Self-organizing Mechanism for Sustaining Stationary I-mode in EAST

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I-mode, characterized by a very sharp edge temperature pedestal without edge density pedestal and ELMs, represents a potential and credible solution alternative to H-mode for standard operation scenario in the future fusion reactor [1-3]. Moreover, the following advantages: preventing metallic impurity central accumulation and facilitating fusion product ash removal, are crucial points for a fusion reactor. However, the intrinsic physical mechanism explaining I-mode formation is not yet elucidated.

In the EAST tokamak, I-mode was recently identified and characterized [4]. Besides the features similar to other tokamaks: strong temperature pedestal with no particle transport barrier; unfavorable plasma configuration; no heating preference; presence of a weekly coherent mode (WCM) of 40−150 kHz, the EAST I-mode is usually a quasi-steady state and accompanied by an edge low-frequency coherent mode of 6−12 kHz. Using ECEI/ECE and tomography reconstruction through the 64-channel bolometer arrays, it has been shown that the low frequency coherent mode corresponds to a radially localized edge temperature ring oscillation (ETRO) with azimuthally symmetric structure (m=0, n=0) [5]. Turbulence analysis shows that ETRO is probably caused by alternating turbulence transitions between an ion diamagnetic drift turbulence (IT) and an electron diamagnetic drift turbulence (ET). Then in return, the alternating transition is controlled by the local electron temperature gradient. The excitation of ET leading to an additional outward particle flux can explain the absence of particle transport barrier in I-mode plasmas. Moreover, WCM synchronously grows with ET and modulate ET and the corresponding transport, which is also consistent with previous conjecture that WCM may play the key role for driving outward flux during I-mode [6]

The self-organizing system including ETRO, turbulence transitions and transport modulation should play the key role in sustaining the I-mode confinement. These results provide a novel physics basis for accessing, maintaining and controlling stationary I-mode in the future.

References

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