§26. Study of MHD Equilibrium and Stability in Heliotron Configuration

Sakakibara, S.

In heliotron configuration, activity of pressure driven mode is one of key issues for realization of high-beta plasma. Especially, since it is predicted theoretically that excitation of interchange instability strongly depends on the magnetic field structure such as magnetic shear, magnetic well/hill and so on, and the dependence of the configuration and the effect on plasma confinement has been studied in stellarators and heliotrons. The final purpose of this study is to understand characteristics of MHD activities with change of the equilibrium such as finite-β effects, plasma current and so on in Heliotron-J with low-magnetic shear and magnetic hill configurations and to compare with experimental results in LHD with strong magnetic shear and magnetic hill. In this fiscal year, the dependence of observed MHD modes on rotational transform and the effect of plasma currents were investigated in order to understand the basic characteristics of MHD activity in Heliotron-J.

Figure 1 shows amplitudes of magnetic fluctuations in configurations with different rotational transform at the plasma edge ($\iota_a/2\pi$). The data is obtained in the plasmas with $<\beta_{dia}> < 0.45$ % and I_p = 0~3 kA. The fluctuations are enhanced around $\iota_a/2\pi$ = 0.5 and 0.66, and they have m/n = 2/1 and 5/3 spatial structures, respectively. The example discharge in the configuration with $\iota_a/2\pi$ = 0.56 is shown in fig.2. The burst-like m/n = 5/3 mode was excited at 0.23 s and plasma stored energy W_p abruptly decreased then. The W_p started to increase again at 0.265 s, which is due to the suppression of the m/n = 5/3 mode. It is predicted that the increase in the plasma current shifts the m/n = 5/3 resonance to the outward and leads to the reduction of the pressure gradient around the resonance. Although the plasma current is too small to excite the current driven instability, it significantly affects characteristics of pressure driven one through change of the magnetic field structures such as the location of the resonance, the increase and decrease in the magnetic shear and so on, especially, in low-magnetic shear configuration. Also the effect of low-order MHD mode on the plasma confinement in low-magnetic shear configuration is relatively significant compared to the case of high-magnetic shear LHD.

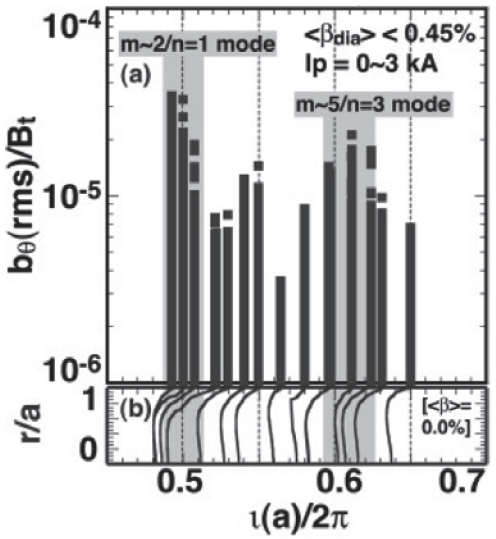

Fig.1 Relationship between observed MHD modes with f < 20 kHz and rotational transform at the plasma edge.

On the other hand, internal measurements of the low-order MHD mode may make the identification of the current profile possible by the movement of the resonance. Here we attempt to identify the location of the m/n = 2/1 mode in the plasmas with co- or counter beam currents by the measurement with the soft-X ray diode array[1]. In the case of the co- current increasing the rotational transform, $\iota_a/2\pi$ was set at 0.5, whereas $\iota_a/2\pi$ = 0.48 in the counter-current case. The maximum currents in the co- and counter currents cases are 2.5 kA and 1 kA, respectively, and the difference is due to the bootstrap currents. The resonant position in the co-current case is ρ = 0.8~0.9, and that in the counter-current case is ρ ~ 0.75. The movement of the resonance was not observed in both discharges. The analyses of MHD equilibria taking into account the plasma currents and its profile suggests that the experimental results can be interpreted by considering the balance of the profile between Ohkawa-current and bootstrap current.

1) G. Motojima *et al.*, proc. ITC-17 (2007) P2-046.

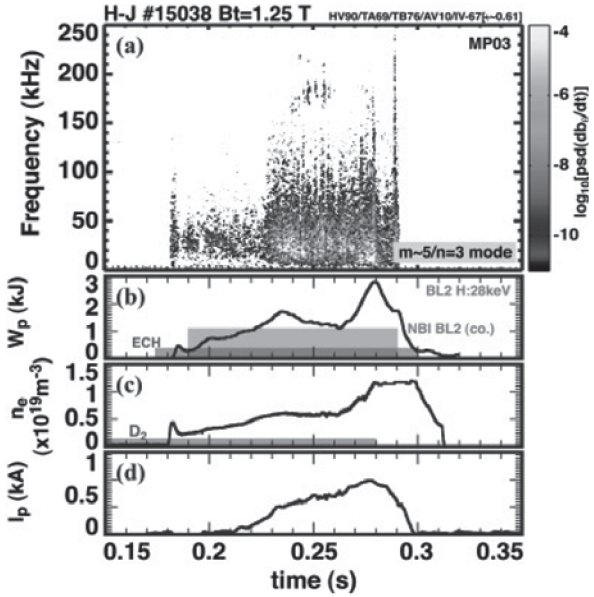

Fig.2 MHD activities in ECH and NBI plasma of the configuration with $\iota_a/2\pi$ = 0.56