§25. Parameter Dependence of Particle Transport in LHD

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The characteristics of the particle confinements are studied from density modulation experiments at standard configuration (Rax=3.6m) [1]. The diffusion coefficient (D) and convection velocity (V) can be estimated without knowledge of absolute value of particle source. The power of NBI and toroidal magnetic field (Bt) were scanned to study electron temperature (T_e), T_e gradient and B_t dependence. Examples of the analysis are shown in Fig.1 ~2. Clear differences of the electron density (n_e) and T_e profiles were observed under different heating power. As shown in Fig.2, two fitting variables of D and V, which represents core and edge value are used. The core and edge value of D are modeled to be constant at $\rho = 0 \sim 0.65$ and $\rho = 0.75 \sim$ plasma boundary respectively and the convection profile increases linearly from $\rho = 0$ till $\rho = 0.7$ and change the gradient. These profiles of D and V can fit not only modulation profile and but also equilibrium profile as shown in Fig.1 (b).

Figure 3 (a) shows T_e dependence of D_{edge} under different B_t. Positive T_e dependence, which is typical character of anomalous dominated L mode plasma, was observed. The observed T_e dependences are $D_{edge} \propto T_e^{1.95\pm0.54}$ at 1.49T, $D_{edge} \propto T_e^{1.25\pm1.02}$ at 2T and $D_{edge} \propto T_e^{0.89\pm0.19}$ at 2.75,2.8T. Although data number is small (5 shots) and dynamic range of T_e scanning are small at 2T, there is a increase of temperature index as B_t decreases. This suggests turbulence character changes under different B_t. Figure 3(b) shows B_t dependence of D_{edge}. Here, the data, whose edge Te is from 0.6 keV to 0.7 keV are shown. Ten shots at 1.49T, 4 shots at 2T and 5 shots at 2.75, 2.8T are used for the analysis. Then, observed B_t dependence is $D_{edge} \propto B_t^{-0.73\pm0.23}$. The observed T_e and B_t dependences are not simple Bohm like ($\propto T_e / B_t$) nor gyro-Bohm like ($\propto T_e^{1.5} / B_t^{2}$). Further consideration comparing possible theoretical model is necessary to explain observed dependence.

Figure 4 shows the normalized T_e gradient dependence of V under different B_t. The value of V at $\rho = 0.7$ is considered to be V_{core}, and V_{edge} is considered to be the value at $\rho = 1.0$. The electron temperature gradient is the averaged over the region $\rho = 0.4 \sim 0.7$ for core and $\rho = 0.7 \sim 1.0$ for the edge. At B_t = 2.75,2.8T, core convection is directed inward at lower $-\text{grad}T_e/T_e$ and reverses the sign at higher $-\text{grad}T_e/T_e$. On the other hands, in the edge region, the dependence is more complicated. There is a minimum value of V_{edge} although clear increase of V_{edge} with increase of $-\text{grad}T_e/T_e$ was observed at B_t=1.49T. In both core and edge, the convection is more outward directed at lower B_t under same $-\text{grad}T_e/T_e$. The toroidal magnetic field and $-\text{grad}T_e/T_e$ influential or maybe determining parameter to determine V and density profile in LHD.

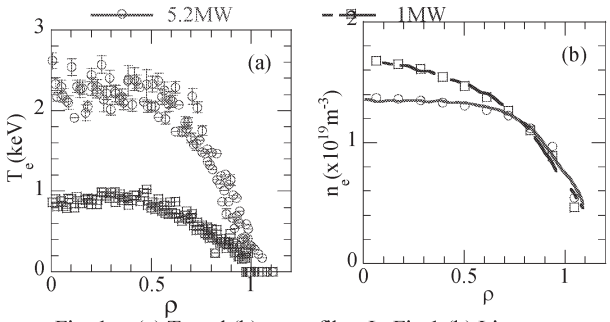

Fig. 1. (a) T_e and (b) n_e profiles. In Fig.1 (b) Lines indicate reconstructed profile, symbols indicate calculated profiles with D_{mod}, V_{mod} . B_t=2.8T

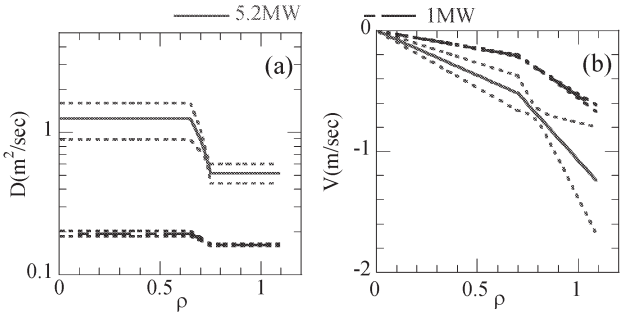

Fig. 2. (a) D and (b) V profiles. Dashed lines indicate upper and lower error limit. Negative V indicates inward directed

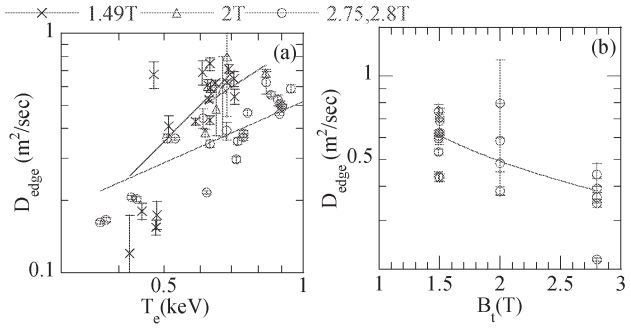

Fig.3 (a) T_e dependence under different B_t and (b) B_t dependence under similar T_e(0.6~0.7keV) of D_{edge}

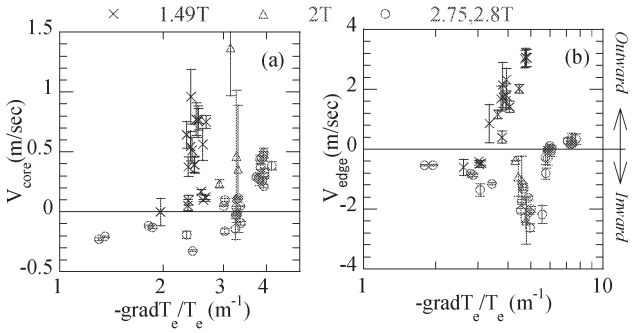

Fig.4 Normalized T_e gradient dependence of (a) V_{core} and (b) V_{edge}

Reference

1) Tanaka, K.,et al., to be published Nucl. Fusion