7th Asia-Pacific Conference on Plasma Physics, 12-17 Nov, 2023 at Port Messe Nagoya

# Interaction between magnetic island and turbulence and its impact in facilitating plasma disruption

Min Jiang, Yuhong Xu, Wulyu Zhong, Wei Chen, Zhongbing Shi, Jiquan Li, Yucai Li, WeiXing Wang, Yi Liu and HL-2A team
[1] Southwestern Institute of Physics, China
[2] Institute of Fusion Science, Southwest Jiaotong University, China
E-mail (speaker): jiangm@swip.ac.cn

Improved understanding of tearing mode physics and the interaction with plasma flow and turbulence is important as it can lead to the improvement of plasma performance, and therefore has potential implications for future fusion devices such as ITER.

In this work, experimental studies on the interactions between the tearing mode and turbulence in HL-2A plasmas are reported. The plasma perpendicular flow shear is enhanced significantly at the island boundary radially across island O-point [1]. Both the density fluctuations and temperature fluctuations are modulated by the island rotation, with the minimum (maximum) value at island O-(X-) point, consistent with the trend of the temperature gradient [2]. While at the island O-point boundary, the density fluctuations (especially the quasi-coherent modes) are enhanced dramatically when the temperature gradient exceeds a threshold [3]. The observed fluctuations have the characteristics of the trapped electron mode.

In addition, it is discovered that both the electrostatic and electromagnetic turbulence at the island X-point enhances significantly towards the plasma disruption [4], as seen in figure 1. Also, from the electron cyclotron emission imaging measurement, the turbulence spreads poloidally from the island X-point to O-point, resulting in finite turbulence observed at island O-point, which may play a role in the formation of the cold bubble from the island O-point. It is found by GENE simulation that the observed turbulence enhancement near the X-point cannot be fully interpreted by the linear driving mechanism, but could be due to the nonlinear effects such as the reduction of the EXB shear by the stochasticity and turbulence sprading. The observed turbulence at the reconnection region can result in the stochasticity of the magnetic field lines and decline of the flow shear, and thus, further increase of turbulence and turbulence spreading. Such a feedback loop facilitates the plasma current quench.

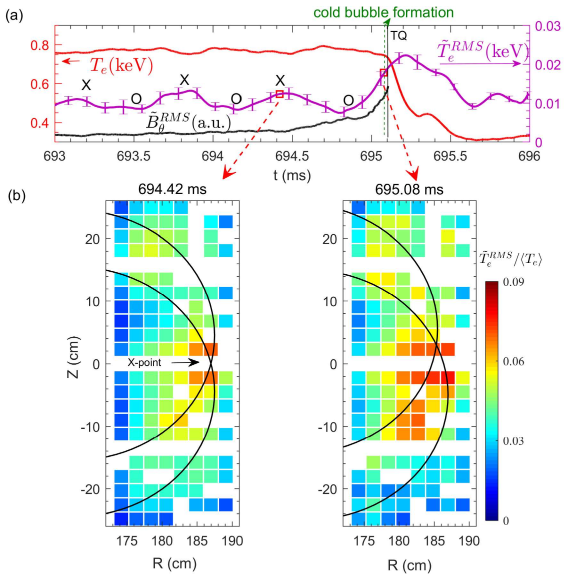


Figure 1. (a) Times evolutions of core $T_e$ (red curve), $\tilde{T}_e^{RMS}$ (purple curve) and $\tilde{B}_\theta^{RMS}$ (black curve) signals. The $\tilde{T}_e^{RMS}$ is obtained by averaging serveral channels of $T_e$ fluctuations (15-100 kHz) measured around the island X-point. The $\tilde{B}_\theta^{RMS}$ is the RMS value of $B_\theta$ fluctuations in the range of 15-400 kHz from the Mirnov coils mounted on the outbard midplane. (b) Two dimensional distribution of relative temperature fluctuations ($\tilde{T}_e^{RMS}/\langle T_e \rangle$) in the frequency range of 15-100 kHz. The black curves denote the island separatrices.

References
[1] M. Jiang, et al., Nucl. Fusion 58 026002 (2018).
[2] M. Jiang, et al., Nucl. Fusion 59 066019 (2019).
[3] M. Jiang, et al., Nucl. Fusion 60 066006 (2020).
[4] Y. C. Li, M. Jiang*, Y. Xu*, et al., Sci. Rep. 13 4785 (2023).