03pA08

LHD高Te放電の輸送解析および新古典輸送シミュレーションとの比較
Transport analysis of LHD high-Te discharge and comparison with neoclassical transport simulation

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NIFS, RIST[1], PPPL[2]

In helical plasmas as in the Large Helical Device in NIFS, it is known that the ambipolar condition for the neoclassical ion and electron radial particle transport determines the radial electric field profile in the plasma. To evaluate the ambipolar radial electric field, we have developed a neoclassical transport code FORTEC-3D[1] which solves the drift-kinetic equation in 5D phase space by the δf method. One of the main purpose of FORTEC-3D is to include the effect of finite drift motion perpendicular to the magnetic field lines and flux surfaces, or finite-orbit-width effect, into the neoclassical transport calculation. The finite-orbit-width effect is neglected in the other local transport codes such as GSRAKE and DGN/LHD. FORTEC-3D was first applied for ion neoclassical transport calculations in LHD plasmas since it is expected that the finite-orbit-width effect is important for ions because of their large radial orbit width compared to that of electrons. However, It is revealed that, in high-T_e and low-collisionality LHD plasmas, the finite ∇B and curvature drift across the magnetic field lines significantly affects the dependence of electron neoclassical particle flux Γ_e on the radial electric field E_r[2]. Therefore, to analyze the plasma particle and heat transport as well as to estimate the ambipolar E_r in LHD high-Te discharges, it is important to calculate both Γ_e and Γ_i with taking account of the finite-orbit-width effect.

FOTEC-3D can treat only one particle species at once. Therefore, in the previous studies we have solved only either Γ_e or Γ_i by FORTEC-3D, and the local calculation results for the other particle species to seek the ambipolar condition $\Gamma_e(\mathrm{r}, \mathrm{E_r})$=$\Gamma_i(\mathrm{r}, \mathrm{E_r})$ on each flux surface. In the present study, a new way to estimate the ambipolar condition by using FORTEC-3D simulation both for ions and electrons is explained.

The other topic in the presentation is that the new ion temperature meausement method in LHD experiment. High-Te discharge in LHD is usually obtained in ECH heated plasmas. The new X-ray imaging crystal spectrometer (XICS) installed in LHD[3] enables us to measure the ion temperature as well as poloidal rotation velocity, without NBIs. Using the observed $\mathrm{n_e}$, T_e and $\mathrm{T_i}$ profiles, we have conducted precise neoclassical transport simulation for a LHD high-Te discharge. It is found that the ambipolar $\mathrm{E_r}$ is positive (electron-root) in the core region (r<0.8) and is negative at near the plasma edge (r>0.8a). The magnitude of the $\mathrm{E} \times \mathrm{B}$ rotation speed agrees with the poloidal rotation velocity from XICS measurement. Also, neoclassical radial energy flux is compared with the power balance analysis of the discharge. It is found that at the electron-root core region, ion neoclassical energy flux is comparable to that is estimated from the power balance, while electron neoclassical energy flux is by a factor 2 smaller than the power balance.

[1] S. Satake, et al., Plasma Fus. Res. 3 (2008) S1062.
[2] S. Matsuola et al., Phys. Plasmas 18 (2011) 032511.
[3] N. Pablant, et al. Rev Sci Istrum (2012)