§5. Effects of Pressure Flattening in LHD

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Since the interchange mode is driven by the pressure gradient, it can be stabilized by flattening the pressure profile around the resonant surface. It was studied how effectively the mode is stabilized by the pressure flattening in the LHD configuration with inward-shifted vacuum magnetic axis. Figure 1 shows the profile of the rotational transform of a currentless equilibrium at $\beta_0 = 2\%$ with the smooth pressure profile P_s given by $P_s(\rho) = P_0(1-\rho^2)^2$, which is shown by the solid line. In this case, there exists the rational surface with $\iota = 1/2$ in the plasma column. The stability calculation with the RESORM code[1] gives an unstable $n = 1$ ideal mode. Figure 2 shows the mode structure of the stream function. The dominant component is $m = 2$ which is resonant at the surface with $\iota = 1/2$ and shows a typical interchange type structure. The half-width of the component is 0.14 in ρ.

The effects of the pressure flattening is considered by assuming the profile of $P = P_s + \lambda(\rho - \rho_s)\exp\{-0.5[(\rho-\rho_s)/w]^2\}$. Here w is the measure of the width of the flattened region, and λ is determined so as to satisfy $dP/d\rho = 0$ at a specified position, $\rho = \rho_s$. In this case, $\rho_s = \rho|_{\iota=1/2}$ is chosen to see the stabilizing effects of the interchange mode. The flattened pressure profile for $w = 0.035$ is also plotted in Fig.1 (dashed line). Figure 3 shows the dependence of the growth rates of the interchange mode on the width of the flattened region. The mode is effectively stabilized by enlarging the width, and is completely stabilized by the pressure flattening with $w = 0.037$ at $\beta_0 = 2\%$ which is about a quarter of the half-width of the mode for the smooth pressure profile. Similar stabilization is also obtained at $\beta_0 = 1\%$ and 3% as shown in Fig.3.

Thus, the interchange mode can be stabilized by flattening the pressure at the resonant surface with much narrower width of the flattened region than the half width of the mode. One of the possible ways to control of such pressure flattening is providing the magnetic island formation. In the LHD, utilizing the local island divertor coils may be effective.

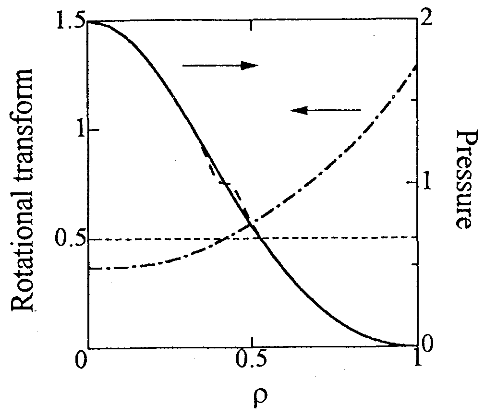

Fig.1 Profiles of rotational transform and pressure at $\beta_0 = 2\%$.

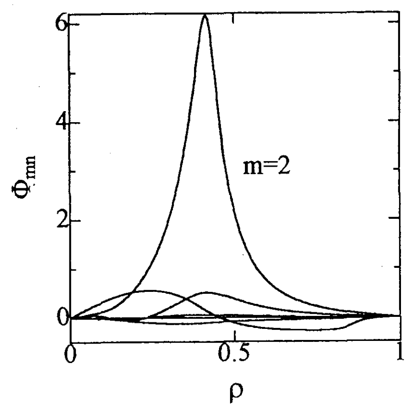

Fig.2 Fourier components of the n=1 mode for smooth pressure.

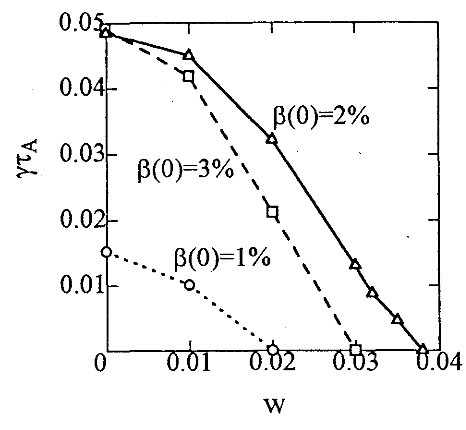

Fig.3 Growth rates of the n=1 modes versus w.

References
1) Ichiguchi, K., et al., Nucl.Fusion 31 (1991) 2073.