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タングステン不純物輸送コードにおけるドリフトの効果の比較 -IMPGYROコードとDIVIMPコードのベンチマーク-

W transport simulations in divertor and SOL plasma using IMPGYRO code and benchmark against DIVIMP

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With the move in current and future fusion devices to all-metal walls, and particularly with tungsten (W) plasma-facing components, understanding heavy ion impurity transport processes in the Scrape-Off Layer (SOL)/divertor region is becoming one of the most critical issues for tokamak operation. To improve this understanding, we are continuing to develop the kinetic SOL/divertor impurity transport code IMPGYRO[1], which tracks the trajectory of impurity ions in the plasma, resolving their full gyro-orbits.

Our goal is to validate the understanding of W transport, including comparisons with experiments, and other existing W transport codes. In this presentation, we have performed the comparison of the parallel W transport process between the IMPGYRO and the traditional kinetic transport code, DIVIMP[2].

The comparison has been performed on the ITER geometry F57 (Fig. 1) and its background plasma parameters obtained from the SOLPS-ITER code suite[3,4] calculation. In order to obtain basic understanding of the difference of the parallel transport processes between both codes, the simple assumptions have been made for the W particle source and the cross-field transport. W impurities are launched from the outer divertor plate 10.7 cm outside the separatrix. The initial velocity distribution of test particles is assumed to be monoenergetic at 10 eV with a cosine angular distribution. The W anomalous diffusion has been set to zero and the electric potential of the background plasmas is neglected (i.e. no ExB drift forces act on the W ions). All the particles reaching the core and wall boundaries are assumed to be absorbed.

Figure 2 shows the normalized W^{+5} density distribution along the W launch field line near the outer divertor plate, one of the examples of the calculation results, of both codes. Qualitatively, both codes has similar tendency i.e. the W impurities have been pushed toward the upstream of the divertor region. The W^{+5} distribution decreases monotonically in the IMPGYRO, on the other hand, the DIVIMP has a peak of the density 3cm away from the outer divertor plate. The difference can be understood from the mean free path of the W impurities projected on the field line, the friction force the prompt re-deposition. The result shows that the lack of the combination of the friction force and the prompt re-deposition may leads to the over estimation of the W concentration in the core. The comparison of the absolute value of the density in both codes is ongoing.

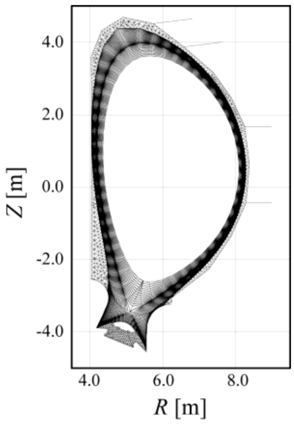

Fig. 1. SOLPS-ITER computational mesh for ITER(F57) geometry.

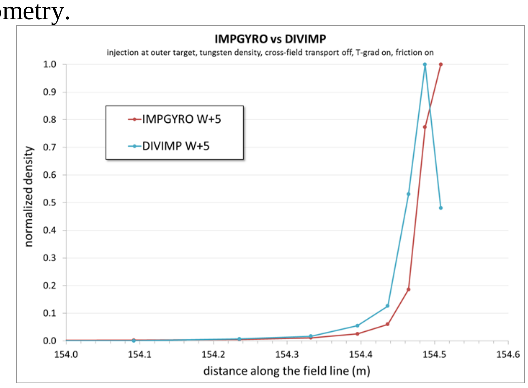

Fig. 2. W^{5+} density distribution along the W launch field line near the outer divertor plate.

[1] A. Fukano et al., J. Nucl. Mater. 363–365 (2007) 211.
[2] P. C. Stangeby, et al., Nucl. Fusion 28 (1988) 1945.
[3] S. Wiesen, et al., J. Nucl. Mater. 463 (2015) 480.
[4] X. Bonnin, et al., Plasma Fusion Research 11 (2016) 1403102.