§6. Dependence of Resonant-magnetic-perturbation Threshold on Magnetic Configuration

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Magnetic island dynamics has been studied under the viewpoint of the balance between the electromagnetic torque and viscous torque, investigating the island behavior when the time-varying resonant magnetic perturbation (RMP) is imposed. Typical wave forms are shown in Fig.1 in which the RMP is swept in time. In the beginning of the discharge, the RMP does not penetrate into the plasma, which can be realized by that the $\Delta\Phi_{m=1} = \Delta\Phi_{RMP}$ and $\Delta\theta_{m=1} = -\pi$ (rad). Here, $\Delta\Phi_{m=1}$, $\Delta\Phi_{RMP}$ and $\Delta\theta_{m=1}$ are the plasma response, the RMP and phase difference between the plasma response and the RMP. When the RMP reaches $\Delta\Phi_{RMP} = 1.6\times10^{-4}$ (Wb) at t = 5.35 s, the RMP penetrates into the plasma. The thresholds of RMP for the transition differ in each RMP trends[1], and depends on the magnetic axis position R_{ax}. The island dynamics has been investigated based on the hypothesis that the poloidal flow drags the magnetic island and electromagnetic force attempts to lock the island[2-4]. Here, the ratio of electromagnetic torque $\vec{j}\times\vec{B}$ relevant value $\Delta\Phi_{m=1}\Delta\Phi_{RMP}\sin\Delta\theta_{m=1}$ to the poloidal flow ω_{pol} is defined as

$$R_{EV} \equiv \Delta\Phi_{m=1}\Delta\Phi_{RMP}\sin\Delta\theta_{m=1}/\omega_{pol} \qquad (1)$$

Figure 2 shows the R_{ax} dependence of R_{EV} (Closed circles), in which the R_{EV} increases with R_{ax}. From the viewpoint of the torque balance, the R_{EV} is supposed to be constant even in the different R_{ax}. These experimental data are acquired under the condition that the RMP is penetrated. These experimental observations imply that a hidden (still not found) parameter should exist. The poloidal flow acts on the magnetic island as a drag force with the viscosity. Under the condition of the constant poloidal flow, the drag force on the magnetic island becomes large in the higher viscosity plasma. The open circles in Fig. 2 are the neoclassical poloidal viscosity (NPV) calculated by FORTEC-3D code, in which the increase in NPV with R_{ax} can be seen. These results indicate that the drag force at larger R_{ax} becomes strong via the NPV and are corresponding to the experimental fact that the magnetic islands are likely to be healed at the larger R_{ax}. This work was supported by the budget of NIFS under contract No.NIFS13ULPP014.

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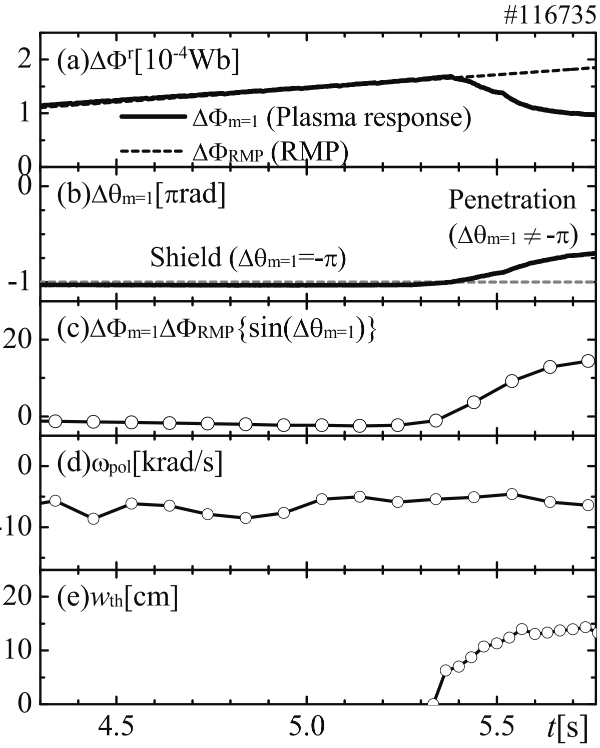

Fig.1 Time evolution of (a) Plasma response field (solid) and RMP (dashed), (b) phase shift, (c) parameter equivalent to electromagnetic torque, (d) poloidal flow, and (e) flattening width of T_e.

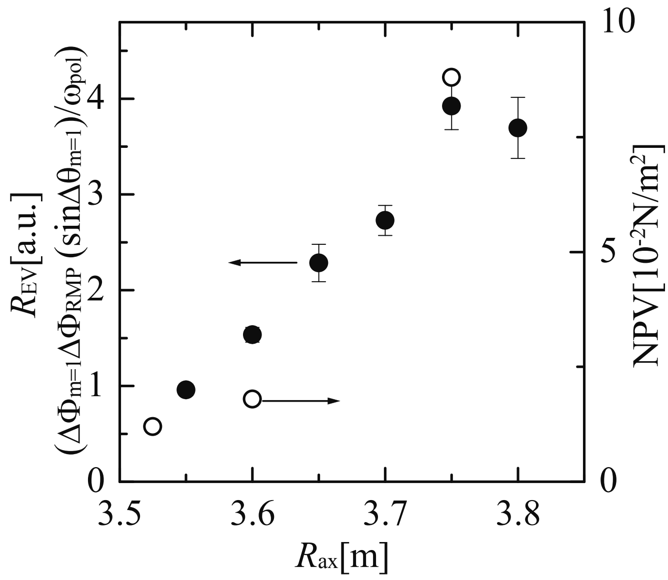

Fig.2 (Closed circle) Ratio of electromagnetic-torque-equivalent parameter to poloidal flow. (Open circle) calculation result of neoclassical poloidal viscosity.