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統合輸送解析スイートTASK3D-aのさらなる進展とLHDプラズマの物理的理解の促進への貢献

Further progress on integrated transport analysis suite, TASK3D-a, and its contributions for promoting scientific understandings of LHD plasmas

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The integrated transport analysis suite, TASK3D-a (Analysis), has been developed to be capable for routine whole-discharge analyses of plasmas confined in three-dimensional (3D) magnetic configuration such as the LHD. The routine dynamic energy balance analysis [1] for NBI-heated plasmas was made possible in the first version ("a01") released in September 2012. Recently, the suite has been further extended by implementing additional modules ("a02"), and then "a03" for upgraded NBI module for multi-ion species target plasmas [2].

The "a01" consists of four parts: LHD data interface, 3D equilibrium, heating, and energy balance analysis. The LHD data interface part automatically transfers experiment data from the LHD Analysed Data Server. Then the coordinate mapping from the real coordinates to effective minor radius is performed by utilizing measured electron temperature (T_e) data [3]. This provides the density and temperature profiles for all the timings of T_e measurement as a function of minor radius, which are compatible as inputs to TASK3D-a. A 3D equilibrium used above is provided to NBI deposition calculation, in which slowing down process of beam particles is also evaluated. The evaluated NBI heating power is given to the energy balance part, where the experimental energy balance is estimated in a dynamic manner (profile evolution taken into account).

Based on recent extension, neoclassical energy diffusion flux can also be routinely calculated by the implemented GSRAKE code [4], and by that, systematic comparison with experimental energy balance has been available. An example is shown in Fig. 1. Here, time-dependent comparison for ion energy transport is shown for a certain radius of a high-ion-temperature discharge. This comparison is available not only at a particular radius, but from the center to the edge, by simply executing TASK3D-a02 with only specifying the shot number. These kinds of data have been accumulated for elucidating turbulent transport contribution in a wide parameter space of LHD plasmas.

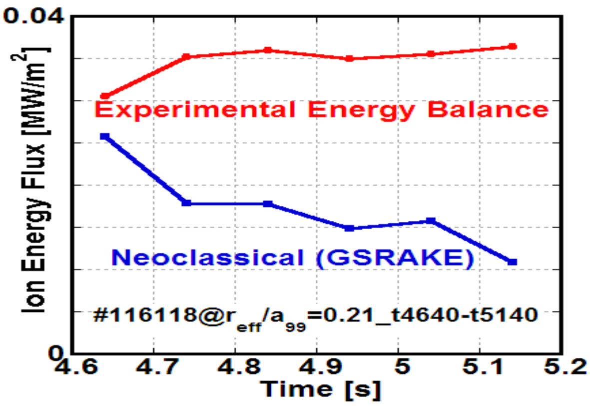

Figure 1: Time-dependent comparison between experimental and neoclassical ion energy flux at a certain radius of a high-ion-temperature discharge. This data can be easily obtained by the execution of TASK3D-a02.

TASK3D-a has also already provided profiles and equilibrium data to several large-scale simulation codes such as gyrokinetic instability, energetic particles/Alfvén eigenmodes, and neoclassical plasma flows, which has much simplified and enhanced verification and validation activities of large simulations for LHD plasmas.

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[3] C.Suzuki et al., Plasma Phys. Control. Fusion **55** (2013) 014016.
[4] C.D.Beidler and W.D.D'haeseleer, Plasma Phys. Control. Fusion **37** (1995) 463.