# §17. Improvement of Ion Heat Transport in LHD Plasmas

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Improvement of ion heat transport in the core region (so-called ion ITB) has been observed in NBI heated plasmas, and it has extended the high-ion-temperature regime of helical plasmas beyond 5 keV. The relatively slow transition to ion ITB was realized after superposition of additional NBI heating. For the enhancement of ion ITB, a carbon pellet was injected just before the superposition of NBI. In this study, the ion heat transport was analyzed in the transition phase to ion ITB and discuss about the comparison with neoclassical transport.

Figure 1(a) shows the ion temperature gradient as a function of ion heating power normalized by averaged ion density, where the ion density is estimated by electron density with $Z_{\mathrm{eff}} = 1$. The carbon density reaches about 3% of electron density, and fortunately it decreases quickly just after ion ITB formation less than 1% due to anomalous exhaust of impurity ions. Thus the uncertainty of the normalized ion heating power due to impurities is considered as about 20 % at the maximum. The ion temperature gradient in the core region significantly increases with ion heating power, while that in the periphery seems to saturates or slightly decreases in the high power heating regime. The ion temperature gradient as a function of local heat flux normalized by ion density is shown in Fig.1(b). The heating power profile of NBI plasma is calculated by the FIT code for the density of $n_{\mathrm{e}} = 1.0$, 2.0, 3.0 and $4.0 \times 10^{19}$ $\mathrm{m}^{-3}$ as a data base. In the transport analysis, the NBI heating profile is obtained from the interpolation of this FIT data base. The local heat flux produced by the time evolution of temperature and density profiles is also calculated. The improvement in the core and the degradation in the periphery are clearly shown in Fig.1(b). The thermal diffusivity profiles are shown in Fig.1(c). The improvement of ion thermal diffusivity with the factor of three is observed in the core region and the thermal diffusivity reaches down to the same order with that obtained by neoclassical calculation. It is noted that the anomalous transport is significantly reduced in the ion ITB core region.

The significant enhancement of toroidal rotation was also observed, indicating the improvement of momentum transport in the ion ITB core. The analysis of momentum transport is in progress, and the comparison with heat transport will be reported in near future.

1) K. Nagaoka, M. Yokoyama, M. Yoshinuma, K. Ida, Y. Takeiri, J. Plasma and Fusion Res., vol.86, no.2-3 (2010) pp.69-96 (in Japanese).

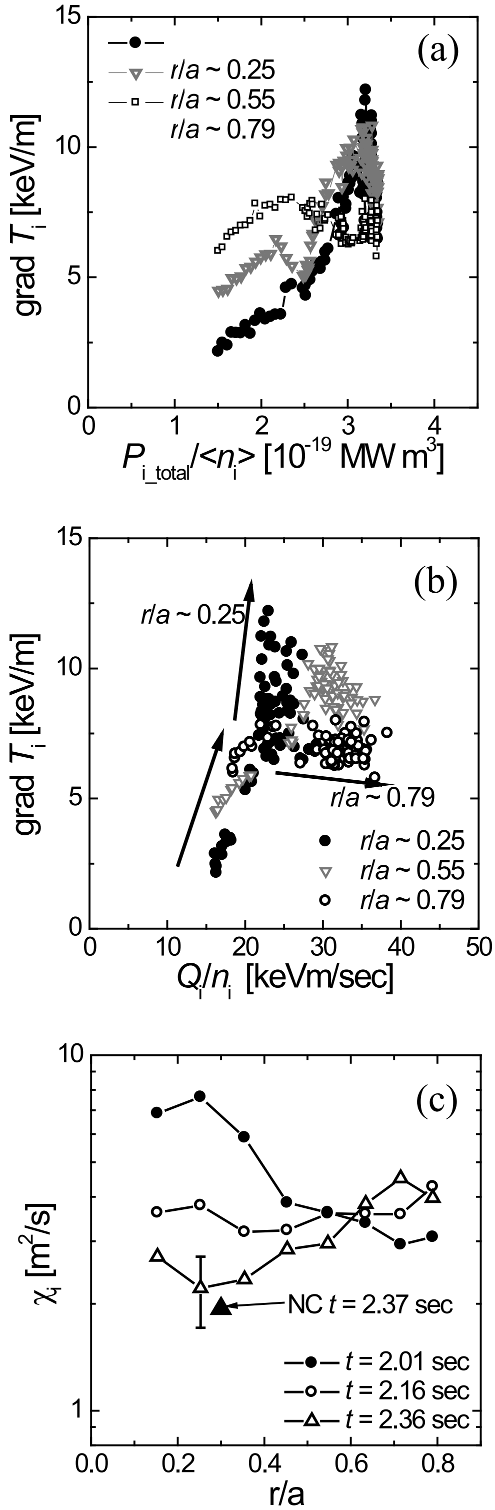


Fig. 1: (a) The ion temperature gradient as a function of ion heating power normalized by the ion density. (b) The ion temperature gradient as a function of local heat flux normalized by the ion density. (c) The time evolution of thermal diffusivity profile. The calculated thermal diffusivity by neoclassical (NC) theory at $t = 2.37$ sec is also ploted.