§12. Neoclassical Transport Optimization Effect on Electron Heat Transport in Low-Collisionality LHD Plasmas

Murakami, S., Yamada, H., Wakasa, A. (Hokkaido U.)

Reduction of the neoclassical transport is one of key issues for a future reactor based on a helical system. Recent LHD[1] and CHS[2] experimental results have shown good plasma performances in the "inward shifted" configurations, where the ideal MHD stability analysis predicts instability. These facts suggest that the MHD stability problem is not a severe one for plasma confinement in heliotrons and makes it reasonable to consider shifting the magnetic axis further inwards in LHD where further improvement of the neoclassical transport is expeccted. In this paper, we show an optimized configuration of LHD to a level typical of so-called " advanced stellarators" , and demonstrate experimentally the effect of neoclassical transport optimization on the thermal plasma transport.

The thermal plasma transport in the long-mean-free-path regime (1/ν regime) is investigated to make clear the optimization effect on the neoclassical transport in LHD. The transport coefficients are compared shifting the magnetic axis position, R_{ax}. Figure 1 shows the comparison of electron temperature (center) and the transport coefficient (right) in the two configurations (R_{ax}=3.53m[s32303] and 3.6m[s32123]) with nearly same density profile (left). We set the magnetic field strength to become a similar heating deposition profile (r/a<0.2). We can not see clear difference in the region r/a>0.5 but higher electron temperature was obtained in the central region (r/a<0.4) in the R_{ax}=3.53m configuration case. We analyze the effective electron heat transport coefficient and compared with the neoclassical transport prediction by DCOM (assuming E_r=0) to show the role of neoclassical transport. We can see that the outside region r/a>0.5 the anomalous transport play important role and the no clear difference can be seen in the electron temperature. On the other hand, the region r/a<0.4 the neoclassical transport becomes important and the reachable temperature is dominated by neoclassical transport. The neoclassical heat transport coefficient (E_r~0) strongly depends on the temperature ($\chi_e \propto T^{7/2}$) and magnetic field structure. Comparing with the χ_e in the R_{ax}=3.6m case, the increase of the χ_e due to about 1.4 times higher T_e in the R_{ax}=3.53m case is compensated by the reduction by a factor of three due to the magnetic field optimization, resulting in similar values of χ_e for both cases in Fig. 1(right).

REFERENCES

[1] S. Murakami, et al, Nculear Fusion **42** (2002) in press.

[2] A. Wakasa, et al., J. Plasma Fusion Res. SERIES, Vol. **4** (2001) 408-412.

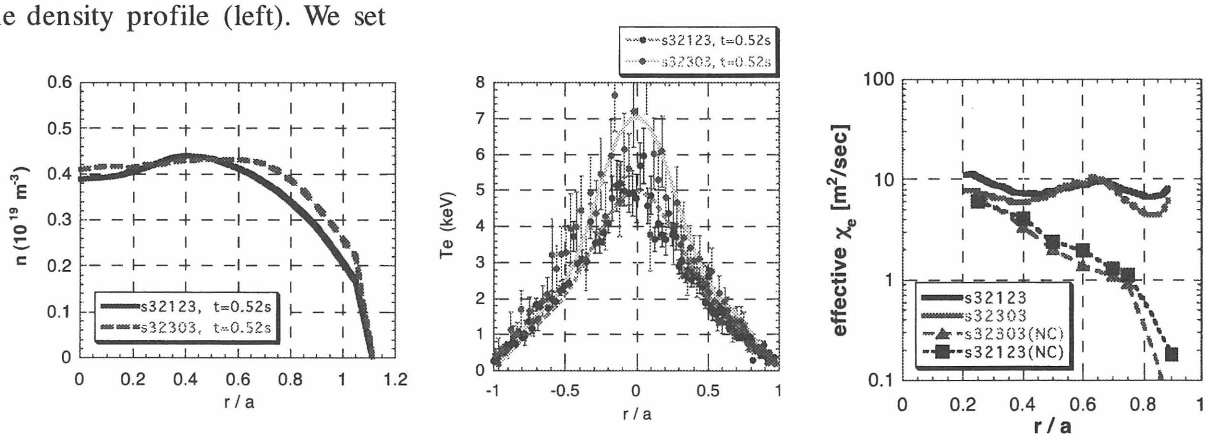

Fig. 1: Comparisons of the radial profiles of the density (left), the electron temperature (center), and the effective electron heat transport coefficient (right). The neoclassical transport coefficients evaluated by DCOM are also plotted.