§19. Comparison of Particle Transport in the Hydrogen and Helium Plasma of LHD Normal Confinement Plasma

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Understanding of ion species effects on transport are important to improve plasma performance of LHD D-D experimental campaign starting from 2016 and also important for the future D-T fusion reactor operation. In 18th cycle experimental campaign, systematic study of particle transport was done by the density modulation experiments in the hydrogen and helium plasma experiments with NB heating was done. Confinement mode is normal confinement which follow ISS04 scaling. The ratio of H and He are controlled by the wall conditioning and fueling.

In this series of experiments, only parallel injected negative ion based NB (N-NB) was used for the heating. The particle fueling from N-NB is small, thus density profile is mainly determined by transport process rather than particle fueling. Data set are summarized for the H rich plasma, where $n_H>4n_{He}$ and He rich plasma, where $n_H<n_{He}$ as well as energy transport study[1]. Figure 1 shows comparison of the electron density (n_e) and electron temperature (T_e). Due to the difference of the wall recycling, the density of He rich plasma is lower and profile are more hollow than that of H rich plasma. For the quantitative understanding of particle transport, diffusion coefficients (D) and convection velocities (V) are necessary to be separately estimated. Then, density modulation experiments were done for this estimation. The model of D and V in Fig.2 and ionization profiles in Fig.3 from the EIRNE code[2] are used for the analysis. Figure 4 shows collisionality (ν_{ei}) dependence of D and V. The normalization of the collisionalty was done at boundary between 1/ν regime and plateau regime of electron neoclassical transport. Due to the limit of the data set, there are no data at same collisionality, However, Fig. 4 shows there is no clear difference of ν_{ei} dependence of D and V. This is similar to the ν_{ei} dependence of χ_e (ρ=0.4-0.7) but different from that of χ_i (ρ=0.4-0.7) in the normal confinement plasma. Ion thermal conductivity in He rich plasma is clearly higher than taht in H rich plasma[1]. This indicates that the transport characteristics in H and He plasma is different depending on the transport channel.

The shape of density profile are determined by the non dimensional parameter aV/D (profile factor), where a is minor radius. Figure 5 shows ν_{ei} dependence of profile factor. Figure 1 (a) and (b) shows density profiles are more hollow in He rich plasma, however, the ν_{ei} dependence of H and He rich plasma lines on almost same line suggesting that there is no clear difference of particle transport in H and He rich plasma. This is qualitatively same as previous result of particle transport study of ECH plasma

1) Tanaka, K., et al, this report "Comparison of electron and ion energy transport in the hydrogen and helium plasma of LHD normal confinement plasma"
2) Shoji, M, et al., annual report 2014
3) Tanaka, K., et al., annual report 2014," Comparison of the Particle Transport in Hydrogen and Helium plasma in LHD"

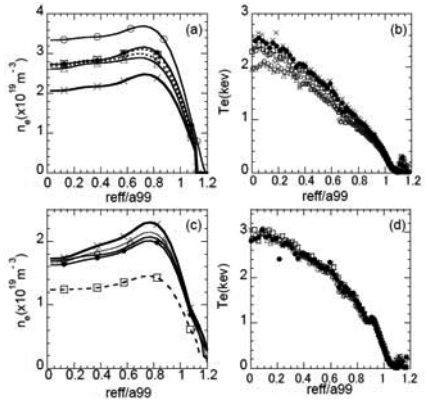

Fig.1 comparison of n_e and T_e profiles (a),(b) in H rich ($n_H>4n_{He}$)plasma and (c),(d) in He rich plasma ($n_H<n_{He}$)

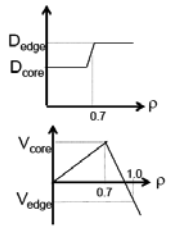

Fig.2 Model of D and V

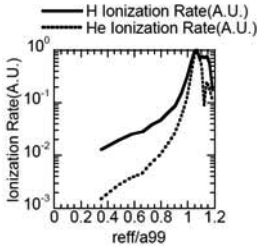

Fig.3 Ionization rate profile

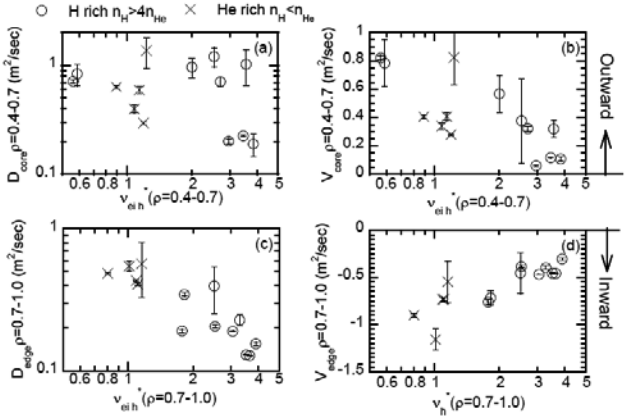

Fig.4 Collisionality dependence of (a) D_{core},(b) V_{core},(c) D_{edge} and (d) V_{edge}

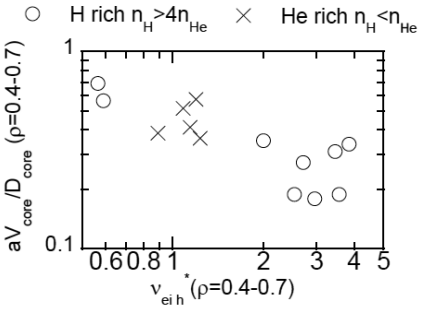

Fig.5 Collisionality dependence of profile factor