§20. Structure of Thin Current Layer in Two-dimensional Open System

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Magnetic reconnection is an important bridging process between microscopic physics, which leads to the generation of electric resistivity, and macroscopic physics which determines global plasma transport and global change of field topology. Thus, the spatial structure of current layer, which is a typical measure of microscopic physics, is not independent of macroscopic physics such as external driving field. In order to clarify relationship between microscopic physics and macroscopic physics controlling magnetic reconnection, we have examined the dependence of current layer structure on external driving electric field by using two-dimensional particle simulation code developed for an open boundary system.

The previous simulation study [1] have revealed that dynamical behavior of collisionless driven reconnection is strongly dependent on the spatial scale of driving field E_d, but insensitive to the amplitude of the field E_d. In order to clarify physical meaning of this result, we have carried out particle simulation of collisionless driven reconnection for larger mass ratio and wider parameter range of the driving field E_d. The simulation parameters are as follows; mass ratio Mi/Me=100, total number of particles is 12000000, and the spatial scale of E_d is fixed to the same value in the previous simulation when the steady reconnection was realized [1].

The steady reconnection is realized in the same way as the previous simulation for each case. As is shown in Fig. 1, two-scale structure is formed in the current density profile at the steady state, except for the smallest driving field case. Figure 2 shows the temporal evolution of spatial scales of current layer for the amplitude of the driving field E_{z0}=-0.05. The larger scale is equal to ion meandering scale, while the smaller scale corresponds to the electron meandering scale. This result is in good agreement with the recent simulation result [2] that the reconnection electric field is sustained by the pressure tensor term originating from the ion stochastic motion near the neutral sheet. It is interesting to point out that a threshold value of the driving field may exist in forming the two-scale structure.

Reference

1) W. Pei, R. Horiuchi and T. Sato, Phys. Plasmas, **8** (2001), pp. 3251-3257.
2) A. Ishizawa, R. Horiuchi, and H. Ohtani, Phys. Plasmas, **11** (2004) 3579-3585.

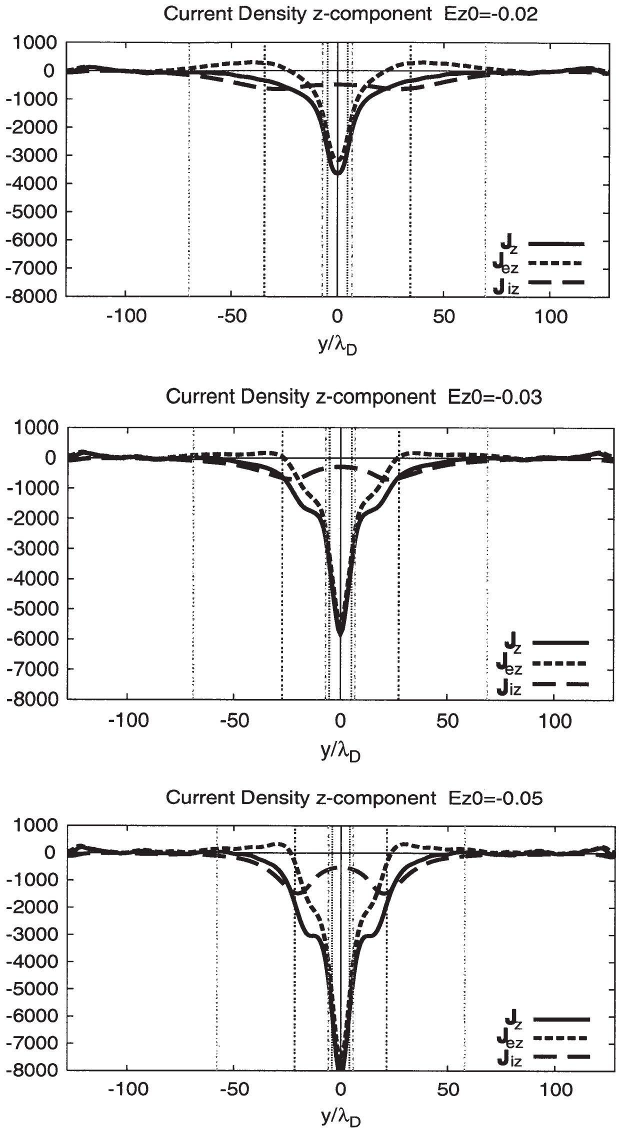

Fig. 1. Spatial profiles of current density profile for the driving field E_{z0}=-0.02 (top), 0.03 (middle), 0.05(bottom).

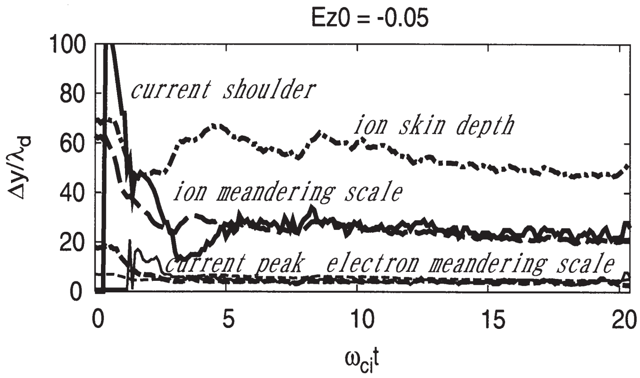

Fig. 2. Temporal evolution of spatial scales of current layer for the driving field E_{z0}=-0.05.