Experimental observations of the turbulence correlation and transport in the EAST superconducting tokamak

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With the increase of the plasma temperature and density, the gradient of plasma parameters in the radial will change, so that the continuous turbulence in the different regions and the different scale turbulence in the same region will change accordingly, and these phenomena can be observed through analysing the turbulence correlation. The changes of the micro-turbulence correlation reflect the changes of the turbulence structure, and also reflect the change of the transport. The short-scale turbulence is perpendicular to the magnetic field line which can be observed by measuring the wave vectors of k_r along the radial direction and k_θ along the poloidal direction.

In the recent EAST experiments, the turbulence correlations of k_r and k_θ have been observing by the CO_2 laser collective scattering system, many meaningful results in the L-H transition are found which have not been found to be reported in other documents. The previous studies for the micro-turbulence in the radial k_r found that there is almost no obvious correlation structure in the frequency domain between k_r=10cm^{-1} and k_r＝20cm^{-1} in the core in the L-mode, but after the transition to H-mode there are significant correlation structures in the medium-low frequency band (about 0−120 kHZ) and around the quasi-coherent frequency (f ≈ 175 kHZ) [1]. In the last year, the correlations of the poloidal k_θ are observed during the L-H transition. In the core plasma, it is found that the broadband correlation structure for k_θ=12cm^{-1} and k_θ＝22cm^{-1} can disappear rapidly with the input of the 2.45GHz lower hybrid wave and the low frequency component has not been observed significant changes, also the correlation structure has not been observed significant changes during the L-H transition. In the edge, the correlation structures of both broadband and low frequency decrease gradually with the input of the lower hybrid wave. In the L-H transition the correlation intensity is not observed special change. For k_θ=12cm^{-1}, in the L-H transition, the broadband correlation structure between the core and the edge turbulence suddenly disappear and the correlation coefficient is greatly reduced. For k_θ=22cm^{-1}, with the input of 2.45GHz lower hybrid wave, the broadband correlation structure of the two regions gradually narrows and the correlation degree becomes weak, and then the L-H transition occurs.

It can be seen from the observations, during the L-H transition, the micro-turbulence correlation structures have significant changes either in the radial or in the poloidal, therefore it can be inferred, from L mode to H mode, the structural characteristics of the core micro-turbulence also change greatly and the plasma transport is changed correspondingly. Many more detailed studies are still in progress, and they will provide a more comprehensive understanding of the micro-turbulence during the L-H transition.

References

[1] G. M. Cao, Y. D. Li, et al. Phys. Scr. 90 (2015) 025603.