§8. Dependence of the Particle Confinement Coefficients on the Magnetic Field Configuration on LHD

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Dependence of the particle confinement coefficients on the magnetic field configuration on LHD was studied from the density modulation experiments. Three different configuration, Rax=3.6, 3.75, and 3.9m (Rax is the position of the magnetic axis) were studied. Electron density was modulated sinusoidally at 1 Hz by changing gas fuelling rate. 1Hz was determined to modulate the central part of the plasma. Diffusion coefficient (D) and convection velocity (V) were determined from the fitting of the modulation amplitude and phase profiles obtained from experimental measurements to the calculated ones by using modelled D and V. Figs. 1 and 2 show comparison of the D and V from modulation experiments and the values from the neoclassical prediction. Dotted lines indicate the lower and upper limit of fitting error. In figs. 2 the neoclassical convection velocity V_{neo} is defined as

$$V_{neo} = \left(- D_n eEr(n_e / T_e) - D_t n_e \nabla T_e / T_e\right) / n_e \quad (1)$$

where D_n and D_t are the on and off diagonal elements of the transport matrix, E_r is the radial electric field.

As shown in figs.3, the density gradient changes at around ρ = 0.6 on Rax = 3.6m and ρ = 0.7 on Rax =3 .75 m and 3.9m. The effect of the particle source is negligible around this region (ρ <0.7), the change of the density gradient is due to the change of the transport. Therefore, the spatial profile of D and V were assumed to change at around this location. As shown in figs.2, V changes significantly around this location. On the other hands, spatial profiles of estimated D shows small spatial dependence. The background density profiles were calculated from the solution of the steady state particle balance equation by using estimated D and V of the modulation experiments. As shown in figs.3 , the calculated profiles well agree with Abel inverted density profiles. However, further study is necessary for the comparison of D and V between equilibrium values and value from modulation experiments changing modulation frequency.

As shown in figs.1, the estimated D from the modulation experiments are about one order larger on all magnetic filed configuration. In all configurations, the particle diffusion is anomalous. D from the modulation experiments are slightly larger on more outward shifted configuration. But the differences are almost within the error bar. V from the modulation experiments are zero (on Rax=3.6m)or small outward (on Rax=3.75 and 3.9m) in the core and inward directed in the edge region. The small outward convection produced hollow profiles on Rax=3.75 and 3.9 m. Er is negative value, because the operation regime of these series of experiments was ion root[1], and temperature gradient is always negative one in the NBI discharge. Therefore, from eq. (1), neoclassical theory predicts outward convection in the whole region of the plasma. The observed inward convection in the edge region are against neoclassical prediction. However, still, fitting error is large. More detail analysis and further experiments are needed to confirm this.

Central ion temperature measured from the broadening titanium ion shows 1.4keV on Rax=3.6m, 1.25keV on Rax=3.75m and 0.9keV on Rax=3.9m. From figs.1 and 2 , D and V do not differ very much among three different configuration, however, similar characteristics of the particle confinement are achieved at the higher temperature on more inward shifted configuration.

1) K. Ida et al., Phys. Rev. Lett. 86 (2001) 5297

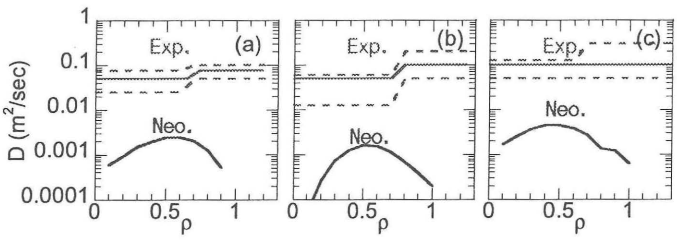

Fig.1 Obtained D profiles (a) Rax=3.6m, (b) Rax=3.75, and (c) Rax=3.9m.

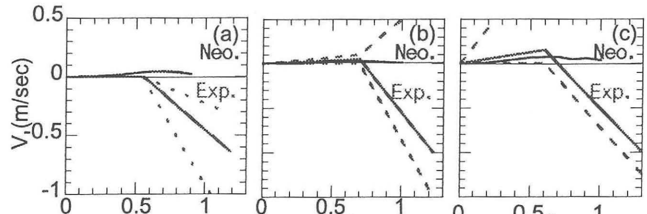

Fig.2 Obtained V profiles (a) Rax=3.6m, (b) Rax=3.75, and (c) Rax=3.9m. Positive V indicates outward , negative V indicates inward convection.

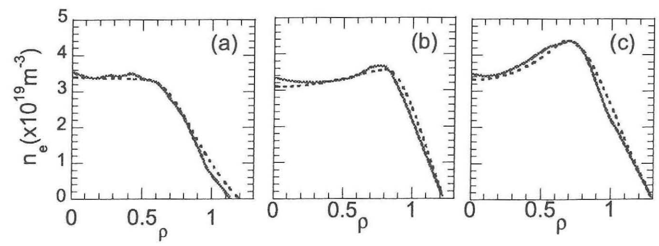

Fig.3 Obtained n_e profiles (a) Rax=3.6m, (b) Rax=3.75, and (c) Rax=3.9m. Thick lines indicate Abel inverted density profiles, which is averaged profile during one modulation periods. Dotted lines. indicate calculated profiles by using obtained D and V shown in figs. 1 and 2.