## §2. Effect of Thermal Conductivity on Resistive Ballooning Modes in High Beta LHD Plasmas

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The effect of thermal conductivity on resistive ballooning modes in high beta LHD plasmas has been investigated by MHD simulation in order to clarify how high beta plasmas are obtained in LHD experiments. In our previous studies, one-fluid model is numerically solved by MIPS code[1)] and an isotropic thermal conductivity was assumed. Here the normalized thermal conductivity was assumed to be $10^{-7}$ and the corresponding realistic value is about $1m^2/s$ under the condition such that $a \sim 0.5m$, $R_0 \sim 3.65m$, $B \sim 1T$, $T_e=T_i=0.5keV$, $n=4\times10^{19}m^{-3}$, where a, $R_0$, B, $T_e(T_i)$ and n are minor radius, major radius, magnetic field, electron(ion) temperature and plasma density, respectively. Therefore, the thermal conductivity used in the simulation is same order as the anomalous transport coefficient observed in experiments. From the simulations, it is found that the central pressure significantly deceases at the saturated state although the resistive ballooning modes are destabilized in the peripheral region.

In this study, the dependence of the thermal conductivity on the resistive ballooning modes has been investigated. Fig. 1 shows the dependence of the (m,n)=(0,0) component of the pressure at the saturated state on the thermal conductivity where m (n) is poroidal (toroidal) mode number in the Boozer coordinates. Here the MHD equilibrium is constructed by HINT2 code[2)] and the central beta value is assumed to be about 7.4%. Although there is a tendency to suppress the reduction of the central pressure as the thermal conductivity increases, the resistive ballooning modes influence the core region even though the thermal conductivity is unrealistic large value. Thus, the simulation results under the isotropic thermal conductivity do not agree with the experimental results.

In realistic plasmas, the thermal conductivity is anisotropic and the thermal conductivity parallel to the magnetic field line is extremely larger than one perpendicular to the magnetic field line. Since the ballooning modes are destabilized in the outer torus, the large thermal conductivity parallel to the magnetic field line may suppress the resistive ballooning modes. In this study, the effect of the parallel thermal conductivity on the linear growth rate of the resistive ballooning modes has been also investigated. For simplicity, a periodic condition is imposed at $\phi=0$ and $\phi=2\pi/10$ where $\phi$ is the toroidal angle. Thus, only the harmonics of n=10, i.e. n=10, 20,..., are analyzed in the simulation. Form the simulation, most unstable mode is n=10 and the dependence of the linear growth rate on $\chi_{\parallel}/\chi_{\perp}$ is shown in Fig. 2 where $\chi_{\parallel}$ and $\chi_{\perp}$ are the parallel thermal conductivity and the perpendicular one, respectively. Although the linear growth rate slightly increases for $\chi_{\parallel}/\chi_{\perp}\sim10^6$, the liner growth rate significantly reduces when $\chi_{\parallel}/\chi_{\perp}$ is larger than $10^6$. Thus, the large $\chi_{\parallel}$ has a stabilizing effect for the resistive ballooning modes in LHD plasmas. The effect of the parallel thermal conductivity on the saturation level for the full torus will be investigated near future.

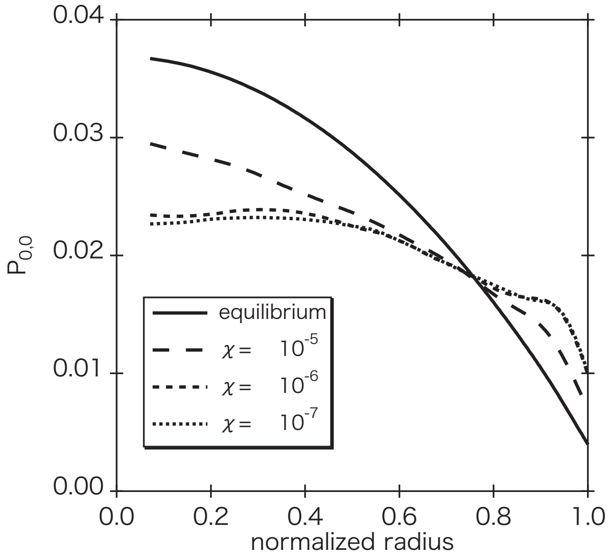


Fig. 1. Dependence of the pressure profile at the saturated state on the isotropic thermal conductivity.

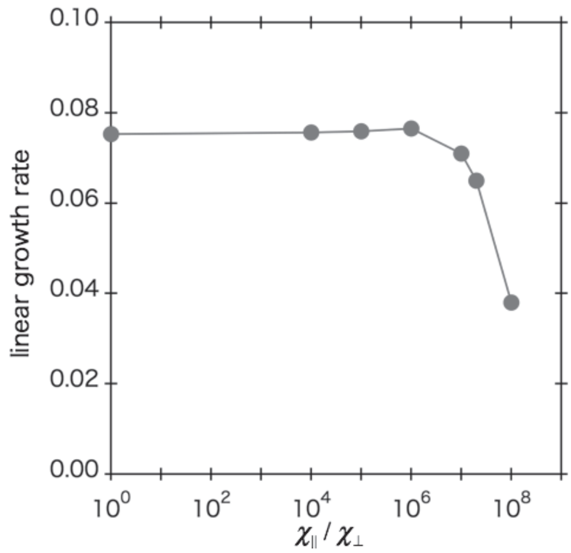


Fig. 2. Dependence of the linear growth rate of the resistive ballooning mode with n=10 on the ratio of parallel thermal diffusivity to perpendicular one.


1) Todo, Y. et al.: Plasma and Fusion Resarch **5** (2010) S2062.

2) Suzuki, Y. et al.: Nuclear Fusion **46** (2006) L19.