_e internal transport barrier (ITB) in plasmas with similar parameters as in this work [1]. The core toroidal rotation decreased as the TM disappeared. The torque driven by the neoclassical toroidal viscosity (NTV) effect was modelled by NTVTOK, and the results indicated that the difference in the NTV torque driven by the three modes caused the change in the toroidal rotation. These results suggest that more caution and work are required in predicting the stability of MHD modes and rotation profile in long-pulse discharges, especially for fusion reactors such as ITER. The relationship between these MHD modes and particle/heat transport, and the formation of T_e ITB will be investigated in future work.

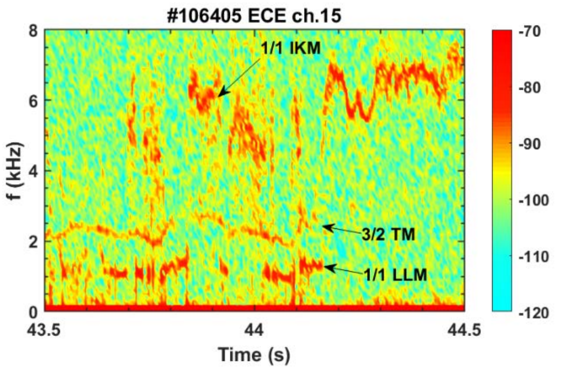

Figure 1. Power spectrum of ECE system ch.15, near the q=1 surface.

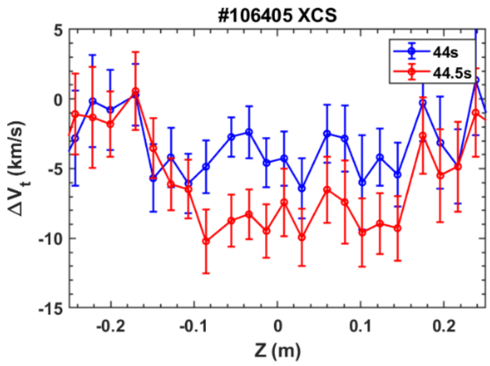

Figure 2. Relative toroidal rotation profile measured by XCS system.

[1] E. Li, X. L. Zou, L. Q. Xu, *et al.*, Phys. Rev. Lett. **128** (2022) 085003.

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Suggested sorting topic: Topic 6: "Integrated core performance and heat/particle exhaust with edge transport barriers".

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