§19. Plasma Blob Transport in Detached Plasmas of the LHD Device

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Blobby plasma transport is an already well-known phenomenon in the edge of several fusion devices. Plasma blobs are detected as positive spikes of ion saturation current I_{sat} fluctuation; thus, Langmuir probe is one of the primary diagnostics to investigate such a cross-field transport. In LHD, detailed analysis of I_{sat} signals measured at a divertor plate has been reported.[1)] Now, it was recognized that the blobby plasma transport in LHD would be enhanced around the detached-divertor. Further, fluctuation characteristics on the detached-divertor plate were greatly different from that in the attached one. To clarify the cause of these things, analysis of I_{sat} measured in the upstream region of the detached-divertor is desired.

In the beginning, we have analyzed I_{sat} fluctuation measured by a fast scanning probe (FSP) in a discharge with attached-divertor. The FSP was installed on the top of vacuum vessel in LHD, as shown in Fig. 1. Sampling frequency was 1 MHz.

To detect the blobs and holes from the I_{sat} fluctuation, skewness, which is defined by the third order central moment divided by the three-halves power of the second order central moment, is the often-used statistic. As well as in the previous study[2)], skewness on the divertor leg was negative; skewness inside the private region was positive in this study. The positive and negative skewness implies existences of blobs and holes, respectively.

Figure 2(a) shows the distributions of I_{sat} and the skewness near the private side edge of the divertor leg. The horizontal axis is a height from the midplane z. This is the first to indicate that the boundary where the skewness was almost zero corresponds to the position where the I_{sat} distribution had a maximum gradient. Figure 2(b) shows absolute values of the wavelet coefficients, indicating that high-frequency components around 100 kHz strongly appear at around the same position. The z-axis points to low-field side (LFS) direction in the measuring range of the FSP; therefore, blobs and holes would be generated at the LFS and high-field side (HFS) of the LFS edge of the divertor leg, respectively, as shown in Fig. 3.

In tokamaks, blobs and holes are thought to be generated near the LFS separatrix[3)] where the steep pressure gradient exists. There are similar characteristics near between the LFS separatrix in tokamaks and the LFS edge of the divertor leg in LHD. There is universality related to the phenomenon in the different magnetic configurations; however, the expected effects of the cross-field transport are extremely different.

The blobby plasma transport in LHD would be a localized phenomenon inside the divertor region unlike in tokamaks. Therefore, the phenomenon does not influence directly the core region in LHD. In addition, the cross-field transport occurred near the divertor plate is expected to contribute to the broadening of particle and heat loads to the divertor plate.

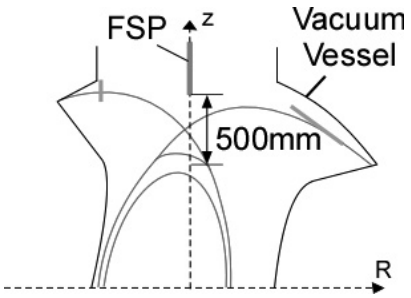

Fig. 1 Schematic diagram of the FSP on the elongated poloidal cross-section in LHD.

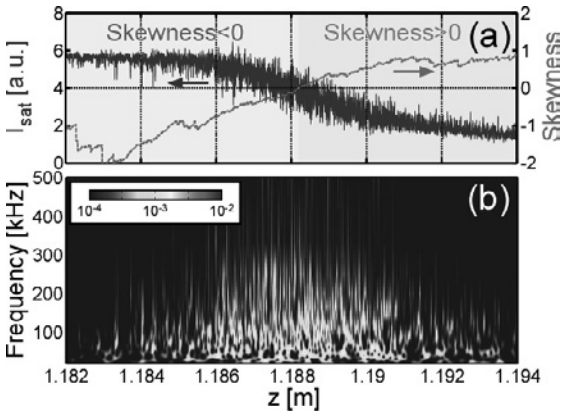

Fig. 2 (a) Distributions of I_{sat} (solid line), skewness (dashed line), and (b) absolute values of wavelet coefficients near the private side edge of the divertor leg.

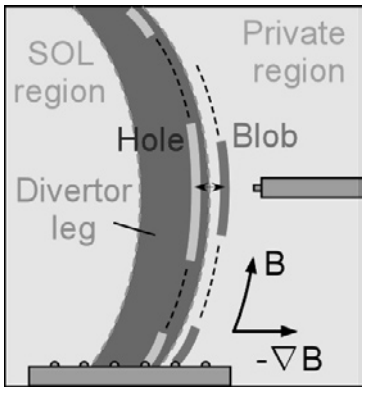

Fig. 3 Pattern diagram of the blobby plasma transport in LHD.

1) Tanaka, H. *et al*.: Phys. Plasmas **17** (2010) 102509.
2) Masuzaki, S. *et al*.: Proc. of ITC/ISHW2007.
3) Xu, G.S. *et al*.: Nucl. Fusion **49** (2009) 092002.