3P53

LHDにおける閉じ込め・輸送特性の次元相似性からの考察
Remarks on Transport Characteristics from Dimensional Similarity on LHD

山田 弘司[A,B]、田中 謙治[A,C]、關 良輔[A,D]、鈴木 千尋[A]、居田 克巳[A,D]、
横山 雅之[A,D]、仲田 資季[A,D]、村上 定義[E]、徳沢 季彦[A]、吉沼 幹朗[A]、藤井 恵介[E]
H.Yamada[A,B], K.Tanaka[A,C], R.Seki[A,D], C.Suzuki[A], K.Ida[A,D],M.Yokoyama[A,D],
M.Nakata[A,D], S.Murakami[E], T.Tokuzawa[A], M.Yoshinuma[A], K.Fujii[E]

[A]核融合研/NINS、[B]東大新領域、[C]九大総理工、[D]総研大、[E]京大工
[A]NIFS/NINS, [B]Univ.Tokyo, [C]Kyushu Univ, [D]SOKENDAI, [E]Kyoto Univ.

Isotope effect on confinement/transport is a long standing mystery in magnetic fusion research. It should be emphasized that experience that deuterium works out better than hydrogen is not enough. Elucidation of the underlying physics of isotope effect is demanding and demanded in order to prospect DT burning plasmas. Recently, LHD has started deuterium experiment. Discussion of isotope effect has been just began based upon findings in elaborated experiments.

Energy confinement time, local thermal transport and particle confinement time of NBI-heated plasmas in LHD are discussed in terms of non-dimensional parameters in particular the normalized gyro radii, colilisionality, and pressure, namely ρ*, ν* and β. Uneventful ordinary NBI-heated plasmas without spatial and temporal peculiarity have been chosen carefully in order to secure accuracy of analysis. It should be noted that electron heating is predominant in these plasmas and consequently $T_e(0)>T_i(0)$.

Statistical regression analysis of thermal energy confinement time has yielded the scaling expression of

$$\tau_{E,th}^{scl} \propto A^{-0.01\pm0.02} B^{0.85\pm0.02} \bar{n}_e^{0.78\pm0.01} P_{abs}^{-0.87\pm0.01},$$

which indicates no isotropic influence on energy confinement time. However, when this expression is rephrased in non-dimensional parameters as follows

$$\tau_{E,th}^{scl}\Omega_i \propto A^{1.01} \rho^{*-3.03} \nu^{*0.19} \beta^{-0.28},$$

clear mass dependence is identified and at the same co-existence of the gyro Bohm nature is confirmed.

Comparison of non-dimensional similar plasmas is highlighted in local thermal transport analysis. By adjusting three operational parameters such as B, n_e and P_{abs}, plasmas with the same non-dimensional parameters such as ρ*, ν* and β, but with different mass, namely hydrogen and deuterium can be obtained. If the gyro-Bohm model holds in this comparison, these non-dimensional similar plasmas should have the same normalized thermal diffusivity χ/Ω_i. However, in the experiment, deuterium plasmas show clear improvement compared with hydrogen plasmas. The tendency of this improvement has been investigated in several tens pairs of non-dimensional similar plasmas.

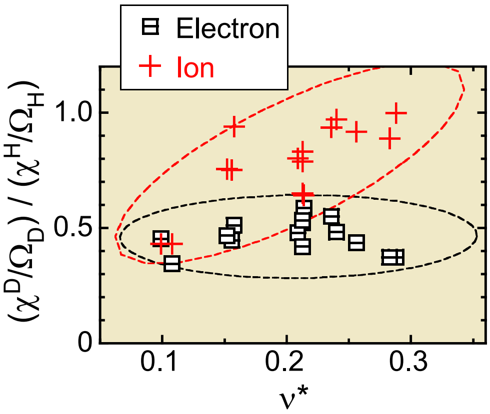

Figure shows the ratio of normalized thermal diffusivity in deuterium to that in hydrogen as a function of ν*. Here thermal diffusivity at ρ=2/3 is evaluated. The ratio of electron heat diffusivity (black symbols) stays robustly stays significantly below 1 regardless of ν*. In contrast, improvement in ion channels (red symbols) becomes less pronounced with the increase of ν*. Correlation analysis of this improvement ratio with other non-dimensional parameters such as β, L_n/R and T_e/T_i suggests that improvement in electron channels is insensitive to these parameters while ion channel shows significant correlation with β and T_e/T_i. This observation suggests that physics related to these non-dimensional parameters independently affects peculiarity in ion channel.

In contrast to energy confinement time, the particle confinement time has moderate dependence on mass ($\propto A^{0.26}$). It is suggested that isotope effects on energy/thermal transport and particle transport are different.