§17. Development and Increased Applications of Integrated Transport Analysis Suite for LHD Experiment, TASK3D-a

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Integrated transport analysis suite, TASK3D-a (Analysis version)<sup>1)</sup>, has been developed for conducting automated energy confinement analyses for NBI plasmas in LHD. The capability of TASK3D-a has been gradually increasing from its first version TASK3D-a01 (released in Sep. 2012) by implementing modules such as for neoclassical transport, international Stellarator-Heliotron Confinement Database<sup>2)</sup>, and neutral penetration from the plasma periphery etc. Significance and usefulness of TASK3D-a are described from the viewpoints of its close link to LHD experiment data and then making systematic analyses possible.

In brief, TASK3D-a consists of the equilibrium specification, NBI deposition and energy balance calculation. They are sequentially executed in an automated manner. It has an LHD experiment data interface part, which has a direct link to a so called LHD Kaiseki (analysis in Japanese) Data Server<sup>3)</sup> and TSMAP (real-time coordinate mapping system)<sup>4)</sup>. Processed diagnostics data are registered onto the Kaiseki Data Server in a common format (ASCII file, so called eg-format), and then mapping of profile data such as temperature and density (which are required for transport analyses) from the real geometry to the effective minor radius, reff, defined by TSMAP. Then such mapped profile data are transferred to TASK3D-a as inputs. Some of TASK3D-a results (NBI deposition profile, ion and electron heat diffusivity etc.) are then registered to the Kaiseki Data Server for common use. Users just need to login to the Kaiseki Data Server for utilizing these results. The dataflow described above is conceptually drawn in Fig. 1. The words written with small characters are names of registered data (so called eg data).

One of highlighted results produced by extensive TASK3D-a applications is introduced below. Figure 2 shows the ion and electron heat diffusivity as a function of temperature ratio,  $T_e/T_i$ , at a specific radius,  $r_{eff}/a_{99}\sim0.4$  based on dynamic transport analyses. Here  $a_{99}$  is the plasma minor radius in which 99 % of the total stored energy is confined. Generally, data for  $T_e/T_i < 1$  correspond to high- $T_i$  plasmas (larger symbols), and those for  $T_e/T_i>1$  to medium-to-high density plasmas (smaller symbols). The diffusivity is normalized by Gyro-Bohm temperature scaling,  $T^{1.5}$ . The tendency is recognized that the normalized ion (electron) heat diffusivity decreases (increases) as  $T_e/T_i$  is decreased.

Thus, it can be considered that present high- $T_i$  plasmas in LHD are situated in a  $T_e/T_i$  regime with smaller ion diffusivity but with larger electron diffusivity. From this systematic plot, it is implied that plasmas with  $T_e \sim T_i$  are favorable from the viewpoint of simultaneously small ion and electron heat diffusivity. This implication is consistent with recent trials for increasing  $T_e$  in high- $T_i$  plasmas (from  $T_i > T_e$  towards  $T_i \sim T_e$ ) through the increase of available ECH power.

This work has been supported by NIFS Collaborative Research Programs NIFS11KNTT008 and UNTT006. The one of authors (MY) also acknowledges the grant-in-aid from the Future Energy Research Association.

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Fig.1 The close link between TASK3D-a and LHD experiment data (centralized to LHD Kaiseki Data Server) is schematically shown.



Fig.2 Ion and electron heat diffusivity evaluated with the dynamic transport as a function of temperature ratio, Te/Ta at a specific radius (reff/a99~0.4).