

Evidence of $\mathbf{E} \times \mathbf{B}$ staircase in HL-2A L-mode tokamak discharges

Wenbin Liu^{1,2}, Yihang Chen³, Rui Ke³, George Mckee⁴, Zheng Yan⁴, Kairui Fang³, Zengchen Yang³, Zhe Gao², Yi Tan², George Tynan⁵, and HL-2A team³

¹ College of Physics and Optoelectronic Engineering, Shenzhen University

² Department of Engineering Physics, Tsinghua University

³ Center for Fusion Science, Southwestern Institute of Physics, China

⁴ University of Wisconsin, Madison

⁵ Center for Energy Research, University of California San Diego

e-mail (speaker): liuwenbin@szu.edu.cn

Theory and simulation suggest the existence of an $\mathbf{E} \times \mathbf{B}$ staircase in the plasma core consisting of a series of nested $m/n = 0/0$ $\mathbf{E} \times \mathbf{B}$ shear layers that regulate turbulent transport across the layers together with mesoscale transport events occurring between them.^[1,2] Here we show evidence for these phenomena in HL-2A L-mode discharges. High resolution Electron Cyclotron Emission (ECE) T_e profiles and Frequency Modulated Continuous Wave (FMCW) reflectometer n_e profiles both show multiple gradient corrugations. Analysis of simultaneous poloidally and radially separated Beam Emission Spectroscopy (BES) turbulent density fluctuation measurements over most of the minor radius of the plasma provide evidence of increased eddy tilting and local minima of turbulence correlation length. The radial variation of the conditional spectrum $S(k_\theta|f)$ shown in Fig 1 demonstrates the reversals or rapid changes of the propagation direction. The corresponding positions of these turbulence features are coincident with those of the profile corrugations, which reveals the

existence of multiple shear layers. In addition, long range transport events were observed in between the shear layers.^[3]

In this work, multiple plasma behaviors were studied together to give a more thorough experimental view of the $\mathbf{E} \times \mathbf{B}$ staircase. The results provide significant additional evidence for the existence of an $\mathbf{E} \times \mathbf{B}$ staircase that influences particle and heat transport in L-mode discharges. Moreover, the features of the $\mathbf{E} \times \mathbf{B}$ staircase under different heating conditions (type and/or power) have been compared.

References

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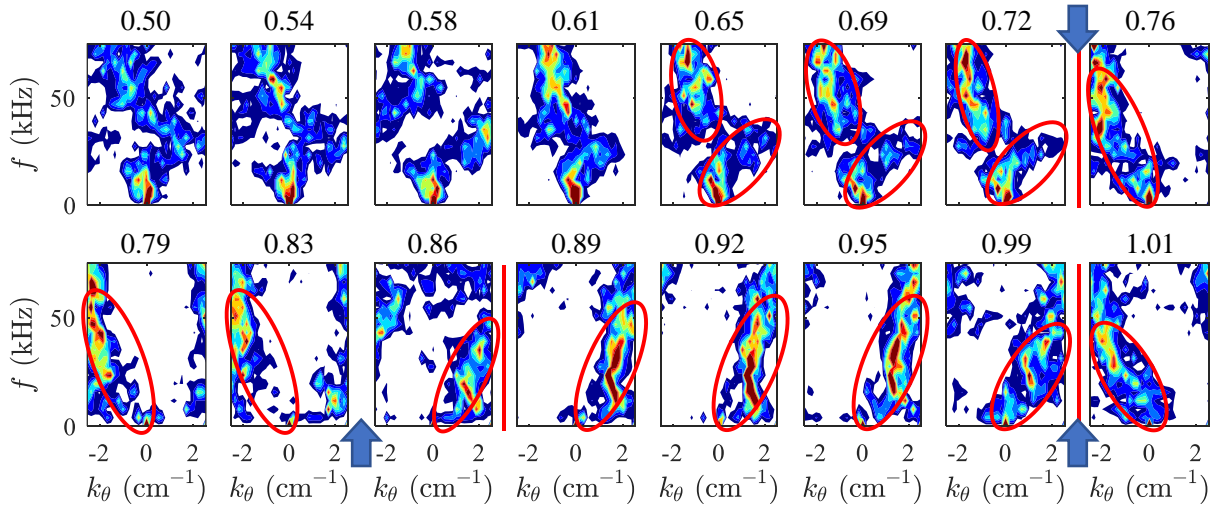


Fig 1 Radial variation of $S(k_\theta|f)$. The corresponding normalized radius $\rho = r/a$ is shown above each contour. The red straight lines mark the positions with ∇T_e and ∇n_e corrugations. The blue arrows indicate the positions with the reversals of poloidal propagation.