§34. Study of Effect of Plasma Flow on Magnetic Island Dynamics in Helical Plasmas with Various Magnetic Configurations

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The understanding of the magnetic island dynamics is an important issue from the viewpoint of its effect on the MHD stability and plasma confinement. In the previous collaboration research of LHD and TJ-II, the common phenomenon which a magnetic island is healed after the increase in a poloidal flow has been observed despite the direction of a poloidal flow differs [1]. It is needed to proceed with the study of magnetic island focusing on the correlation between the magnetic island and plasma flow in helical plasmas with various magnetic configurations. In addition to two devices mentioned above, the study in Heliotron-J is expected to obtain the detailed experimental observation about the magnetic island. Recent study of magnetic island in the LHD, the magnetic diagnostics and flow measurement has been the powerful tool to find out the detailed behavior of the magnetic island. The magnetic diagnostics can estimate the electromagnetic torque on the island whereas the viscous torque on the island can be evaluated from the plasma flow. Typical waveforms of the plasma response field ($\Delta\Phi_{m=1}$), RMP field ($\Delta\Phi_{RMP}$), phase shift ($\Delta\theta_{m=1}$), poloidal flow (v_{pol}), and radial profiles of electron temperature T_e are shown in Fig. 1. In the case that the RMP is ramped up during the discharge (Fig. 1 left), the phase shift $\Delta\theta_{m=1}$ keeps $-\pi$ (rad) and the plasma response field $\Delta\Phi_{m=1}$ linearly increases like $\Delta\Phi_{RMP}$ until t = 5.35 s (Fig. 1 (a, b)). This condition means that the plasma response field compensates the RMP field. As a result, the magnetic island shows healing. The T_e profile does not show the local flattening region (Fig. 1 (d)). After t = 5.35 s when the RMP reaches $\Delta\Phi_{RMP} = 1.6\times10^{-4}$(Wb), the phase shift departs from $\Delta\theta = -\pi$ (rad), which means that the RMP penetrates into the plasma and the local flattening appears in the T_e profile at R = 3m (Fig. 1 (e)). In the ramping-down RMP case (Fig. 2 right), the RMP field penetrates until t = 5.3 s. In this period the local flattening appears in the T_e profile at R = 3m (Fig. 1 (i)). After t = 5.3 s when the RMP reaches $\Delta\Phi_{RMP} = 1.3\times10^{-4}$(Wb), the phase shift reaches $\Delta\theta = -\pi$(rad) and the plasma response field, $\Delta\Phi_{m=1}$, decreases linearly with ramped $\Delta\Phi_{RMP}$, which means that the RMP is shielded. As a result, the magnetic island disappears. The T_e profile does not show the local flattening region (Fig. 1 (j)). During these transitions, the v_{pol} is almost constant.

In the Heliotron-J, the CXRS system measuring a CVI line has been installed to obtain the parallel flow velocity $v_\parallel$ [2]. Figure 2 shows the radial profile of $v_\parallel$ in various configurations (high mirror, standard and reversed mirror configurations). The $v_\parallel$ outside ρ = 0.8 is not shown due to the low S/N ratio. In the high mirror configuration, the $v_\parallel$ is about half of that in the standard and reversed mirror configurations at the core region (ρ < 0.5). In the Heliotron-J, the magnetic diagnostic system has been installed, which enables us to estimate the electromagnetic torque on the magnetic island. In addition to the magnetic diagnostics, the plasma flow measurement system CXRS is expected to take more detailed behavior of the magnetic island. This work was supported by the budget of NIFS under contract No.NIFS12KUHL052.

1) Y. Narushima, et al., (2011) Nucl. Fusion **51** 083030
2) H. Lee, et. al., (2013) PPCF **55** 035012

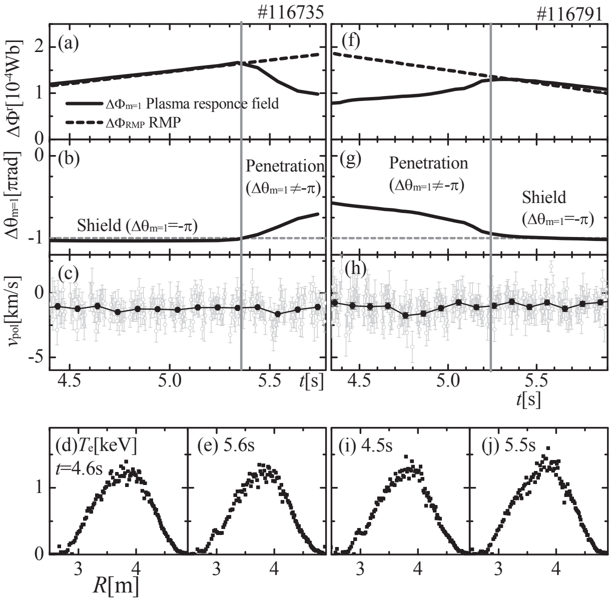

Fig.1 Time evolution of (a, f) plasma response field (solid) and RMP (dashed), (b, g) phase shift $\Delta\theta$, (d, e, i, j) electron temperature. (Left) Case of RMP ramp up (Right) Case of RMP ramp down.

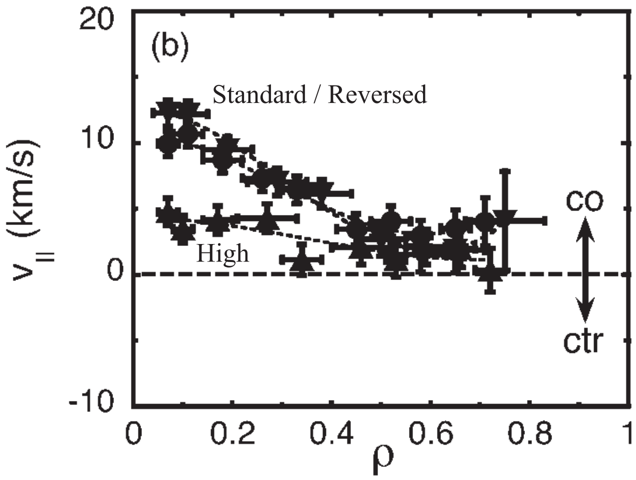

Fig. 2 (Heliotron-J) Radial profile of parallel flow velocity [H. Lee, et. al., (2013) PPCF **55** 035012].