Isotope effects on transport and turbulence in LHD

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Isotope effects on transport and turbulence in magnetically confinement plasma are essential topic for the prediction of future reactor operation. In Large Helical Device (LHD), systematic experiments are conducted for the comprehensive understanding of isotope effects on transport in hydrogen (H) and deuterium (D) plasmas. Density was scanned under constant ECRH power (1.6MW). As shown in Fig. 1 (a), τ_E are almost identical in H and D plasma at $\bar{n}_e < 1.6 \times 10^{19}\ \mathrm{m}^{-3}$, while τ_E is clearly higher in D than in H plasma at $\bar{n}_e > 1.6 \times 10^{19}\ \mathrm{m}^{-3}$. Both in H and D plasma, τ_E increases with increase of density. However, the density dependence becomes moderate at higher than $1.6 \times 10^{19}\ \mathrm{m}^{-3}$ in H and $2.6 \times 10^{19}\ \mathrm{m}^{-3}$ in D plasma. These densities are defined as a transition density. The transition densities correspond to the minimum values of turbulence level measured by phase contrast imaging as shown in Fig. 1(b). Turbulence level decreases with increase of density at lower than the transition density both in H and D plasmas. In this density regime, linear growth rate of ion temperature gradient (ITG) mode reduces with increase of density due to the collisionality stabilization effects. On the other hand, turbulence level increases at higher than transition density both in H and D plasma and turbulence level is clearly lower in D plasma. Present gyrokinetic linear analyses including the effects of kinetic electron and collisionality does not account for the positive density dependence and lower turbulence level in D plasma, because ITG/TEM growth rate decreases with increase of collisionality. It is likely that turbulence switched to different mode at higher than transition density. One possible interpretation of the mode in high density regime is resistive interchange (RI) turbulence. The growth rate of RI increases with increase of collisionality and decreases with ion mass. These dependences qualitatively agree with observation of turbulence level in high density region.

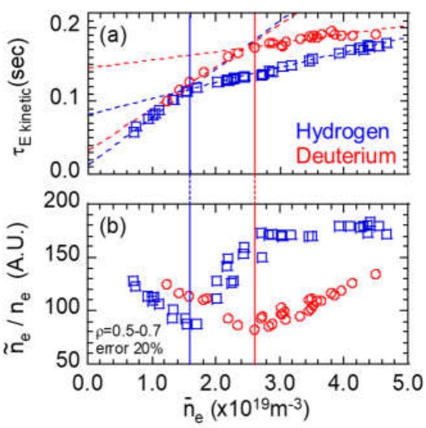

Fig. 1 Density dependence of (a) kinetic global energy confinement time τ_E and (b) turbulence level