§15. Parameter Dependence of the Particle Confinements Coefficients on LHD

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Dependence of the particle confinement coefficients on the electron temperature and normalized collision frequency ($\nu^*=\nu_{ei}Rq/Vth$) is studied from the density modulation experiments at Rax=3.6m and Bt=2.8T (Rax is the position of the magnetic axis and Bt is toroidal magnetic field) on LHD. In order to scan ν^*, seven cases of data set are obtained. In the five of seven cases, NBI power is scanned from 0.98MW up to 6.9MW keeping the averaged density almost constant ($1.4\sim1.6\times10^{19}m^{-3}$). In the two of seven cases, the density is scanned from $2.8\times10^{19}m^{-3}$ up to $3.5\times10^{19}m^{-3}$ keeping NBI power constant (1MW). From these series of scan, the data of the whole plateau are obtained.

Figure 1 shows the electron temperature and density profiles of three cases of NBI power scan data set. As the NBI power increased and peaked temperature profiles are formed, the density profile are flattened. A simple model of diffusion coefficients (D) and convection velocity (V) (D=constant, V=r/a V_0, where D is diffusion coefficient, r is radial position, a is averaged minor radius and V_0 is convection velocity at plasma edge) is used for the fitting of modulation amplitude and phase distributions. From Fig.1, at the higher temperature, the higher diffusion produces the flat density profile and at the lower temperature, the lower diffusion and inward pinch produces the peaked density profile. Figures.2 and 3 show parameter dependence of D and V on ν^* and T_e. D shows clear dependence both on ν^* and T_e, however, V does not show clear dependence. V becomes constant inward pinch at $T_e<1.7$keV and $\nu^*>0.004$. Since operation regime is ion root, neoclassical particle flux is predicted outward direction. This inward pinch is anomalous one. D is proportional to $T_e^{1.7}$. This dependence is close the gyro-reduced Bhom diffusion, which is proportional to $T_e^{1.5}$ at same Bt. Figure.4 shows comparison of the dependence on ν^* and P_{NBI} between D and χ_{eff}. On tokamak experiments $\chi_e=2\sim4D$ is reported. On LHD $\chi_e=8\sim30D$ is obtained as shown in Fig.4. At higher density and ν^* the difference between χ_{eff} and D becomes bigger. Lower D at higher density might play a role on good performance of high-density operation on LHD, which is achieved by gas fuelling and pellet injection

Preliminary comparison of D with neoclassical value calculated by the DCOM code shows D is more than one order larger, so, diffusion process is anomalous as well as inward pinch.

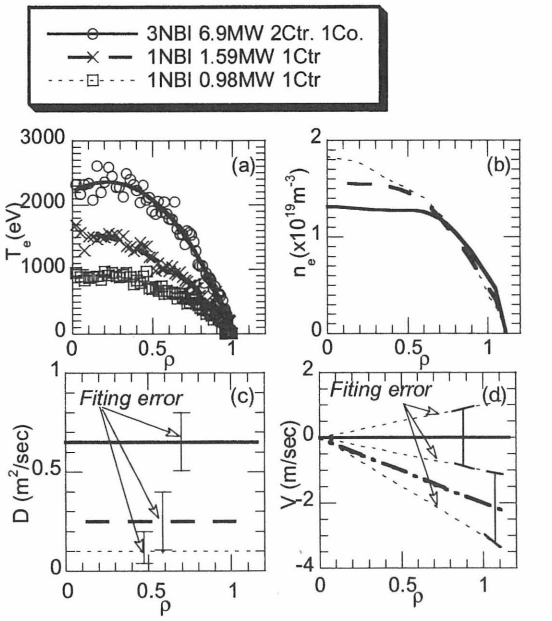

Fig.1 NBI power scan data. Profiles of (a) T_e (b) n_e (c) D and (d) V

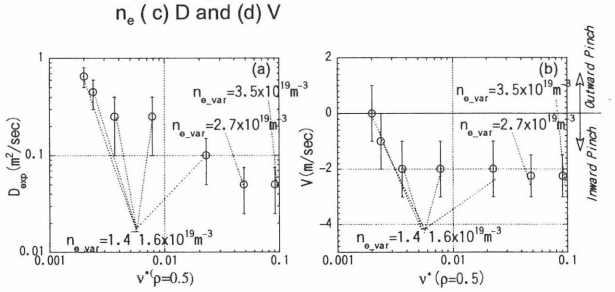

Fig.2 ν^* dependence of (a) D and (b) V

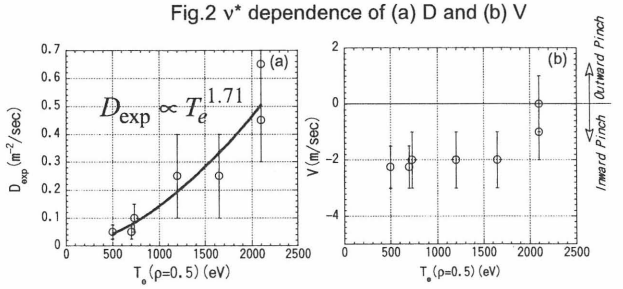

Fig.3 T_e dependence of (a) D and (b) V

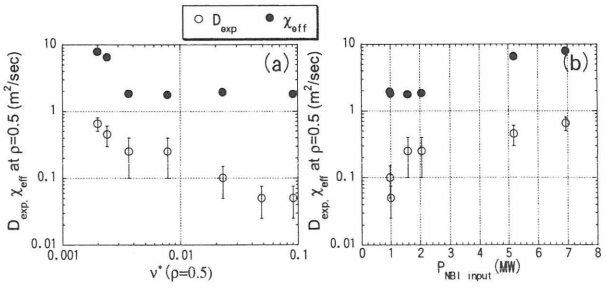

Fig.4 Comparison between D and χ_{eff} (a) ν^* and (b) P_{NBI} dependence