S-P1-4

Plasma Behavior Analysis through PWI Phenomena in the Dynamic Ergodic Divertor Plasma

動的エルゴディックダイバータプラズマにおける
PWI現象を利用したプラズマ挙動解析

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The dynamic behavior of rotating helical magnetic field perturbation at SOL is studied by analyzing the phase difference between H_α intensities at a poloidal limiter, an ALT-II tile and a DED tile and the DED coil current in TEXTOR. In the case of the counter-rotating DED, the phase difference decreases when the mode (m/n=2/1) onsets. When ECRH is applied, the mode disappears and the phase difference recovers to the former value. The phase differences shift toward the advanced direction with increase in the electron density except that of the DED tile in the case of the co-rotating DED. This means that the density perturbation at SOL advances with increase in the electron density. It may be attributed to the change in the diamagnetic frequency due to the density increase.

1. Introduction

Helical magnetic field perturbations are produced by the currents flowing in the dynamic ergodic divertor (DED) coils in the TEXTOR tokamak to study a lot of interesting researches of effects of externally-applied magnetic perturbations on plasma properties such as plasma confinement, excitation of MHD, mitigation of ELMs, plasma shielding and heat load distribution on the wall. The behavior of peripheral region of plasma is complicated.

The dynamic behavior of rotating helical magnetic field perturbation at scrape off layer (SOL) has been studied by analyzing the phase difference ($\Delta\phi$) between H_α intensity and the DED coil current in TEXTOR. The interacting position between plasma and a limiter or a divertor tile shifts according to the helical rotation of the magnetic field perturbation. The H_α intensity is also perturbed due to the plasma-wall interaction. So, the change in $\Delta\phi$ should correspond to the behavior of the magnetic perturbation field.

2. Experimental Results

The H_α intensities were measured at poloidal limiters (PL), an ALT-II tile (AL) and a DED tile (DT). The value of $\Delta\phi$ was obtained by using a cross spectrum between signals of the H_α intensity and the DED coil current.

The counter-rotating DED with its mode of m/n=3/1 at 1kHz AC was applied to NBI (300 kW) heated plasma (B_T = 2.25 T, I_p = 300 kA and $\bar{n}_e$ = 2.0 x 10^{19} m^{-3}) and the amplitude of the DED coil current was ramped up to 2.0 kA. At the threshold of the DED coil current (~1.6 kA), m/n=2/1 tearing mode was exited and the mode was locked to the DED perturbation. At that time, $\Delta\phi$ at each position decreased. Under the definition of the cross spectrum, the decrease in $\Delta\phi$ means that the rotation of the perturbation field draws back in the opposite direction. When ECRH with the power of 800 kW was applied after the mode onset, the 2/1 tearing mode was suppressed and $\Delta\phi$ recovered to the former value.

Next, The electron density was increased from 2 x 10^{19} m^{-3} to 4 x 10^{19} m^{-3} during the co-rotating DED with its mode of m/n=3/1 at 1kHz AC. As the electron density increased, $\Delta\phi$ at PL and AL increased and that of DT did not change probably due to an effect of near field. This means that the rotation of the perturbation field at SOL advanced with increase in the density. It may be attributed to the change in the diamagnetic frequency due to the density increase.

Acknowledgments

This work was mainly conducted during my stay in IPP Juelich as a dispatched researcher supported by MEXT and subsequently it was done under the IEA-REXTOR collaboration program. I would like to express my sincere appreciation to the collaborators of TEXTOR especially Dr. K.H. Finken.