## §18. Configuration Effects on Particle Transport in LHD

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The particle transport was investigated using density modulation for three different magnetic configurations, represented by the magnetic axis position in vacuum ($R_{ax}$) of 3.6, 3.75 and 3.9m [1]. Figure 1 shows the change of the $T_e$ and $n_e$ profiles at three different $R_{ax}$. The heating power was adjusted to maintain almost identical electron temperature profiles. In a previous study [2], it was found that for constant density, the electron temperature and its gradient are key parameters for controlling particle diffusion and convection respectively. Despite this, as shown in Fig. 1(b), the achieved density profiles are rather different for almost identical $T_e$ profile. The average density is almost the same for $R_{ax}$ = 3.6 and 3.75m, but the density profile is more hollow for $R_{ax}$ = 3.75m. The achieved density was lower for $R_{ax}$ = 3.9 m compared with other configurations under almost identical particle fuelling.

Figure 2 shows parameter dependence of D and V. The electron temperature and –grad $T_e/T_e$ are averaged over $0.4<\rho<0.7$ for the core and $0.7<\rho<1.0$ for the edge. As shown in Fig.2 (a), (b), positive $T_e$ dependencies are observed in all configurations. For more outward shifted configurations, the diffusion coefficient becomes larger at the same $T_e$ both in the core and edge region The temperature dependence also varies with $B_t$. Stronger $D_{edge}$ variation with $T_e$ at lower $B_t$ was observed at $R_{ax}$=3.6m.

A positive dependence of $V_{core}$ on –grad $T_e/T_e$ is observed for all configurations as shown in Fig.2(c). As shown in Fig. 1(d), the edge convection velocity is proportional to -grad $T_e/T_e$ at $R_{ax}$=3.6m and 3.75m, and also reverses direction from inward to outward with increasing -grad $T_e/T_e$. However, at $R_{ax}$=3.9m, $V_{edge}$ does not change dramatically. Each graph in Fig. 2 appears to show an offset linear trend, with a different offset for each configuration.

Figure 3 shows comparisons of D and V with neoclassical values and their dependence on the normalized collision frequency ($\nu^*_h$), which is normalized by the collision frequency of boundary between plateau and 1/ν regime. As $\nu^*_h$ is decreased, the experimental $D_{core}$ increases, and the neoclassical value of $D_{core}$ becomes closer to the experimental value as shown in Fig.3 (a). However, the experimental $D_{core}$ is around one order magnitude larger than neoclassical even in the 1/ν regime ($\nu^*_h$ <1). The difference between the experimental and neoclassical $D_{edge}$ values is larger. For all values of collisonality, the experimental value of $D_{edge}$ is more than one order magnitude larger than the neoclassical one.

As shown in Fig. 3(a), the experimental $V_{core}$ is comparable with neoclassical for all values of $\nu^*_h$. Although, at $R_{ax}$=3.6m, $B_t$=2.8T, $V_{core}$ from experiments at higher $\nu^*_h$ is directed inward contrary to neoclassical prediction, which is directed outward. Generally, both experimental and neoclassical $V_{core}$ almost agree within experimental error.

Reference

1) Tanaka, K.,et al., to be published Fusion Science and Technology
2) Tanaka, K.,et al., Nucl. Fusion 46 (2006) 110–122

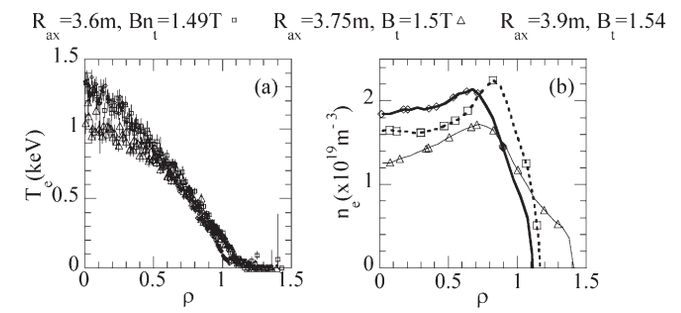


Fig. 1. (a) $T_e$ and (b) $n_e$ profiles of three different configurations

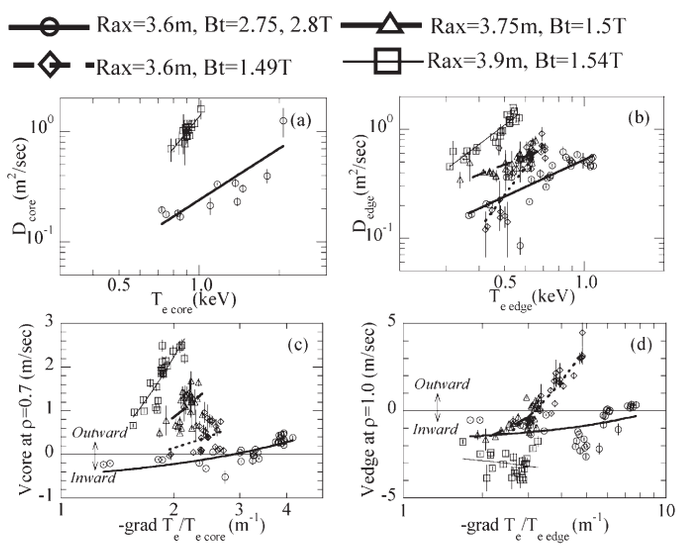


Fig.2 Parameter dependence of D and V (a) $T_e$ dependence of $D_{core}$, and (b) $D_{edge}$, –grad $T_e/T_e$ dependence of (c)$V_{core}$ and (d) $V_{edge}$

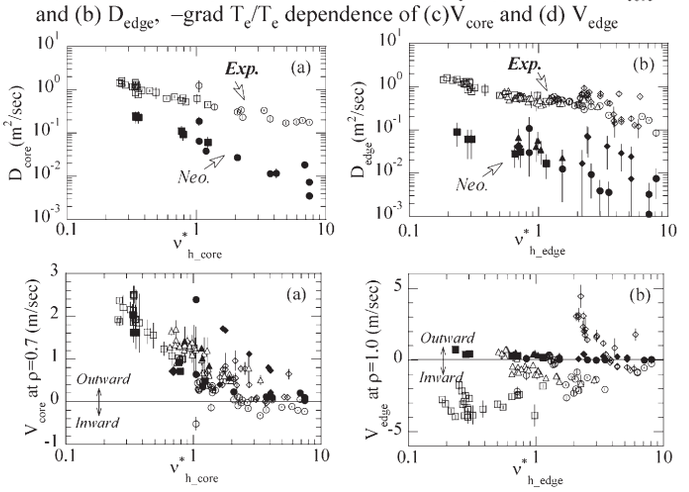


Fig.3 Comparison with neoclassical estimation (a) $D_{core}$, (b) $D_{edge}$, (c) $V_{core}$ and (d) $V_{edge}$. Symbols are same as in Fig.2 Coloured symbols indicates neoclassical estimation.