

§2. Influence of Guide Magnetic Field on Collisionless Driven Reconnection

Horiuchi, R., Ohtani, H., Usami, S.

Magnetic reconnection is one of basic plasma processes commonly observed in various natural systems such as solar corona, earth magnetosphere, fusion devices, and so on. It is widely believed that magnetic reconnection in each system is controlled by common and/or similar physical processes, regardless of big differences in magnetic configuration and temporal-spatial scales. Although there exists strong guide field in fusion devices, which is considered to alter microscopic physical processes, its role in magnetic reconnection is not clear. In order to clarify the influence of guide magnetic field on collisionless driven reconnection, we have carried out a series of particle simulation runs in a microscopic open system, using “PASMO” code.

An initial condition is one-dimensional equilibrium with a guide field in which the magnetic field is described as:

$$B_z = B_{z0} + B_{z1} \operatorname{sech}(y/L), \quad B_x = B_0 \tanh(y/L),$$

where B_{z0} , B_{z1} and B_0 are constant, and $L(=0.98\rho_{i0})$ is a scale height. By imposing plasma inflow with the same velocity and spatial profile at the upstream boundary, we have succeeded in demonstrating island formation process in the same way for three different guide fields. The current density profile becomes asymmetric because off-plane component of magnetic field is composed of symmetric guide field and quadrupole component generated through the Hall effect. Figure 1 shows the spatial profiles of ion temperature in three cases when a magnetic island grows and moves toward the downstream boundary. Here, the relation $B_{z1} = -B_{z0}$ is assumed. It is clear from this figure that ion heating in the islands is weakened as guide field increases. The same result is obtained for the electron temperature. This is because strong guide field accumulated inside the islands plays a role in making plasmas magnetized and weakening the kinetic effect.

Figure 2 illustrates the ion and electron energy spectra at the final stage for $B_{z0}/B_0=2$. High energy non-thermal component is clearly observed in the electron energy spectrum, while thermal component is dominant in the ion energy spectrum. This is because electron non-thermal component is mainly used to sustain current density profile. Although not shown here, we found that high energy components tend to increase as guide field decreases in both ion and

electron spectra. Furthermore, it is also found that the dissipation of magnetic field energy takes place inside narrow electron dissipation region in the vicinity of reconnection point and energy transfer happens mainly between kinetic energy of bulk motion and thermal energy.

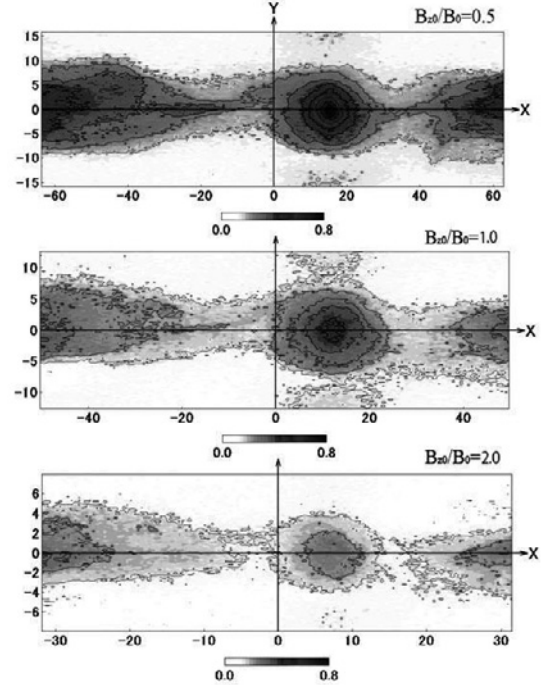


Fig. 1 Spatial profiles of ion temperature at island growing phase where top, middle and bottom panels correspond to the results for $B_{z0}/B_0=0.5, 1, 2$, respectively, and $B_{z1} = -B_{z0}$.

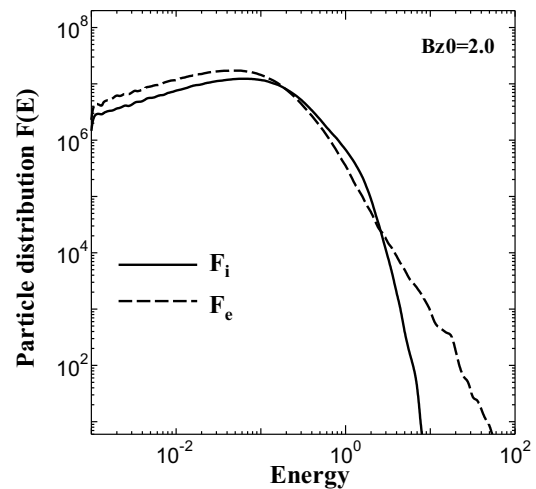


Fig.2 Ion and electron energy spectra at the final stage for $B_{z0}/B_0=2$.