§14. Investigation of Impurity Transport in Peripheral Region Using IMPMC Code

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This research is aimed at understanding the behaviour in the Large Helical Device (LHD) peripheral region using simulations. The simulation code used in this research will be extended to be coupled to a core plasma code, which leads a holistic simulation. As a beginning, IMPMC code, which stands for IMPurity Monte-Carlo, is used. The IMPMC code has been developed in Japan Atomic Energy Agency (JAEA) [1].

The IMPMC code is based on 2-dimensional geometry and has been applied intensively for Tokamaks, especially for the JT-60U. On the other hand, the LHD has a inherent 3-dimensionality. Thus applying the IMPMC code to the LHD requires expansion to 3-dimensional geometry or developing an 2-dimensional modeling which enables evaluate the 3-dimensional LHD behaviour.

Code expansion to 3-dimensional geometry is planned in FY2008-2009. In this fiscal year we developed a concept named LEAP, which stands for LHD Equivalent Axisymmetric Plasma. This LEAP concept is not the specific modeling but an general 2-dimensional approach for the LHD edge transport.

The LEAP model enables us to reduce difficulty on understanding or describing a physical picture of peripheral region and also to reduce computer resources to perform parametric simulation study. It is noted that the model is also profitable in order to expand the code into 3-dimensional geometry.

Modifying the Code Structure of IMPMC

At the beginning the IMPMC code was ported to a computer in NIFS and verified to function correctly. Then internal code structure has been modified to consist of modules or components, which are separated based on physical model or physical scale layer. On performing such modifications we have to be careful not to mix in bugs or unintended actions. A procedure to reduce troubles and man power in code modification has been developed and we have been modifying the IMPMC code under the procedure. It should be noted that the code modification into having modules or components structure is essential for coupling between edge code and core code, and is helpful for expanding to 3-dimensional code.

Concept of LEAP and a model for impurity transport

As an example of the LEAP model for impurity transport, we set a region with artificially enhanced transverse diffusion coefficient $D_\perp = D_0 + D_{\rm stc}$ inside the separatrix region. An effect of enhancing radial diffusion because of the magnetic stochasticity is taken account in by the term of $D_{\rm stc}$. How large the diffusion coefficient should be enhanced is estimated or evaluated from the magnetic connection length (magnetic structure) and the transverse diffusion coefficient without this effect D_0.

Figure shows a result from the LEAP model mentioned above. We can observe that the density of highly charged carbon (C^{4+}, C^{5+}, C^{6+}) was decreased by the factor of 3 inside the separatrix or core region, and that the density of C^{4+} in the neighbourhood of the divertor plate was increasing with the artificially enhanced transeverse diffusion coefficient, which corresponds to the ergodic magnetic field outside the separatrix of LHD.

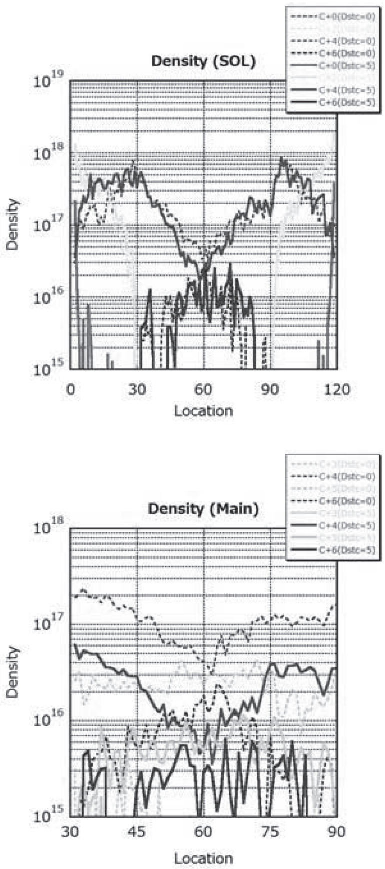

Figure simulation results based on LEAP model

1) Shimizu, K. et al., J. Nucl. Mater. **363-365** (2007) 426.