§10. Analysis of Density Fluctuations Measured in CHS Plasmas and Understanding of Turbulences in Helical Systems

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We developed a laser imaging method (LIM) with a folded beam to obtain information concerning the spatial distribution of electron density fluctuations in magnetically confined plasmas. The LIM produces real images of the fluctuations, so it is possible to use standard signal analysis tools such as FFT tools. However, the characteristics of these phenomena have blocked researchers from exploiting the full potential of the LIM with the standard analytical methods alone: i) signal decomposition is not performed by the hardware, so it is necessary to perform a multidimensional (spatiotemporal) analysis via software (on the other hand, this also allows for significant diversity in processing); ii)the signal is line-integrated along the probing beam axis; iii) a wavenumber spectral analysis must be carried out with a small number of spatial data; and iv) the polar coordinate system is the most useful as it can specify the propagation directions of fluctuations. With the LIM in particular, a method of analysis with superior resolution of the wavenumber spectrum is required, as the LIM method has, under certain conditions, to identify the spatial locations of the fluctuations from the analysis of their propagation directions.

The authors have carried out investigations of a 2-dimensional maximum entropy method (MEM) with polar coordinates as a means of analyzing data that is appropriate for the LIM. The MEM in particular is anticipated to provide a high spectral resolution, in spite of the low number of data. So, we have developed an analytical technique which can reduce the deterioration of the resolution, especially in a low wavenumber range by formulating the MEM using polar coordinate. [1)]

Figure (a) shows the results of applying the developed 2-dimentional MEM[1)] with polar coordinates, to the data obtained in the CHS plasma with a transport barrier. The probing beam passed through the top and bottom edges of the plasma. Fig.(b) shows the angular distribution calculated from Fig.(a) at $k=0.4\text{mm}^{-1}$. In this method, the spatial position is determined to correspond with the propagation angle. Dotted line in Fig.(b) represents the angle corresponding to the LCMSs on the probing beam alone . The fluctuations were not only in peripheral but also internal plasmas and those fluctuations propagated in the opposite direction. The spatial resolution obtained was much smaller than the diameter of the plasma in the low-wavenumber $k = 0.4\text{mm}^{-1}$.

We will proceed with the analysis to allow a comprehensive understanding of whether such data will be compatible with the electric field of the plasma density and temperature distribution and behavior of the fluctuations observed in the CHS. In addition, we plan to compare with turbulences in the other confinement devices and discuss the validity of this measurement system for other devices.

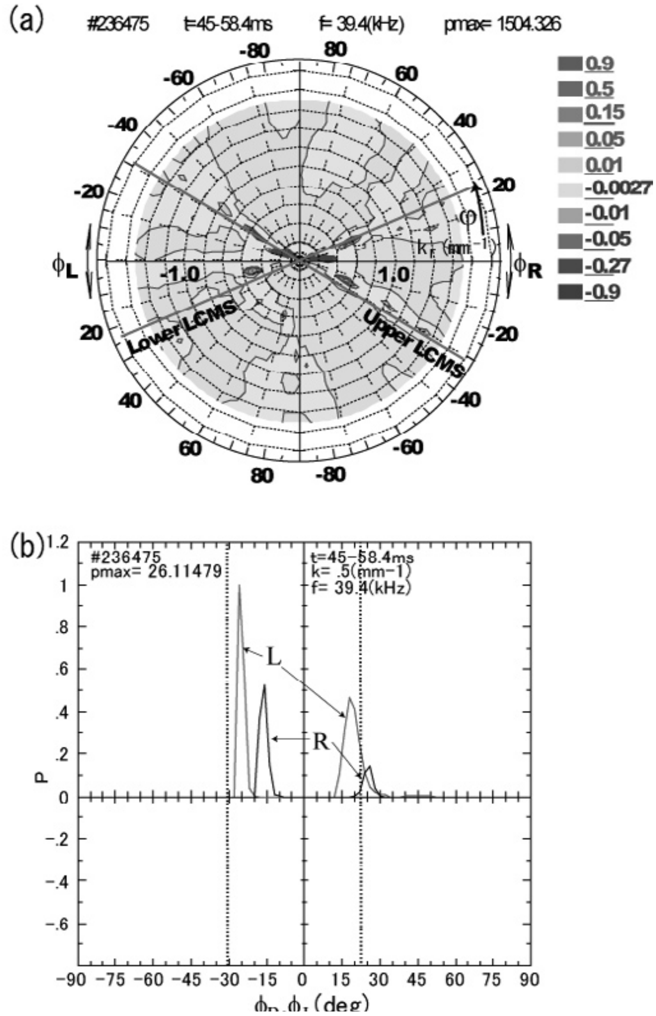

Fig.(a)An example of the analyzed 2-dimensional spatial spectra with polar coordinate Density fluctuations are strong in directions corresponding to the LCMSs. Fig.(b) shows the angular distribution calculated from Fig.(a). Dotted lines correspond to the LCMSs. 0 deg corresponds to the center of the plasma.

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