

Isotope effects on transport and turbulence in LHD

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In LHD, hydrogen and deuterium isotope experiments were extensively carried out from the 2017 experimental campaign. In ECRH plasma, positive isotope effects in global energy confinement time $\tau_{E\ ECH} \propto A^{0.22 \pm 0.01} n_{e\ bar}^{0.60 \pm 0.01} P_{abs}^{-0.51 \pm 0.01}$ and negative isotope effects in global particle confinement time $\tau_{P\ ECH} \propto A^{-0.33 \pm 0.02} n_{e\ bar}^{0.52 \pm 0.02} P_{abs}^{-0.69 \pm 0.02}$ were found [1]. Figure 1 shows comparison of profiles for almost identical $n_{e\ bar}$ and P_{abs} in H and D plasma. As shown in Fig.1 (a), n_e profiles are clearly different. In D plasma, n_e profile is clearly hollow, while it is flat in H plasma. Since neutral penetration of H and D are almost identical, the difference of n_e profile is due to the difference of transport. T_e is clearly higher in D plasma at $r_{eff}/a_{99} < 1.0$, while ECH power deposition profiles are almost identical. In H plasma, logarithmic gradient (L_{Te}^{-1}) of T_e is constant at $r_{eff}/a_{99} = 0.2 \sim 0.9$. In D plasma, however, L_{Te}^{-1} varies depending upon the location. Stronger stiffness is found in H plasma. Figure 1 (d) shows comparison of ion scale ($k\rho_i \sim 0.2$) turbulence level measured by two-dimensional phase contrast imaging [2]. The edge turbulence levels at $r_{eff}/a_{99} > 0.9$ are almost identical both in H and D plasma, while, core turbulence level at $r_{eff}/a_{99} < 0.9$ in H plasma is clearly higher than turbulence levels in D plasma. Trapped electron mode (TEM) and ion temperature gradient mode (ITG) are possible candidates for measured turbulence. Both TEM and ITG can be stabilized in the positive density gradient of hollowed profile [3]. Suppressed turbulence level in the positive gradient region qualitatively agrees with gyrokinetic linear prediction.

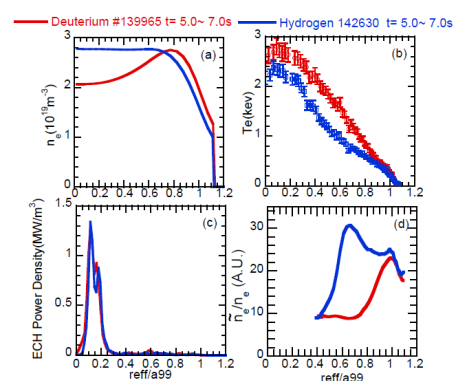


Fig 1 Comparison of profiles in D and H plasmas (a) n_e , (b) T_e , (c) ECH deposition profile and (d) turbulence level

[1] K. Tanaka et al, submitted to Nucl. Fusion, [2] K. Tanaka et al, Rev. Sci. Instrum. 79, (2008), 10E702 3, [3] M. Nakata et al, Plasma Phys. Control. Fusion in press