Isotope effects on particle transport in TCV ohmic discharge

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Isotope effects of particle transport are an essential ingredient of fusion power generation in a future reactor. However, the isotope dependence of particle transport is less understood than the isotope dependence of energy transport. This is due to the difficulty of estimation of particle transport coefficients. In TCV ohmic plasmas with single null divertor configuration, the particle diffusion coefficients (D_{mod}) and convection velocities (V_{mod}) were estimated in Hydrogen (H) and Deuterium (D) plasma by density modulation experiments. Density was modulated at typically 5 Hz by external gas fuelling. The radial modulation amplitude and phase were evaluated from multi-channel far-infrared interferometer signals, and D_{mod} and V_{mod} were then evaluated by model fitting technique.

Figure 1 shows the density dependence of the global confinement time of the kinetic electron energy (τ_{Ee}). The transition from linear ohmic confinement (LOC), where τ_{Ee} increases with the line averaged density ($n_{e\ bar}$), to saturated ohmic confinement regime (SOC), with τ_{Ee} almost constant with density increase, was identified both in H and D plasmas. The ttransition density was lower in H plasma. As shown in Fig. 1(b), D_{mod} at $\rho = 0.75$ - 1.05 are comparable in the low density ($n_{e\ bar} < \sim 3x10^{19}m^{-3}$) LOC regime, however, at high density ($n_{e\ bar} > \sim 3x10^{19}m^{-3}$) in the SOC regime, D_{mod} is clearly lower in D plasma. The different isotope effects in the LOC and SOC regimes might be linked to the different ion scale instabilities in the two regimes. On the other hand, V_{mod} does not show a clear difference over uncertainty of the estimation in H and D plasma. Inwardly directed V_{mod} decreases with higher density in H and D plasma. This is against the characteristics of the neoclassical Ware pinch and suggests that the inward pinch is an anomalous process. The lower edge diffusion in D plasma is favourable for the confinement but unfavourable for plasma density control. Also, it is essential to confirm that the observed isotope effects were due to the difference of bulk ion species rather than other effects such as impurity density or radiation. Gyrokinetic modelling is now underway.

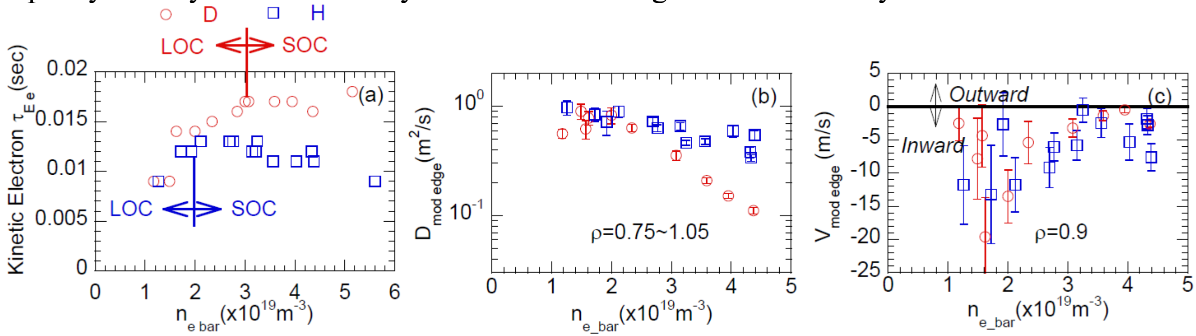

Fig.1 Density dependence, in ohmic discharge, of (a) kinetic electron confinement time, (b) particle diffusion coefficients and (c) convection velocities, for D and H.