

§17. 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., Takahashi, T., Koike, S., Kumagai, T., Daibo, A., Oku, T. (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 rotating, 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 known 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, the poloidal rotation is very sensitive to the external magnetic perturbation. That means there is a possibility to identify the magnetic island or stochastic magnetic field lines from the measurement of the poloidal rotation.

In the LHD experiment, the electrode biasing was used to study the transition to the improved confinement. 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 also the electrode biasing can be used as a knob to control the plasma rotation. In this contribution, we study the relation between the magnetic island and poloidal plasma rotation. The LHD configuration has an intrinsic magnetic island because the error field by the construction error of poloidal field coils is expected. Usually, that intrinsic error field can be cancelled by external Resonant Magnetic Perturbation (RMP) coils. The error field is estimated by a MonteCarlo simulation. However, if we measure the transition of the torque of the electrode biasing, we may de-

tect differences of the transition due to changing external RMPs. Changing the magnetic island width of RMPs, the transition is studied.

The target plasma for the biasing in LHD was produced by ECH ($f=77$ and 84 GHz, $0.2 < P_{ECH} < 0.5$ MW) in magnetic configurations ($R_{ax} = 3.60$ m, $B_t = 1.375$ 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 with 4 cases of external RMPs. At first, we studied linearly increased RMPs cases. The RMP is controlled by the current I_{LID} . Increasing I_{LID} from 0 to 300 A, the current I_E for the transition is increased. That means the magnetic islands drag the poloidal rotation by the electrode biasing. However, it is noted that $I_{LID}=0$ does not mean no magnetic island because of the intrinsic error field. To consider the effect of the intrinsic error field, we tried the “cancel” mode, which is a mode to compensate the intrinsic error field by RMPs. For the cancel mode, I_E is smaller than the case of $I_{LID}=0$. That means significant magnetic islands exist in the case of $I_{LID}=0$.

As a next step, we will optimize I_{LID} to cancel the intrinsic error field completely.

- 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.

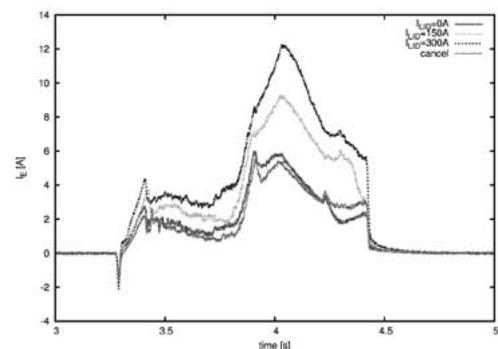


Fig. 1: Results of the biasing experiment with different perturbed field. Increasing the island width, the current to transit is also increased.