§22. Study of Interaction between Magnetic Island and Plasma Flow Using Electrode Biasing Method

Suzuki, Y., Takahashi, H., Masuzaki, S., Shoji, M.,
Ashikawa, N., Tokitani, M., Yokoyama, M.,
Satake, S., Shimozuma, T., Tokuzawa, T.,
Kubo, S., Ida, K.,
Kitajima, S., Okamoto, A., Ishii, K., Sato, Y.,
Kanno, M. (Dept. Eng. Tohoku Univ.),
Inagaki, S. (RIAM, Kyushu Univ.),
Takayama, M. (Akita Prefectural Univ.)

The effect of the viscosity on the magnetic island changing the plasma rotation is experimentally investigated. The poloidal rotation is externally controlled by the hot cathode biasing.

In the LHD experiment, the self-healing of the magnetic island is observed [1]. That is, the static magnetic island produced by external perturbation coils is suppressed by the plasma response. A question is why the magnetic island appears or disappears. One idea is an interaction between the plasma rotation and external perturbation [2]. If the plasma is rotaing, the external perturbation is shielded out by the singular current on a resonant surface. This singular current is driven by the perpendicular viscosity on the rational surface. This effect is well knwon in tokamak experiments as "the kinetic shielding". Recently, this idea is extended to the helical plasma [3]. Then, changing of the poloidal rotation was observed at the self-healing of the island in the LHD experiment [4]. This means the understanding relation between the external perturbation and plasma viscosity is a critical issue. We need consider the relation in the experiment. On the other hand, in the LHD expeirment, the electrode biasing was used to study the transition to the improved confinemnt. Superposing the current from the electrode to the plasma, the plasma rotation can be controlled by $\mathbf{J} \times \mathbf{B}$ driving force. This is alos the electrode biasing can be used as a nob to control the plasma rotation. In this contribution, we study the relation between the magnetic island and poloidal plasma rotation. Controlling the poloidal rotation by the biasing, the change of the magnetic island is studied.

The target plasma for the biasing in LHD was produced by ECH (f=77 and 84 GHz, $0.2 < P_{\rm ECH} < 0.5$ MW) in magnetic configurations ($R_{\rm ax}$ = 3.53, 3.60 and 3.75 m, $1.375 < B_t < 2.75$ T). The electron density and temperature at the magnetic axis were $0.8 \times 10^{18} m^{-3}$ and ~ 1 keV in the Helium target plasma. The electrode was a cylindrical disk of diameter 100 mm and length 40 mm, made of Carbon and inserted to $\rho \sim 0.8$.

Figure 1 shows a result of the electrode biasing experiment without the external perturbation. In figure 1(a) and (b), voltage and current of the electrode are shown. In this experiment, the biasing is superposed by the triangular waveform. A special attention is the waveform of the current. If the transition is happened, the waveform is changed from the triangular form. This is an evidence of the transition.

Figure 2 shows a result of the electrode biasing experiment with the external perturbation. We superpose the perturbed field for 3 cases. If the perturbed field becomes strong, the current to transit the improved confinement is increased. This suggests the magnetic island affects the plasma rotation because the magnetic island make the perpendicular viscosity.

As a next step, we will study the island width after the transition.

1) Y. Narushima, *et al.*, Nucl. Fusion, **48** (2008) 075010.

2) R. Fitzpatrick and T. C. Hender, Phys. Fluids B, **3** (1991) 644.

3) C. C. Hegna, Nucl. Fusion, **51** (2011) 113017.

4) Y. Narushima, *et al.*, Nucl. Fusion, **51** (2011) 083030.

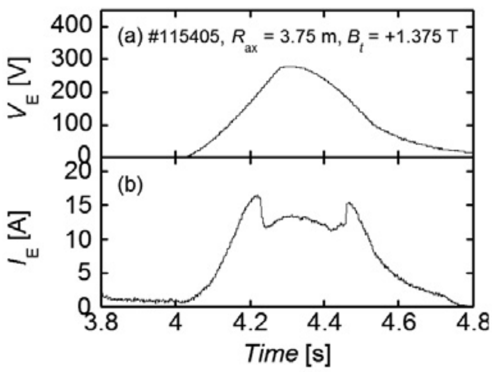

Fig. 1: A result of the electrode biasing experiment without the external perturbed field.

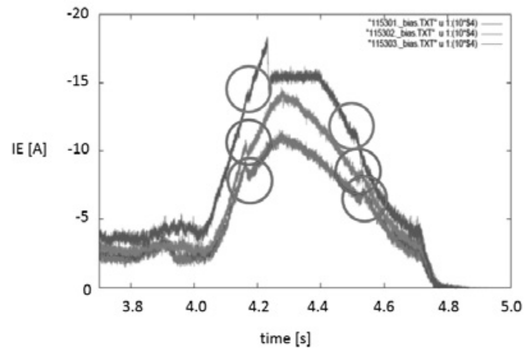

Fig. 2: Results of the biasing experiment with different perturbed field. Increasing the island width, the current to transit is also increased.