§7. Extension of Calculation Grid for LHD Edge and Divertor Plasmas

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Simulation of impurity transport in a fusion device is an important issue related to energy confinement and life time of plasma-facing components. We have developed one-dimensional fluid model of LHD divertor plasma and applied it to ERO[1, 2]. The three-dimensional distribution of plasma is, however, important for quantitative analysis of impurity transport. Although the plasma transport code, EMC3-EIRENE[3], is used to simulate the ergodic layer, i.e. edge/SOL, in LHD, the calculation grid does not include divertor plasma. Technical study of generation method of the grid covering the ergodic and divertor plasma was carried out.

The magnetic shear is strong near the vacuum vessel and causes strong distortion on the grid. That makes it difficult to generate a grid covering whole volume in the vacuum vessel because the grid of EMC3, i.e. plasma fluid code, have to be aligned to the magnetic field lines. EIRENE code, i.e. neutral particle code, does not require the field-aligned grid in three dimension, therefore we split the volume to three class of regions, i.e. ergodic region, divertor leg region and vacuum region. We developed a series of tools to generate grids for each region. Guidelines of boundaries are manually made and a magnetic field tracing code, KMAG[4], is utilized for ergodic and leg regions. Geometrical method was developed to make vacuum grids.

The generated grids are shown in Fig. 1. The figures are on a poloidal cross section in a horizontally elongated plane. They share the same points in boundaries and are connected each other in EMC3-EIRENE. The simulation box has the size of 18° in the toroidal direction. The periodicity and up-down symmetry in horizontally and vertically elongated planes are utilized to reduce the size of the box. We made grids on planes par 1°.

A simulation to test the consistency of grids was carried out. The distribution of electron temperature is shown in Fig. 2. The profile is continuous through the boundaries of grids. We obtained other distributions of connection length, electron density and Mach number. These quantities were physically reasonable. Therefore we conclude that the new calculation grid is technically valid. The vacuum grids are, however, not complete for neutrals because of distortion coming from the boundary shape. In order to fix the problem, reconstruction with optimization are necessary. The optimized grid and development of automated generation tools are future issues.

1) A. Kirschner *et al.*, Nucl. Fusion **40** (2000) 989.

2) G. Kawamura *et al.*, Plasma Fus. Res., **5** (2010) S1020.

3) M. Kobayashi *et al.*,fusion science technology, 58 (2010) 220.

4) Y.Nakamura, J. Plasma Fus. Res., **69** (1993) 41

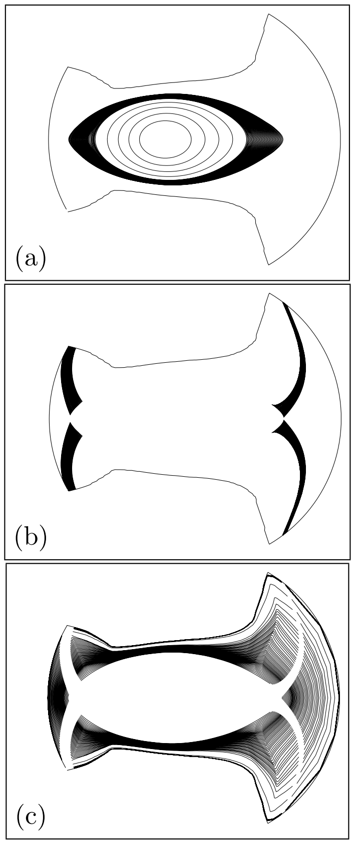

Fig. 1: Generated grids for each region; (a) ergodic region, (b) leg region, (c) vacuum region.

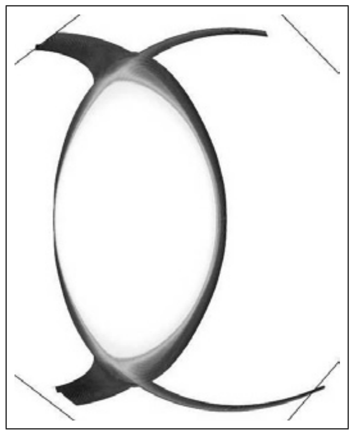

Fig. 2: Contour plot of electron temperature.