§5. Comparison of the Particle Transport in Hydrogen and Helium Plasma in LHD

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The particle transport are studied in hydrogen and helium plasma and its characteristics are compared in LHD. Helium glow discharge cleaning was done to keep helium rich wall condition for helium plasma experiments. Figure 1 shows comparison of the time trace. In 118352 hydrogen plasma, neutral beam was injected till t=2.5sec, then, plasma is sustained by 77 and 154GHz ECRH. In 119049 helium plasma, plasma is produced and sustained by 77 and 154GHz ECRH only. ECRH power of both cases are 0.9MW in total. Density was modulated at 1.25Hz for particle transport study. In ECRH sustainment phase, line averaged density was kept almost constant in hydrogen plasma, while it increases in time in helium plasma. The increase of the density in helium plasma is likely due to the high recycling rate of helium. The fuelling ratio, which is H/(H+He) are around 85-90% in hydrogen plasma and 10-20% in helium plasma as shown in Fig. 1(a). Electron temperature decreased at t=1.6sec in hydrogen plasma and 4sec in helium plasma. This is due to the back transition from electron internal transport barrier to L mode. Ion temperature is kept almost constant in both cases through discharge. The comparison of particle transport was studied by density modulation in L mode phase after back transition.

Figure 2 shows comparison of the temporary averaged profiles at 6-6.8 sec, which is one modulation period. Electron temperature in slightly higher in helium plasma at almost same density. Electron density profile is flat in hydrogen plasma and hollow in helium plasma. In NBI heated plasma, hollow density profiles are widely observed in low collisionality regime of hydrogen plasma[1]. But the peak of the density in NBI plasma is at reff/a99 = 0.7-0.8 and is more outwardly located[1]. This suggests that particle transport in ECRH heating plasma is different from those in NBI heating plasma.

Ionization rate was estimated by 3D Monte Carlo simulation code EIRINE [2]. Particle source penetrates deeper toward core in hydrogen plasma. This is due to that hydrogen atoms penetrates deeper by the charge exchange with high temperature hydrogen ions. Diffusion coefficient (D) and convection velocity (V) are estimated by density modulation experiments [1] taking into account of difference of ionization rate. D and V are determined to fit both equilibrium profile and modulation profile [1]. Estimation was done at t=3.6-9sec in hydrogen plasma and t=4.5-10sec in helium plasma. As shown in Fig.3 (a), core diffusion coefficient are higher than edge values in both cases. Due to the uncertainty of fitting, the difference of core diffusion (at reff/a99 < 0.7) are within fitting error. While in edge region (at reff/a99 >0.7), diffusion coefficients in helium plasma is higher beyond the fitting error. As shown in Fig.3(b), convection velocity is outwardly at reff/a99 < 0.6 in helium plasma but close to zero at reff/a99 < 0.4 in hydrogen plasma. In edge region (reff/a99 > 0/7), higher inwardly directed convection velocity is observed. However, total particle flux is dominated by diffusive flux in this region. Thus, edge particle transport is larger due to larger edge diffusion coefficients in helium plasma.

These results will be useful to consider mass effect on particle transport in LHD.

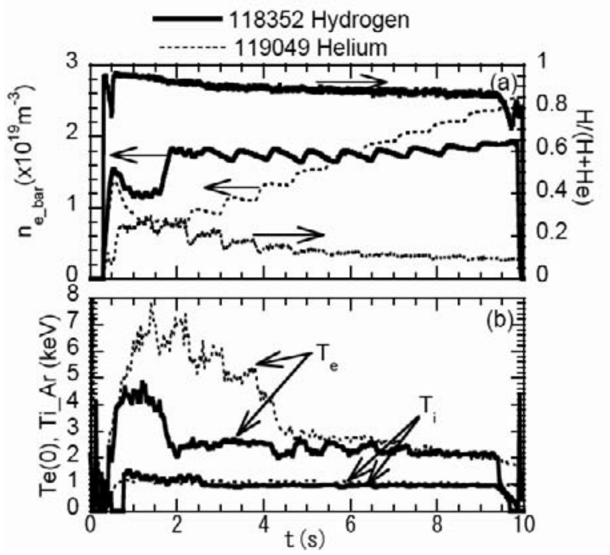

Fig.1 Time trace of hydrogen and helium plasma (a) line averaged density, fueling ration (b) T_e and T_i

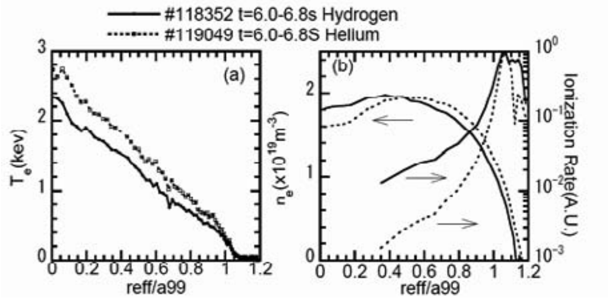

Fig2 Comparison of profiles (a) T_e (b) n_e and ionization rate. T_e profiles are from Thomson scattering and n^e profiles are from FIR interferometer

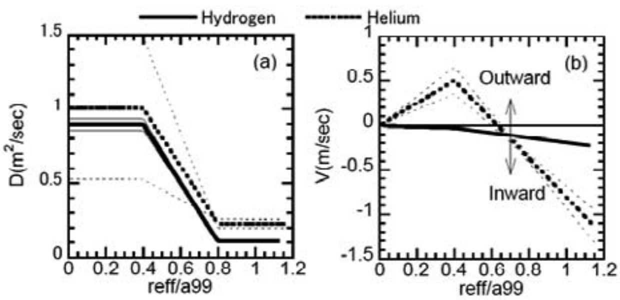

Fig.3 Comparison of (a) diffusion coefficients and (b) convection velocities. Thin lines are upper and lower bounds of fitting error

1) Tanaka. K. et al.: Fusion Sci, Tech. **58**, 70 (2010)
2) Shoji, M, et al., this annual report