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Two-dimensional structure of fluctuations and their modal coupling in linear magnetized plasma

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Fluctuations play an important role in heat and particle transport in magnetized plasmas. Recent studies have revealed that the different kinds of fluctuations which stem from different sources of energy can interact with each other and can coexist at different radial locations [1–4]. These results indicate the necessity of observing the whole cross section of plasma for improving the understanding of fluctuation-induced transport. For this purpose, we have developed tomography systems to observe the two-dimensional structure of fluctuations in the linear magnetized plasma device PANTA.

A tomography system in PANTA is composed of 126 channels. Each channel has a collimator which determines the line-of-sight, and a dichroic filter which selects the wavelength so that line-integrated emissions from a particular atom or ion [5, 6] are obtained. The light which passes through the collimator and dichroic filter is fed to the photodetector, whose bandwidth is designed to be 30 kHz to obtain the emission intensity with its fluctuations. The line-integrated emission data is reconstructed into the local emission intensity using ML-EM method [7]. By reconstructing each temporal set of data, we can obtain the temporal evolution of the emission intensity profile within the whole cross section of the linear magnetized plasma.

After reconstruction, traditional Fourier-Bessel Function (FBF) expansion [8] has been used to investigate the spatial structure of the emission profile. In the method, radial and azimuthal expansion uses the Bessel and sinusoidal function, respectively, to extract the feature of global structure. To extract the azimuthal feature of emission profile and its fluctuations as a function of radial position, we applied a newly developed method called the Fourier-Rectangular Function analysis (FRF) [9].

Here, an interesting result is presented to demonstrate the excellency of the FRF analysis. The example was obtained from a discharge where two distinguished azimuthal modes, m=1 and m=4 [10], and revealed a distinct difference in radial behaviors, core and edge, between the two azimuthal modes. Figure 1(a-1) and (b-1) show the temporally averaged two-dimensional structure of the m=1 mode (here we term as 'father mode') and m=4 mode (termed as 'mother mode') obtained by the FRF analysis, respectively. It is observed that the mean spatial structure of the father mode is strongly tilted in the inner region ($r \leq 2$ cm) while the mother mode is not. The amplitude of father and mother mode exhibited an inverse temporal correlation clearly in the outer region ($r \geq 2$ cm) as shown in FIG. 1 (a-2) and (b-2). On the other hand, the radial correlation analysis of each mode showed that the father mode exhibits only a weak correlation between the outer and inner regions, while the mother mode shows a strong correlation between these regions. Also, the histogram of the tilt angle of father and mother mode was extracted using the FRF analysis, as shown in FIG. 1 (a-3) and (b-3), suggesting that the tilt angle of father mode is varying in time while the spatial structure of the mother mode is temporally stable. In this talk, we will discuss the relation between the temporal variation of the spatial structure of mother mode and modal coupling strength.

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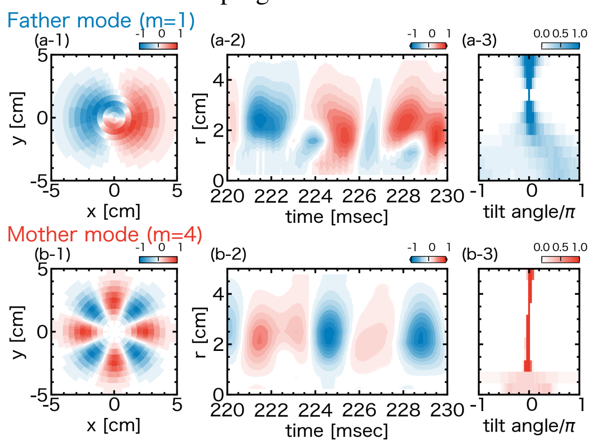

Figure 1 (a1-3) Mean structure, the time evolution of the radial profile of amplitude, and histogram of the tilt angle of Father mode and (b1-3) those of Mother mode. The color contours in (a-2) and (b-2) represent the variation from the mean amplitude at each radial position.

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