Transport simulation of helical plasmas using the TASK/TX code

M. Miki, A. Fukuyama, M. Honda[a]

Graduate School of Engineering, Kyoto University, Sakyo-ku, Kyoto 606-8501, Japan
[a]Japan Atomic Energy Agency, 801-1 Mukoyama, Naka 311-0193, Japan

fukuyama@nucleng.kyoto-u.ac.jp

It is now widely recognized that radial electric field and plasma rotation strongly affect the transport phenomena in toroidal plasmas. The one-dimensional dynamic transport code TASK/TX [1] has been developed to describe the time evolution of the radial electric field and the plasma rotation in addition to the particle density and temperature. In the TASK/TX code, the magnetic-surface averaged multi-fluid equations of motion are directly solved instead of using the gradient and flux relations usually obtained from the stationary solution of the equations of motion.

In the present analysis, the TASK/TX code was applied to helical plasmas by introducing the effects of toroidal viscosity, stochastic magnetic field, and turbulence transport model. The helical magnetic field ripple generates the toroidal viscosity that affects the radial electric field and the neo-classical transport. In the conventional transport simulations, the radial electric field is determined by the ambipolar condition or the diffusion equation for the radial electric field. These relations can be derived from the equations of motion under some approximations. The effect of stochastic magnetic field is expressed by additional radial diffusion in fluid equations. We assume the collisionless limit where the diffusion coefficient is proportional to the parallel velocity. As a turbulent transport model, the current-diffusive interchange mode (CDIM) model [2] is used.

Transport simulation for LHD parameters with toroidal viscosity has indicated that with the increase in heating power, the magnitude of negative electric field increases and the density profile tends to become hollow. Comparison with the analysis using the ambipolor condition will be presented. The diffusion due to the stochastic magnetic field strongly enhances the radial electric field, while the density profile modification is small. The analysis including the CDIM transport model is under way.

[1] M. Honda and A. Fukuyama, J. Comput. Phys. 227 (2008) 2808.
[2] K. Itoh, et al., Plasma Phys. Control. Fusion 36 (1994) 123.