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

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The magnetic island dynamics have been studied to understand its effect on the MHD stability and plasma confinement in magnetically confined plasmas. In helical plasmas, among the Heliotron (LHD) and Heliac (TJ-II), the common phenomenon that a magnetic island is healed after the increase in a poloidal flow has been observed[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 those two devices, the study in the Heliotron-J (Helical-axis Heliotron) is expected to obtain the detailed experimental observation about the magnetic island. In the recent study of magnetic island in the LHD, the relationship between the poloidal flow and the island state shows the clear hysteresis[2]. Figure 1 shows the relationship between the phase difference, $\Delta\theta_{m=1}$, and the poloidal flow, ω_{pol}, at just outside the $\iota/2\pi = 1$, in which arrows indicate the time trend. In the case of the transition from growth to suppression (Fig. 1 (a)) the phase shift $\Delta\theta_{m=1}$ transits from $\Delta\theta_{m=1} \sim -0.1\pi$rad to $\Delta\theta_{m=1} \sim -\pi$rad. The threshold value of the poloidal flow, ω_{pol}^{th}, derived from the fitting of a Heaviside-function is $\omega_{pol}^{th} = -9.4\pm0.8$ krad/s. In the other case of the transition from suppression to growth (Fig. 1 (b)), $\omega_{pol}^{th} = -6.4\pm 0.9$krad/s. These experimental results show the existence of a poloidal flow hysteresis in the magnetic island transition dynamics.

In the Heliotron-J, the CXRS system measuring a CVI line has been developed to obtain the poloidal flow velocity v_θ [2]. Figure 2 shows the radial profile of v_θ in various heating methods (NBI and ECH). In the ctr.-directed NBI heated plasma with input power of 400kW, the electron-diamagnetic directed poloidal flow of $v_\theta \sim$ -2km/s is observed, as shown in Fig 2(a). That profile is almost flat within the measured range of minor radius. On the other hand, the ion-diamagnetic directed poloidal flow is realized in case the ECH is applied to the NBI plasma. It is interested that the velocity of v_θ increases with the ECH power at the core region ($r/a \sim 0.4$). These experimental facts in Heliotron-J imply that the measurement and the profile control of the poloidal flow can be available. This CXRS system is a powerful tool to study the effect of plasma flow on magnetic island dynamics in helical plasmas with various magnetic configurations

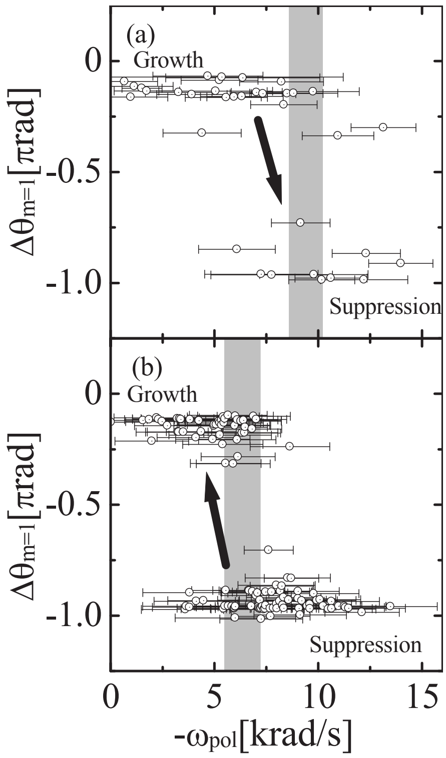

Fig.1 (LHD) Relationship between $\Delta\theta_{m=1}$ and ω_{pol}. Case of (a) growth to suppression, (b) suppression to growth. Arrows indicate time trend. Grey solid line indicates threshold of poloidal rotation for transition (ω_{pol}^{th}). Threshold values of poloidal rotation are (a) $\omega_{pol}^{th} = -9.4\pm0.8$ krad/s and (b) $\omega_{pol}^{th} = -6.4\pm 0.9$krad/s, respectively. [Y. Narushima, et al., *"Experimental Observation of Response to Resonant Magnetic Perturbation and Its Hysteresis in LHD"* Accepted in Nucl. Fusion

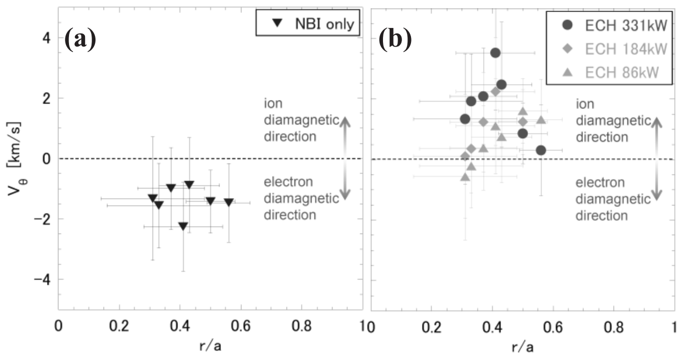

Fig. 2 (Heliotron-J) Radial profile of poloidal flow velocity. (a) Electron-diamagnetic direction in NBI heated plasma. (b) Ion-diamagnetic direction in ECH imposed NBI plasma. [T. Harada, *et. al.,* (2014) Plasma conference 19PB-083].

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1) Y. Narushima, et al., *"Experimental Observation of Response to Resonant Magnetic Perturbation and Its Hysteresis in LHD"* Accepted in Nucl. Fusion
2) T. Harada, *et. al.,* (2014) Plasma conference 19PB-083