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プラズマコヒーレント構造における微視的ダイナミクス
Microscopic Dynamics in Plasma Coherent Structures

長谷川裕記[1], 石黒静児[1, 2]
HASEGAWA Hiroki[1] and ISHIGURO Seiji[1, 2]

核融合研[1], 総研大[2]
NIFS[1], Sokendai[2]

Recently it has been reported that filamentary coherent structures are formed intermittently and propagate from the edge of core plasma to the first wall in scrape-off layer (SOL) of magnetic confinement fusion devices. Such structures are called "blobs" and are thought to play an important role in plasma particles and heat flux transports into the far SOL across magnetic field lines [1, 2]. Dynamics of blobs have been studied on the basis of two-dimensional reduced fluid models by many authors. In such kind of macroscopic model, however, kinetic effects, such as sheath formation between plasma and divertor plate and velocity difference between ions and electrons, are treated under some assumptions and parameterization.

Thus, in this study, we have developed a three-dimensional electrostatic plasma particle simulation code with particle absorbing boundaries [3] and investigated microscopic dynamics in blobs with the particle simulation. When the periodic boundary condition is applied in the toroidal direction, it is observed that a blob evolves to a mushroom-shaped object [4]. This fact coincides with previous results of the fluid model simulations [5]. Furthermore, we have found that the acceleration of propagating blobs in the early stage and the terminal propagation speed of blobs are almost constant independently of the size of blobs.

On the other hand, when the end plates which correspond to divertor plates are placed in both ends in the toroidal direction, we have observed that the propagation speed of blobs is proportional to δ_b^{-2} where δ_b is the blob size in the poloidal direction. Observed propagation speeds are in agreement with theoretical values estimated by the fluid model [1, 2]. Further, it has been found that the electric current system is formed spontaneously in a blob as shown in Fig. 1.

The propagation speeds of the blobs in the latter case are slower than those in the periodic boundary condition case. It is thought that this difference arises from the reduction in the electric field in a blob by the end plates. Strong cross-field transport in the detached divertor plasma was actually observed in some experiments [6-8] and is thought to be provided by the growth of electric field in a coherent structure due to the detached divertor plasma.

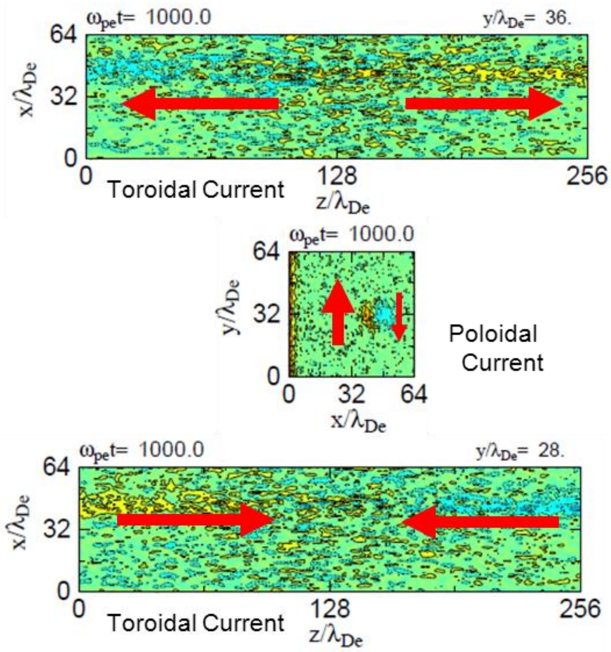

Fig. 1 Distributions of the toroidal (top and bottom panels) and poloidal (middle panel) components of the current density.

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