§17. Tearing Mode in a Heliotron Plasma

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Tearing mode is studied in an LHD plasma carrying the net toroidal current[1]. The global mode analysis is employed by using the RESORM code[2]. The mode with $(m,n) = (2,1)$ is focused here.

As shown in Fig.1, the profile of the rotational transform ι can change at $\beta_0 = 0\%$ depending on the toroidal current I. Two $\iota = 1/2$ surfaces appear in the plasma column for $100kA < I \leq 150kA$ with $B_0 = 3T$ as shown in Fig.2. In the range of $120kA \leq I \leq 150kA$, the ideal internal kink mode is unstable of which the growth rate γ is shown in Fig.2. When the finite resistivity is taken into account, a resistive mode is destabilized at the region where the ideal mode is stable. Figure 3 shows the profiles of the eigenfunction of the resistive mode with $S = 10^7$ at $I = 110kA$, where S denotes the resistive Reynolds number. The mode structure is localized around the inner $\iota = 1/2$ surface. The stream function is odd with respect to the surface and the poloidal flux has a finite value at the surface which corresponds to the generation of the magnetic island. This feature of the eigenfunction is typical for the tearing mode. Figure 4 shows the S-dependence of the growth rate. The dependence calculated with the values for $S = 10^8$ and $S = 10^9$ scales $\gamma \propto S^{-0.54}$ at $I = 110kA$. This is close to that for the tearing mode given by the Δ' theory[3], $S^{-3/5}$. As the current increases and γ of the internal kink mode increases, the dependence becomes weak. This is because the tearing mode is affected by the ideal internal kink mode. This tendency is quite similar to that in the case of the ideal and the resistive interchange modes[4].

As the beta value is increased, the resistive interchange mode is destabilized. A tearing and resistive-interchange hybrid mode is obtained at a finite beta.

References

1) Ichiguchi, K., accepted in J.Plasma Fusion Res. SERIES.

2) Ichiguchi, K., et al., Nucl.Fusion **41**,(2001)181.

3) Furth,H.P., et al., Phys. Fluids, **6**,(1963)459.

4) Ichiguchi, K., et al., Nucl.Fusion **29**,(1989)2093.

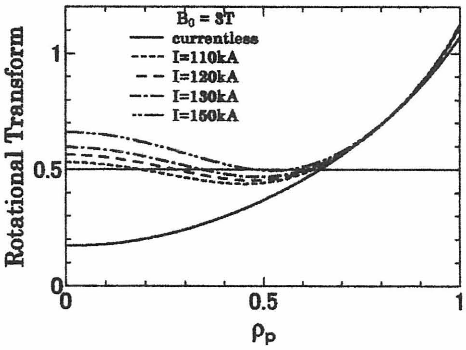

Fig.1 Profiles of rotational transform.

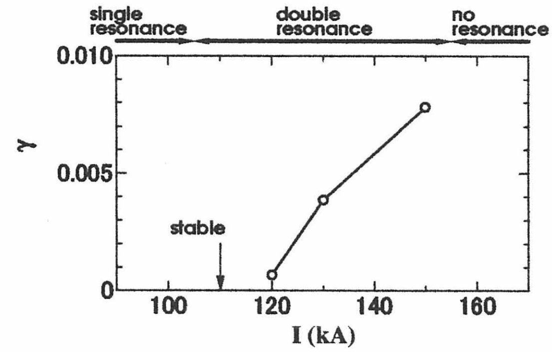

Fig.2 Growth rate of internal kink mode.

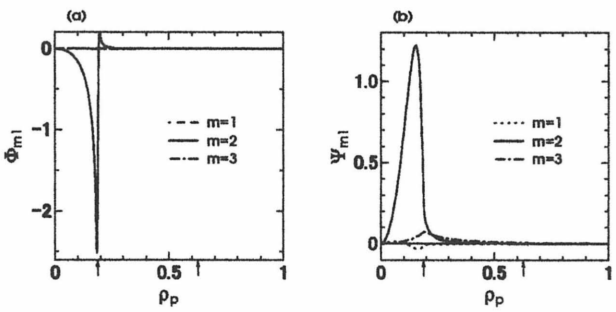

Fig.3 (a) stream function and (b) poloidal flux of the tearing mode.

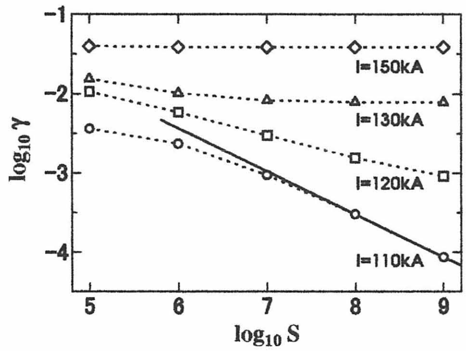

Fig.4 S-dependence of growth rate.