Effects of Drift on the Divertor Plasma Transport in LHD

S. Masuzaki[a,b], H. Tanaka[c], M. Kobayashi[a,b], G. Kawamura[a,b], and the LHD experiment group

[a]*National Institute for Fusion Science, Oroshi 322-6, Toki 509-5292, Japan*
[b]*Department of Fusion Science, SOKENDAI (Graduate University for Advanced Studies), Oroshi, Toki, Japan*
[c]*Graduate School of Engineering, Nagoya University, Furo-cho, Nagoya 464-8603, Japan*

masuzaki.suguru@nifs.ac.jp

The asymmetric plasma heat and particle loads on the divertor tiles, which are located at the positions of a symmetric magnetic field lines structure, have been observed in the Large Helical Device (LHD). The degree of the asymmetry depends on the toroidal field magnetic field direction and plasma operation, and drift is considered to be a cause of the asymmetry. In this presentation, the results of the evaluation of the degree of the asymmetry are shown, and the mechanisms are discussed.

In tokamaks with poloidal divertor configuration, in/out asymmetry is usually observed in divertor particle and heat flux, and that causes the asymmetry of deposition/erosion of plasma facing materials. The mechanisms of the in/out asymmetry are still under investigation, and plasma flow, drift, and the in/out asymmetry of magnetic field configuration can affect the asymmetry. Understanding of the mechanisms of divertor particle and heat load asymmetry is necessary to consider plasma-wall interaction in future fusion reactor.

In LHD, plasma experiments have been conducted under the helical divertor configuration, which is a built-in divertor magnetic field lines structure in the heliotron-type magnetic configuration. To investigate the divertor plasma properties, Langmuir probe arrays are embedded in the divertor tiles, which locate near the mid-plane at torus inboard-side divertor in seven of ten toroidal sections. At each toroidal section, a pair of the Langmuir probe arrays is located at two positions in symmetric relation with regard to the magnetic field lines structure. The asymmetric particle flux and heat load on the divertor tiles have been observed in LHD [1]. The asymmetry is inverted by changing the toroidal magnetic field direction. Therefore, $E\times B$ drift and/or $B\times\nabla B$ drift can be considered to be the cause of the asymmetry. Recently, the first deuterium plasma experiment in LHD was conducted in 2017. The isotope effect on the asymmetry was evaluated, and the result shows that the effect is not clear. That possibly suggest $E\times B$ drift is the dominant mechanism of the asymmetry.

In this presentation, the results of the further investigation of the asymmetry, such as plasma parameter dependences will be shown, and the mechanisms of the asymmetry in helical system will be discussed.

[1] S. Masuzaki, et al., Fusion Sci. Technol. 50 (2006) 361-371.