§2. Role of Magnetic Islands in Collisionless Driven Reconnection

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In some of rapid energy release phenomenon in nature such as solar flare and coronal mass ejection, a clump of plasma, called magnetic island or plasmoid, is intermittently ejected toward surroundings under the influence of magnetic reconnection. The same phenomena is sometimes observed in fusion plasmas. Because dynamical evolution of microscopic reconnection physics in such phenomenon is strongly coupled with surrounding macroscopic physics, we have developed PArticle Simulation code for Magnetic reconnection in an Open system (PASMO) based on standard PIC model, in which there are two open boundaries, i.e., upstream and downstream boundaries [1,2,3].

At the upstream boundary, an external driving electric field is imposed in order to supply plasma inflow into the microscopic system, which is controlled by three parameters; inflow window size, expansion speed and uniform driving field. The spatial profile of the driving electric field is described at four different time periods in Figure1.

By controlling the inflow window size x_{slot}, we find that two different kinds of solutions are realized in the time evolution of the reconnection system starting from the same initial condition, i.e., the first is a narrow window case where no magnetic islands appear in the current sheet (steady reconnection in Figure 2-a), and the second is a wide wind case where magnetic islands are frequently generated and grow in it (intermittent reconnection in Figure 2-b).

Analyzing the simulation results for two different window sizes (19ρ_i, and 38 ρ_i), the roles of magnetic island are investigated.

1. When the spatial size of a magnetic island becomes maximum for a multi-islands case, the effective resistivity reaches its maximum and reconnection proceeds fast.
2. The energy conversion rate from the EM field to particles for a multi-islands case is much larger than that for no island case.
3. Electrons are accelerated by the parallel electric field at the reconnection point and the center of magnetic island, they are heated inside the island. On the other hand, ions are accelerated by the perpendicular electric field when they pass across the magnetic separatrix, and suffers from the compressional heating inside the magnetic separatrix.
4. The EM energy is dominantly converted to ion energy regardless of the existence of magnetic islands [3].

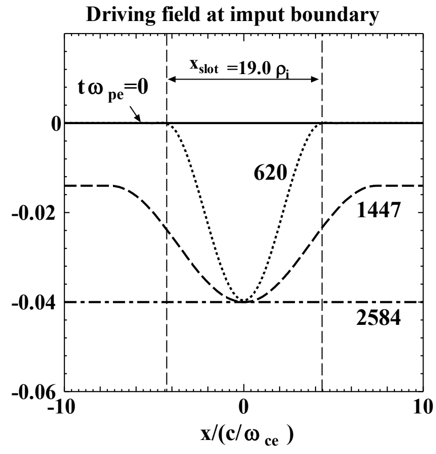

Fig. 1. Spatial profiles of the driving electric field imposed at the upstream boundary for four different time periods.

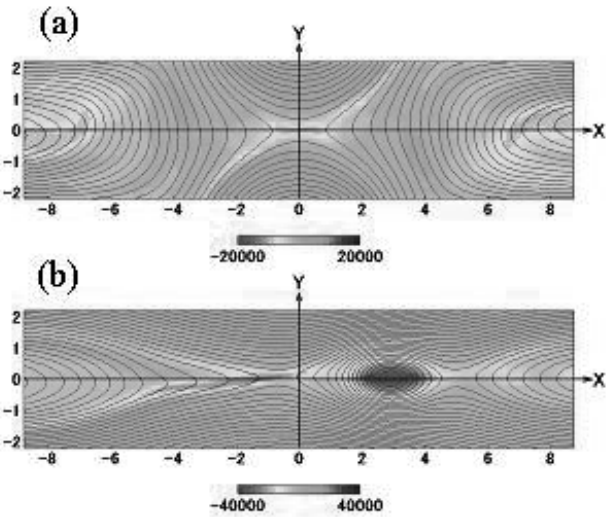

Fig. 2. Current density profiles and magnetic lines of force for two different window sizes; (a):x_{slot} =19ρ_i, (b): x_{slot} =38 ρ_i.

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[3] R. Horiuchi , S. Usami and H. Ohtani, Plasma and Fusion Research, **9** (2014) 1401092.