# §22. Study of Particle Transport in Three Dimensional Non-Axisymmetric System

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In magnetically confining plasma devices, investigation of neutral transport is an important subject for understanding edge plasma behavior and for the estimation of particle confinement characteristics. In non-axisymmetric plasmas, such as helical devices, the analysis of neutral transport becomes complex due to the three-dimensional configuration of the system. The objective of this study is focused on the neutral transport in the above three-dimensional non-axisymmetric plasma and leads to the understanding of its edge plasma and the plasma-wall interactions with such plasmas. In this research, a fully three-dimensional Monte-Carlo simulation code DEGAS[1, 2] is applied to Heliotron-J device[3, 4], which utilizes a helical-axis heliotron configuration and examine the neutral particle behavior in a carbon-target experiment of Heliotron-J.

Figure 1 shows the mesh model of Heliotron-J vacuum vessel and the carbon-target for DEGAS Monte-Carlo simulation. The mesh is divided into 15 segments in radial direction and 28 segments in poloidal direction of plasma cross-section. In order to investigate the precise behavior of neutral particles near the carbon target, the toroidal divided number is doubled (256 to 512), which improves the spatial resolution of D$\alpha$ image reproduced on the carbon target. By using the above mesh model, direct comparison between 2-D image from the high-speed camera and the simulation.

Three-dimensional simulation has just started and the systematic parameter survey has not done yet. In Fig.2 the preliminary results with a test particle number of 50,000 are shown. In this simulation hydrogen is used for the test particle. Figure 2 (a) shows the 3-D profile of atomic hydrogen density in the whole Heliotron-J vacuum chamber. As shown in the figure, localization of hydrogen neutrals is observed near particle source on the carbon target inserted from the bottom of the vacuum chamber. Diffusion of the particle in poloidal direction is also recognized clearly. On the other hand, it is found that toroidal transport is suppressed due to the complicated structure of the helically rotated wall surface.

Figure 2(b) shows the result of H$\alpha$ emissivity calculated from the predicted atomic and molecular hydrogen density together with the given plasma parameters ($n_e$, $T_e$, $T_i$). Compared with the neutral particle density, contribution from the core plasma area inside the separatrix is noticeable. The extent of the localization in the toroidal direction is considerably strong.

From the above results, a basis for the analysis of neutral particle behavior in non-axisymmetric system is established using 3-dimensional Monte-Carlo simulation.

Reference
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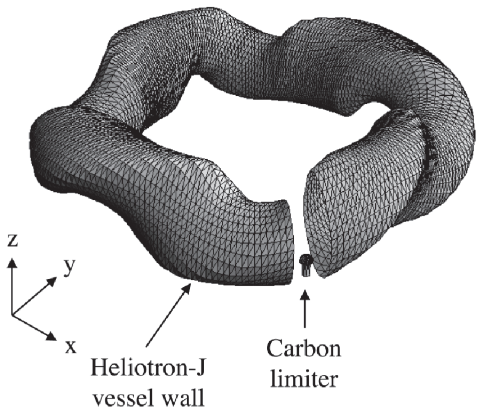


Fig. 1 Improved mesh model of Heliotron-J vacuum vessel and the carbon target

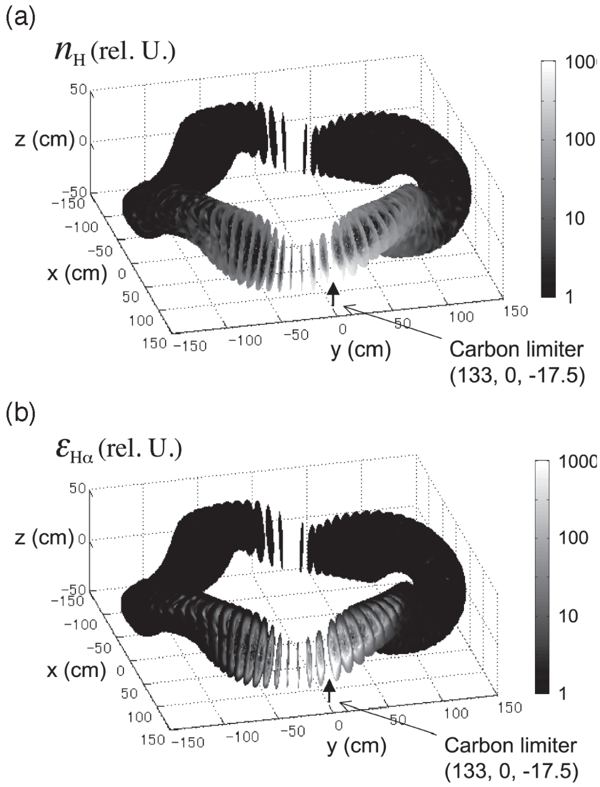


Fig.2 (a) 3-dimensional simulation results by using DEGAS code. (a) Atomic hydrogen density distribution. (b) Profile of the H$\alpha$ emissivity