Implementation of NBI heating module FIT3D to hierarchy-integrated simulation code TASK3D

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In order to systematically clarify confinement physics in toroidal magnetic confinement systems, a hierarchy-renormalized simulation concept is being developed under domestic and international collaborations with universities and institutes [1]. The hierarchy-renormalized simulation model in toroidal magnetic confinement systems consists of a hierarchy-integrated simulation approach and a hierarchy-extended simulation approach. The hierarchy-integrated approach is mainly based on a transport simulation combining various simplified models describing physical processes in different hierarchies. This is suitable for investigating whole temporal behavior of experimentally observed macroscopic physics quantities. For the hierarchy-integrated simulation approach, the integrated modeling code for three dimensional configurations (TASK3D) is being developed based on the integrated modeling code for tokamak plasmas, TASK (Transport Analyzing System for tokamaK) [1], being developed in Kyoto University. In order to extend the TASK code to be applicable to three dimensional configurations, the transport equations for the rotational transform [2] and the radial electric field have been reformulated by taking the three-dimensional nature of configurations into account. With this new formulation, new module for the radial electric field (ER module) has been developed and implemented [3].

In this research, the further development of the TASK3D, implementation of the NBI (Neutral beam injection) heating module (FIT3D module), is reported. The FIT3D has been developed based on three simulation codes: HFREAYA, MCNBI and FIT, where HFREYA evaluates beam ion birth points using Monte-Carlo method and MCNBI calculates radial redistribution of beam ions due to prompt orbit effects. Then, heating profiles are obtained by FIT code solving the Fokker-Planck equation.

With the application of the FIT3D module, we have examined transport properties of various turbulent transport models and the neoclassical transport models including the radial electric field for typical parameters of LHD plasmas. Comparison of radial profiles with experimental observations and energy confinement time with International Stellarator Scaling (ISS95/04) will be reported.

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