05pA03

3次元流体シミュレーションによる閉構造化 LHD配位における周辺プラズマ輸送解析

Three-Dimensional Transport Analysis of Peripheral Plasma in Closed Divertor Configuration of LHD

河村学思, Yuhe FENG[1], 小林政弘, 庄司主, 森崎友宏, 増崎貴
Gakushi KAWAMURA, Yuhe FENG[1], Masahiro KOBAYASHI, Mamoru SHOJI, Tomohiro MORISAKI, Suguru MASUZAKI

核融合研, Max-Planck IPP[1]
NIFS, Max-Planck IPP[1]

Transport simulation of peripheral plasmas of Large Helical Device (LHD) in closed helical-divertor configuration has been achieved in this work. Extension of the calculation mesh of EMC3-EIRENE code[1,2] has made it possible to solve plasma and neutral transport in the peripheral regions, i.e. ergodic and divertor regions. We employed a three-dimensional fluid code to simulate parallel and perpendicular transport of plasma and transport of neutrals and calculate stational distributions self-consistently. Transport simulation of peripheral plasmas of LHD was launched for ergodic region without divertor legs to reduce difficulties arising in making a calculation mesh on outer region of plasma. Although it is reasonable assumption when one focuses on the ergodic region, it is not the case with closed divertor configuration introduced in 80% of toroidal sections. Extension of simulation region toward legs is necessary to simulate global transport of plasma and neutrals. The difficulty due to large distortion of cells in the mesh of legs has been overcome by splitting the mesh into edge-, leg- and vacuum-blockes.

Figure 1 is a simulation result of electron density in the case of inward-shifted configuration with 8MW heating power. Electron density of $2 \times 10^{13}/\mathrm{cm}^3$ is assumed at the inner boundary. Bohm condition is applied at divertor plates, which are drawn as bold lines at the tips of the legs in the figure. Neutral compression under a dome structure was predicted[3] and observed[4] in experiments. We carried out a series of simulations in the open and closed configuration and compared the pressure with measurements, see Fig. 2. They show a good agreement on scaling of neutral gas pressure to the electron density when the heating power is fixed. Simulation suggests that the closed configuration causes enhancement of recycling and hence higher electron density and lower temperature.

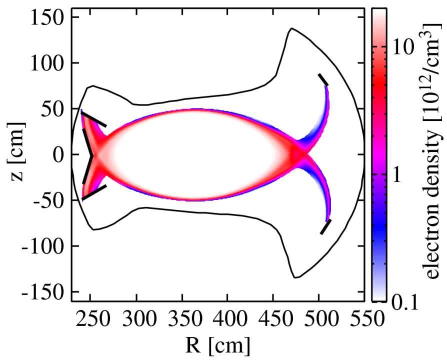

Fig. 1: Distribution of electron density in ergodic region and legs in the case of closed configuration.

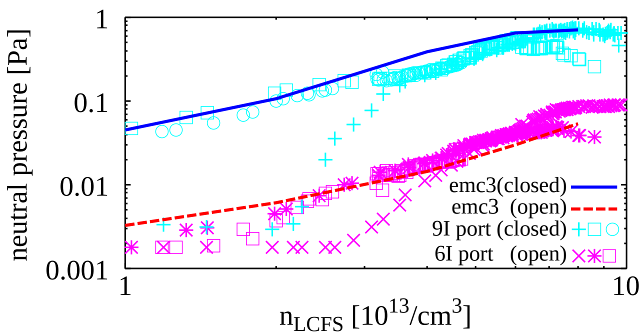

Fig. 2: Comparisons of neutral gas pressure between open and closed configuration. Solid lines and dots stand for simulation and measurements, respectively.

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[3] M. Shoji *et al.*, Nucl. Mater., **390–391** (2009) 490
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