§4. Multi-Scale MHD Simulation of LHD Plasma

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In the LHD experiments, good confinement of the plasma has been observed even in region of parameters predicted to be linearly unstable to ideal interchange modes. In order to investigate the potential mechanism for the plasma stabilization in the beta increase consistently, we have developed a multi-scale MHD simulation scheme[1]. We apply the multi-scale scheme to the LHD plasma with the vacuum magnetic axis located at $R_{ax} = 3.6m$.

Figure 1 shows the time evolution of the kinetic energy. The average beta values at $t = 10000\tau_A$ and $60000\tau_A$ are $\beta = 0.221\%$ and 0.498%, respectively. The total energy varies smoothly in the evolution, which indicates the present multi-scale approach works well. Figure 2 shows the time evolution of the total pressure profile. The profile is deformed continuously as the beta value increases. The deformed structure depends on the interchange mode excited at each beta value. In the present case, the free energy of the mode is not accumulated so much as the disruptive phenomenon is caused. Therefore, the driving force of the mode is weak and the saturated mode width is narrow. Hence, the pressure deformation due to each mode is localized around the corresponding resonant surface through the whole time sequence. Figure 3 shows the Mercier stability for the resultant equilibrium at $t = 60000\tau_A$. The linear stability is improved at dominant resonant surfaces with $\iota = 2/5, 3/7$ and $1/2$ through the local pressure flattening.

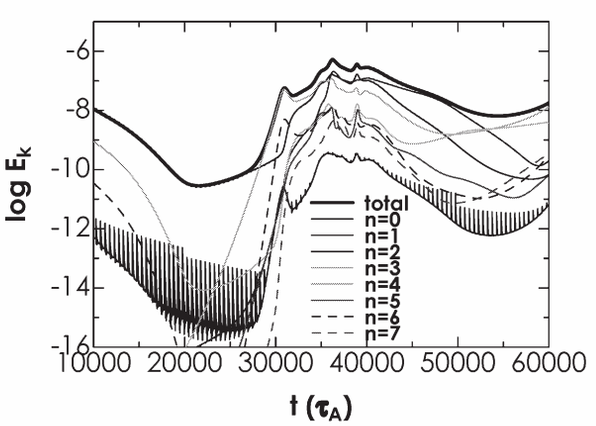
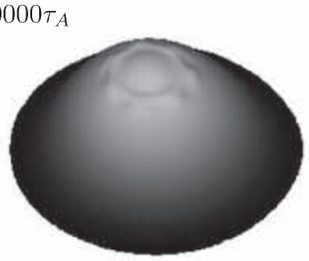


Fig.1 Time evolution of kinetic energy.

This result indicates that the pressure in the LHD can increase with releasing the free energy gradually so as to suppress disruptive phenomena. It can be considered as a self-organization of the pressure.

(a) $10000\tau_A$

(a) $30000\tau_A$



(c) $60000\tau_A$

Fig.2 Bird's eye view of the total pressure profile in the region of $\rho \leq 0.8$.

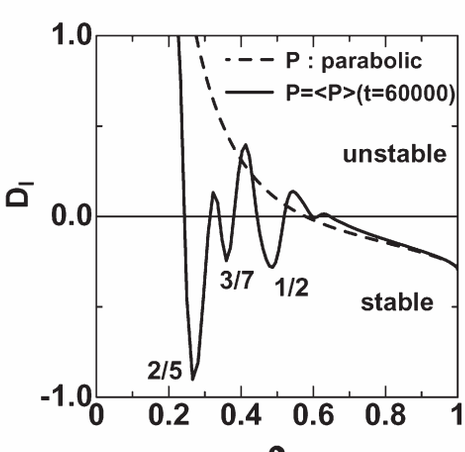


Fig.3 Mercier stability at $\beta = 0.498\%$.

References

1) Ichiguchi,K., Carreras,B.A.: J. Plasma Phys. (accepted).