§49. Neutral Particle Transport in Steady-State Torus Plasmas

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It is an important subject to investigate the behavior of neutral particles in order to evaluate the particle and energy confinement properties in the plasmas. Particularly in long duration and steady-state plasmas, the neutral behavior is though to contain much interesting feature, since the time constant of plasma-wall interactions has longer characteristic time than other time constants such as particle and energy confinement times [1)]. In this study, a neutral transport simulation code is applied to TRIAM-1M tokamak, which produces long duration plasmas, in order to estimate the spatial profile of neutral density and neutral temperature in the plasma. Hα and its spatial profile measurements are also carried out in the several positions in TRIAM-1M. The ultimate goal of this study is a comprehensive understanding of the significant behavior of neutral particles in steady-state torus plasmas.

In TRIAM-1M, totally 14 Hα line-emission detectors are install in major radial direction and toroidal one. By using these detector arrays, detailed spatial profiles of Hα line intensity has been measured and neutral particle behavior was investigated from the neutral transport simulation with the DEGAS Monte-Carlo code [2, 3)]. In the previous research, the spatial profile of the Hα intensity in poloidal cross-section showed a good agreement with the Monte-Carlo simulation. On the other hand, the toroidal profiles obtained from the experiments do not explain its density dependence estimated from the mean-free-path length based on the experimental data. In order to solve this discrepancy, a neutral transport analysis along the toroidal direction has been performed by using a cylindrical mesh model.

Figure 1 shows the mesh model used in the DEGAS simulation. In a cylindrical geometry, a plasma column and scrape-off layer (SOL) region surrounding the plasma are defined. a neutral particle source is given near the midplane of the cylinder and gas is injected uniformly in azimuthal direction. In Fig. 2, the simulation results of the Hα line intensity are plotted along the toroidal direction (Z-axis) As shown in the figure, the decay length of the intensity depends on the SOL width. This result indicates that the geometry of the vacuum vessel and plasma is strongly affects the neutral behavior.

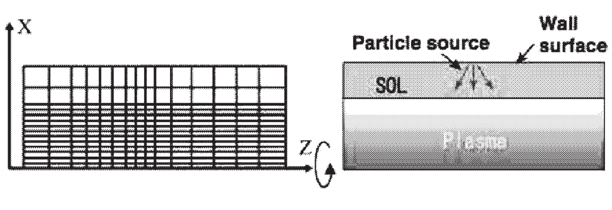

Fig. 1 Toroidal mesh model used in the simulation.

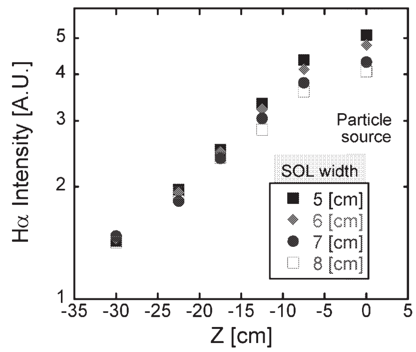

Fig. 2. Simulation result of Hα line intensity obtained by the DEGAS simulation.

Figure 3 shows the 2-dimensional profiles of atomic hydrogen temperature calculated in both low-density and high-density plasmas. It is found that a significant difference is clearly revealed between the two density cases. From this result, the decay length of the neutral particle density in the plasma is affected by not only the plasma density but also the temperature of the neutrals. More detailed and systematic study using DEGAS simulation will be performed in near future.

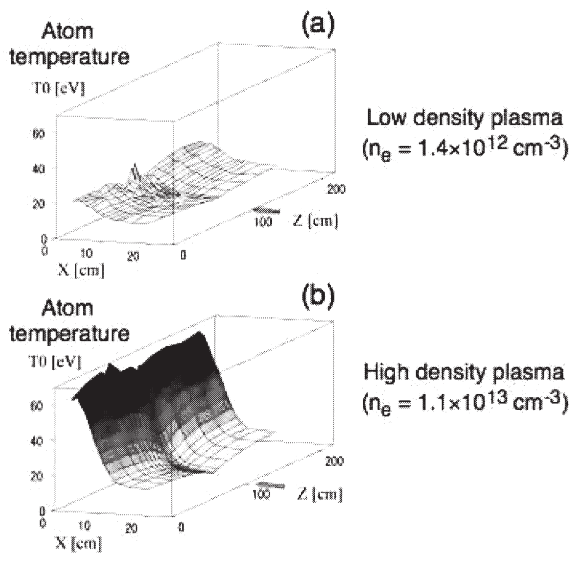

Fig. 3. Spatial profile of hydrogen atom temperature calculated from DEGAS.

Reference

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