§7. Statistical Analysis of Core and Edge Plasma Fluctuations in the GAMMA10

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The tandem mirror device GAMMA10 has common magnetic field lines in the core and divertor regions. This study aims to clarify the interdependency between the core and edge plasmas by analyzing electrostatic fluctuations. To obtain the core-plasma fluctuation, we used the gold neutral beam probe (GNBP)[1]. On the other hand, edge fluctuations were acquired with the target plate, the end plate, and/or Langmuir probes on the divertor module.

Firstly, we had searched periodic fluctuations simultaneously appeared in both the regions in a discharge. At the shot number #226553, plasma potential in the core and floating potential in the edge were measured by the GNBP and the target plate, respectively. The sampling frequencies of them were 333 kHz and measured radius of the GNBP was swept at 200 Hz. Measured position of the GNBP was approximately 10 m distant from the target plate along magnetic field lines. During a flat-top phase at the discharge time of t = [170, 190] ms, both the signals had periodic components around the frequency of 87 kHz.

For the data with high spatiotemporal resolution, we applied the cross-correlation technique with band-pass filter of f_s = [77, 97] kHz. Figure 1(a) shows the cross-correlation function of the potentials measured between the target plate and the GNBP, where the GNBP signal was band-pass filtered on a head. Absolute values of correlation amplitude are large at the radius of r > ~3 cm in the core. In addition, phase differences are small at different radii.

Such an image in ($r - \tau$) domain could be converted to the polar coordinate by assuming rigid body rotation of the periodic fluctuation with mode number of m[2] as follows:

$$\theta \equiv \pm 2\pi\left(\overline{f_s}/m\right)\tau + \theta_0, \quad \theta_0 = \text{const}, \qquad (1)$$

where θ is azimuthal angle and $\overline{\cdot}$ means average. The plus-minus sign depends on the rotation direction. Unfortunately, we couldn't identify m and the rotation direction in the discharge. Therefore, we assumed m = 2 as a trial to demonstrate the coordinate conversion. Figure 1(b) shows cross-correlation function converted to the polar coordinate with θ_0 = 0. We could extract two-dimensional spatial behavior in the core region from the above procedure.

In future, we are planning to analyze a relatively low-frequency periodic component at a few kilohertz that was reproducibly observed under a particular set of conditions.

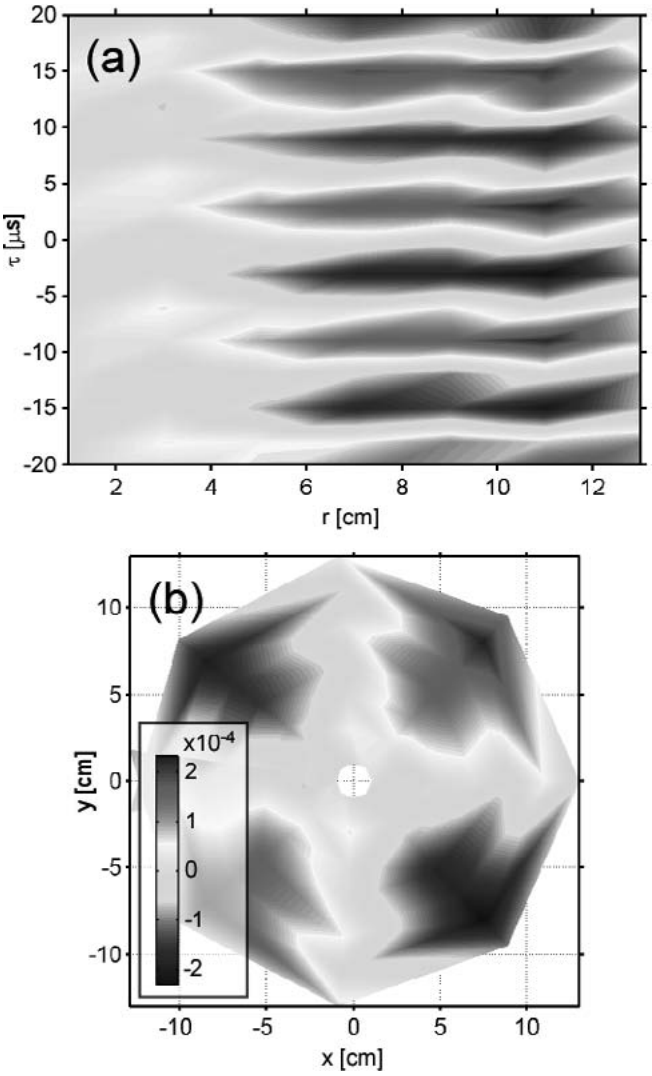

Fig. 1. (a) Cross-correlation function of floating potential at the target plate and band-passed plasma potential measured with GNBP as functions of r and τ. (b) Converted image of the cross-correlation by using Eq. (1).

1) Mizuguchi. M. et al.: Rev. Sci. Instrum. **79** (2008) 10F309.
2) Inagaki. S. et al.: Nucl. Fusion **52** (2012) 023022.