

Observation of Transitions in Meso-Scale Structures Formed in Plasma Turbulence

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Meso-scale structures such as streamers and zonal flows are formed by nonlinear interaction between microscopic drift waves in plasma drift wave turbulence of fusion plasmas and linear plasmas. Since these structures significantly influence the plasma radial transport, to study the formation of meso-scale structures is important in plasma physics and fusion reactors.

By using several Langmuir probe arrays in a low temperature linear plasma device in Kyushu University, our group succeeded in finding the streamer structure and its mediator mode for the first time [1]. The cross-sectional structures of the streamer, its mediator mode, and carrier drift waves were revealed by multiple correlation analysis and bi-phase calculation [2]. Several Langmuir probes arranged in the axial direction including the 64-channel poloidal probe array, and bi-spectral and bi-phase analyses were used to observe the three-dimensional phase structures. The results were well compared with theoretical [3] and numerical [4] works. According to the results, while the streamer structure and carrier drift waves were radially elongated, the mediator mode had a node in the radial direction. Additionally, the axial dimensional research revealed that while the carrier drift waves had an axial mode number one (propagation direction from the end to the source), the streamer and mediator were revealed to have an axial mode number zero [5].

The streamer structure was observed in a relatively low filling Argon pressure condition (~ 0.5 mTorr). With higher filling pressure condition (~ 3 mTorr), a stable nonlinear solitary wave has been observed. Short-lived solitary vortices accompanied by fine-scale structures were also observed with the presence of zonal flow [6]. In this study, we succeeded to observe the structural transition between streamer and solitary wave. New advanced analyzing methods such as wave number decomposed correlation / multiple correlation techniques have been used to report the transition in detail. For example, after the transition from streamer to solitary wave, the mediator mode lost its role and the cross-sectional structure having the node was distorted. Figure 1 shows the cross-sectional structures of the mediator mode before and after the transition.

References

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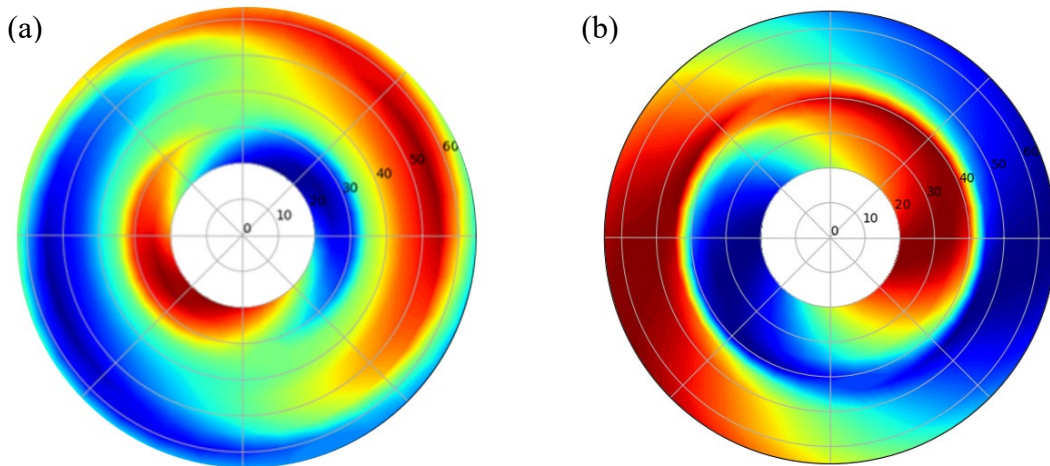


Figure 1. Real part of the cross correlation between the 64-channel poloidal probe and 10-channel radial probe arrays (mode number is 1 and frequency is -1.6 kHz) (a) before and (b) after the transition from streamer to solitary wave.