§4. Resistive Current-Driven Mode in LHD

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An internal kink mode as an ideal current-driven mode can be unstable in the LHD plasma with a substantial net toroidal current, the possibility of the unstable resistive current-driven mode is considered by means of the RESORM code. The current density of the net toroidal current is assumed to be $J = J_0(1-\Phi)^h$ (Φ :normalized toroidal magnetic flux). Since the growth rate of the current-driven mode like tearing mode decreases as m increases, we consider equilibria including resonant surfaces of $\iota = 1/2$. In order to find the resistive modes with the RESORM code, the equilibrium must be stable for the ideal internal kink mode, because only the ideal mode can be obtained when the ideal mode is unstable. The current driven modes are sensitive for the magnetic shear at the resonant surface. Thus, it is fairly difficult to find an equilibrium to be unstable only for the resistive mode because the ideal internal kink mode appears for very weak shear and the resistive mode becomes stable for very strong shear.

Figure 1 shows the two profiles of the rotational transform both of which have two surfaces of $\iota = 1/2$. These equilibria are achieved at $\beta = 0\%$ in which only the outer layer is used in the helical coils in the LHD configuration. In the case of the total current (I) being 160kA and $h = 4$(dotted line) for $B_0 = 3$T, only an ideal internal kink mode appears. In the case of $I = 120$kA and $h = 6$(solid line), no ideal mode becomes unstable and an unstable $m = 2/n = 1$ resistive mode can be obtained. As shown in Fig.2, the poloidal flux of the mode is not zero at the resonant surface owing to the resistivity. In order to know what kind of mode it is, the dependence of the growth rate (γ) on the magnetic Reynolds number (S) is estimated. As shown in Fig.3, we obtained $\gamma \propto S^{0.363}$. This dependence is weaker than that in the tearing mode. It is considered that the equilibrium with $I = 120$kA is marginally unstable for the ideal internal kink mode, and therefore, the resistive mode would be a tearing mode affected by the unstable ideal mode which cannot be obtained numerically.

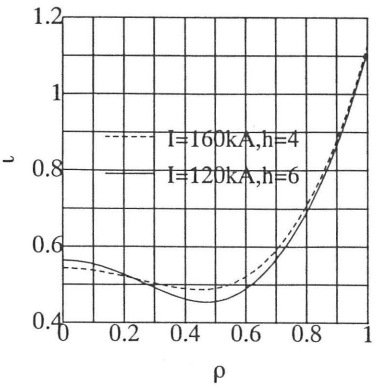

Fig.1 Two types of rotational transform.

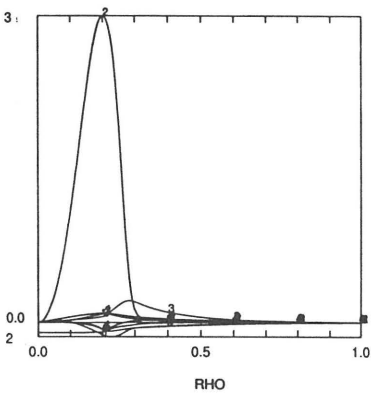

Fig.2 Poloidal flux function of $m = 2/n = 1$ mode.

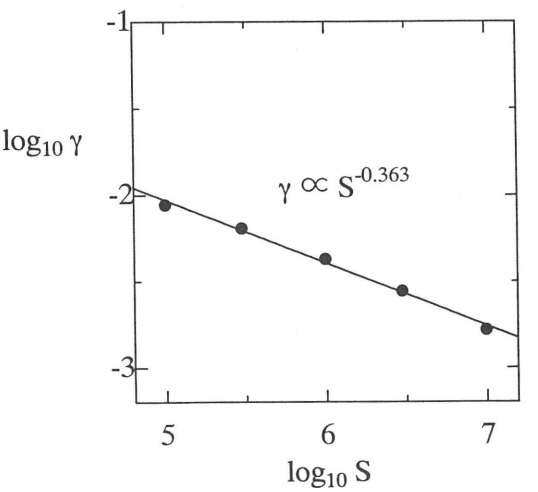

Fig.3 Growth rate versus S.