Statistical analysis of ejection property of plasma blobs from plasma column in the linear plasma device

H. Tanaka**, N. Ohno*, Y. Tsuji, S. Kajita

[1] *Graduate School of Engineering, Nagoya University, Furo-cho, Chikusa-ku, Nagoya 464-860, Japan*
** Email: ohno@ees.nagoya-u.ac.jp*
*** Present Address: National Institute for Fusion Science, Toki 509-5292, Japan*

In the edge regions of fusion devices, convective plasma transport of coherent structures, such as blobs, has become well-known phenomenon over about a decade. High-temporal resolution measurements by using fast-imaging camera and/or Langmuir probes clarified detailed characteristics of plasma blobs: generation region, transport direction, velocity, size, flux, and so on. Blobs are thought to be generated due to instabilities, however the generation mechanism of plasma blobs has not been clearly understood yet.

To validate the generation mechanism, fluctuations in time domain are usually analyzed by statistical techniques in detail. On the other hand, by using the experimental data in time-space domain, the fundamental mode of the fluctuations is extracted with conventional mode analysis; however, irregular characteristics of spatial and time series data are rarely investigated due to the difficulty of the data analysis. This study aims to propose a new technique to access the spatial and time information about the blob generation.

Dynamic behavior of coherent structures released from plasma column has been studied in linear device, NAGDIS-II. The visible light emission on two-dimensional (2D) plane perpendicular to the magnetic field was measured with a fast-imaging camera. As a result, spiral-shaped visible light emissions, which rotate toward the $\mathbf{E}\times\mathbf{B}$ drift direction, were intermittently observed. The fundamental m = 1 mode of the fluctuation was clarified by applying proper orthogonal decomposition (POD) technique [1]. The fundamental component of the spiral structure was found to rotate as a rigid body at f = 3.35 kHz.

Figure 1(a) shows the time and spatial evolution of the visible light emission intensity at a distance of 25 mm from the center of the plasma column. The horizontal and vertical axes indicate time and azimuthal angle θ. Coherent structures rotate at approximately f =3.35 kHz. In order to remove the global rotation effect, the emission intensities are re-plotted as a function of the displaced azimuthal angle Θ, which is defined by $\Theta(t)=\theta(t)-2\pi ft$, as shown in Fig. 1(b). The rearranged image indicates the intermittency and irregularity of the blob generation. By employing structure-function analysis, it was found that the trajectory of the generation position is similar to Brownian motion.

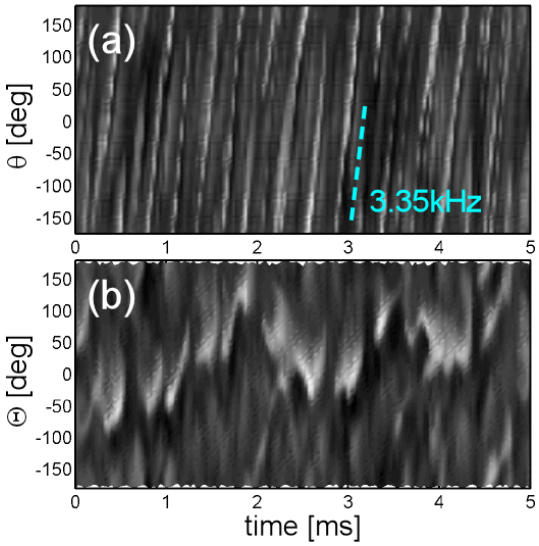

Fig. 1 Time and spatial evolution of the visible light emission intensity as a function of (a) azimuthal angle θ and (b) displaced azimuthal angle Θ.

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