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プラズマコヒーレント構造の輸送ダイナミクスの粒子シミュレーション

Particle Simulation of Plasma Coherent Structure Transport Dynamics

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In recent magnetic confinement fusion device experiments, it has been found that the density profile in the far scrape-off layer (SOL) is flatter than the exponential distribution which is expected from a diffusion model [1]. Motivated by such experiments, some authors have studied the plasma transport in SOL theoretically. Then a theory of plasma blob dynamics has been suggested as the mechanism of the non-diffusive (convective) radial transport [2]. The plasma blob is an intermittent filamentary coherent structure along the magnetic field line and propagates from the edge of core plasma to the first wall. Such structures are thought to play an important role in plasma particles and heat flux transports into the far SOL across magnetic field lines. Many theoretical and numerical studies about dynamics of blobs on the basis of two-dimensional reduced fluid models have been conducted [3, 4]. In such kind of macroscopic fluid models, however, kinetic effects (such as sheath formation between plasma and divertor plates, velocity difference between ions and electrons, temporal and spatial variations of particle velocity distributions, etc.) are treated under some assumptions and parameterization.

Thus, in this study, we have investigated microscopic dynamics in a blob by means of a three-dimensional electrostatic plasma particle simulation code with particle absorbing boundaries [5, 6]. In our previous study, we had investigated the configurations of spontaneous particle flows in a plasma coherent structure [7]. In this paper, we have confirmed the presence of the net poloidal current in a blob (see Fig. 1). Also, Fig. 2 indicates that the toroidal current from the divertor plate is almost converted to the poloidal current.

Furthermore, in our previous study, we had studied kinetic effects on plasma blob dynamics in the system where the periodic boundary condition is applied in the direction parallel to the magnetic field line and found that the symmetry breaking in blob propagation occurs by the kinetic effect. On the other hand, in this paper, we have applied the particle absorbing boundaries to the ends in the direction parallel to the magnetic field line and studied such kinetic effects with the plasma sheath. In the simulation, not only the symmetry breaking shown in the previous study but also other properties which were not found in the periodic boundary case have been observed.

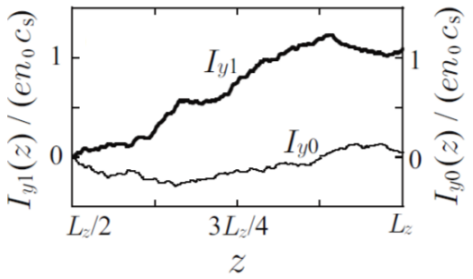

Fig. 1. Net poloidal currents at the background plasma (I_{y0}) and in the blob (I_{y0}) as functions of z.

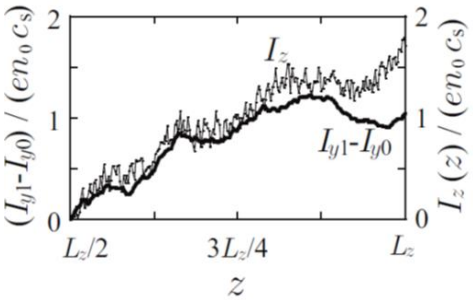

Fig. 2. Net poloidal current (I_{y1}-I_{y0}) and net toroidal current (I_z) as functions of z.

[1] M. V. Umansky *et al*., Phys. Plasmas **5**, 3373 (1998).
[2] S. I. Krasheninnikov, Phys. Lett. A **283**, 368 (2001).
[3] S. I. Krasheninnikov, D. A. D'Ippolito, and J. R. Myra, J. Plasma Phys. **74**, 679 (2008) and references therein.
[4] D. A. D'Ippolito *et al*., Phys. Plasmas **18**, 060501 (2011) and references therein.
[5] S. Ishiguro and H. Hasegawa, J. Plasma Phys. **72**, 1233 (2006).
[6] H. Hasegawa and S. Ishiguro, Plasma Fusion Res. **7**, 2401060 (2012).
[7] H. Hasegawa and S. Ishiguro, Phys. Plasmas **22**, 102113 (2015).