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Multi-scale interactions between magnetic island and turbulence on HL-2A tokamak

M. Jiang[1], Y. Xu[2], W.L. Zhong[1], W. Chen[1], Z.B. Shi[1], J.Q. Li[1], X.T. Ding[1], X.Q. Ji[1], P.W. Shi[1], Z.C. Yang[1], J. Wen[1], A.S. Liang[1], Y. Liu[1], Q.W. Yang[1], M. Xu[1] and HL-2A team

[1]Southwestern Institute of Physics

[2] Institute of Fusion Science, Southwest Jiaotong University

E-mail: jiangm@swip.ac.cn

Magnetic islands in magnetically confined plasmas are found to have significant impact on the profiles and cross field transport, and are even considered to play key roles in the onset of disruption. However, the interactions between different scale modes are believed to link to ITB formation, L-H transition and bifurcation phenomenon in fusion plasma. Therefore, the study on tearing mode (TM) physics and their interaction with plasma flows and turbulence is essential as it can lead to the improvement of plasma performance and therefore has potential implications for future fusion devices such as the International Thermonuclear Experimental Reactor (ITER). In this paper, it is observed that both high frequency density ($\tilde{n}_e$) and temperature fluctuations ($\tilde{T}_e$) are modulated by the rotating TM. The perpendicular flow is quite flat and near zero near the O-point of the island, while it strongly enhances and thus results in a large increase of the flow shear around the boundary of the island. High tempo-spatial resolution two-dimensional (2D) images of $\tilde{T}_e$ show the first evidence that the turbulence modulation occurs only when the island width exceeds a certain threshold value ($w_c \approx 16\rho_i \approx 6.4$ cm) and the modulation is localized merely in the inner half area of the island due to significant alteration of local profiles and turbulence drives. Evidence also reveals that for large islands turbulence spreading takes place across the at temperature of the O-point at the inner half island region, whereas in the outer half area the small temperature gradient drives a low level of temperature fluctuations.

References

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