§ 9. Three-Dimensional Collisionless Reconnection in the Absence of an External Driving Source

Horiuchi, R.

Triggering mechanism of collisionless reconnection in the absence of an external driving source is investigated by means of three-dimensional electromagnetic particle simulation [1,2]. In the same way as two-dimensional case [3] two kinds of plasma instabilities grow in the current layer. The lower hybrid drift instability (LHDI) is observed to grow in the periphery of current layer in an early period, while a drift-kink instability (DKI) is triggered at the neutral sheet as a second instability after the current sheet is modified through nonlinear evolution of the LHDI. We have examined this process in detail.

The LHD mode interacts with particles in the periphery and modifies the particle distribution there. As is shown in Fig. 1, the electrons which exist in the periphery in the early period are scattered over the wide area of current sheet by the electric field excited by the LHDI. The plateau structure appears in the electron distribution as a result of the wave-particle interaction. Figure 2 shows the electron distribution in (y, v_z) space where the top and bottom panels represent the distributions when the simulation starts and when the LHDI fully develops, respectively. The distribution in the periphery is shifted towards the negative v_z direction by the electric field excited by the LHDI, and thus the total electric current density is reduced in the periphery. On the other hand, the electrons in the central region increase their average velocity through the orbit effect. Finally, a peaked current profile is formed near the central region, in which the width is lower than ion Larmor radius (see Fig. 3). Consequently, the DKI is excited in the neutral sheet as a second instability.

References
1) R. Horiuchi et al., Phys. Plasma **6**, 4565(1999).
2) R. Horiuchi et al., EPS, **53**, 439(2001).
3) M. Ozaki, et al., Phys. Plasmas **3**, 2265(1996).

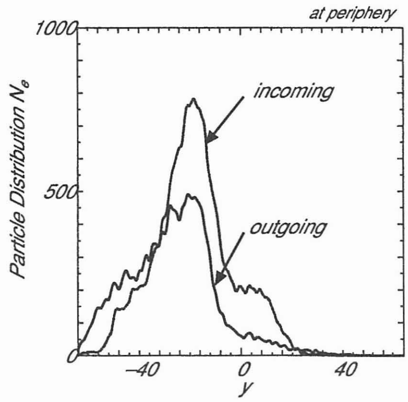

Figure 1: Spatial distribution of electrons at $t\omega_{ce} = 510$, which exist initially in the periphery (solid), and the initial distribution of electrons which exist in the periphery at $t\omega_{ce} = 510$ (dashed).

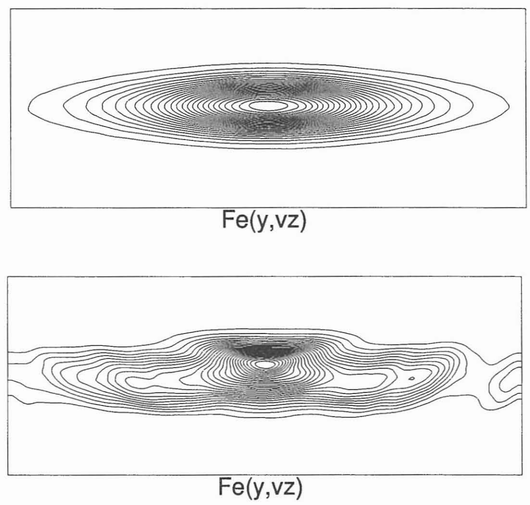

Figure 2: Electron distribution in (y, v_z) space at $t = 0$ (top) and $t\omega_{ce} = 510$ (bottom).

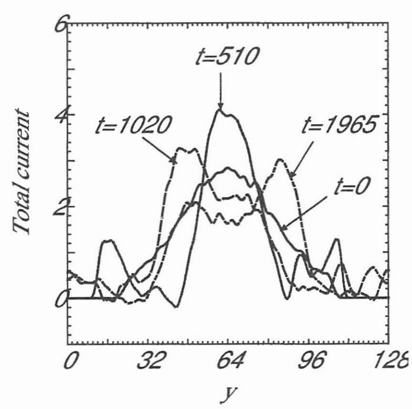

Figure 3: Spatial profile of the electron current density at four different periods.