§22. Three Dimensional Particle Simulation on Collisionless Driven Reconnection

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Magnetic reconection plays an important role in plasmas, and leads to the fast energy release from magnetic field to plasmas and the change of magnetic field topology [1]. To clarify the relationship between particle kinetic effects and anomalous resistivity due to plasma instabilities, we develop a three-dimensional particle simulation code for an open system [2,3]. From last year on, we develop the simulation code in a distributed parallel algorithm for a distributed memory and multi-processor computer system [4]. In this paper, we show simulation results of collisionless driven reconnection.

The number of initial particles is 72 million at the initial time, the simulation box size is $252\lambda_D \times 63\lambda_D \times 192\lambda_D$, the scale length of current layer is $25.2\lambda_D$ at the initial time, the thermal velocities of electron and ion are $0.25c$ and $0.025c$, respectively. λ_D is Debye length. The mass ratio m_i/m_e is 100 and the driving field E_{z0} is $-0.04B_0$.

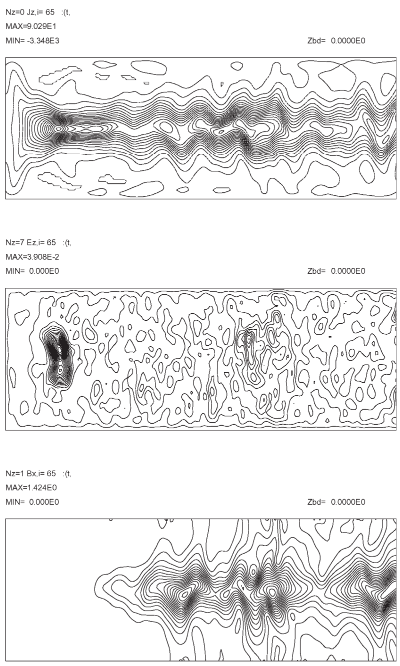
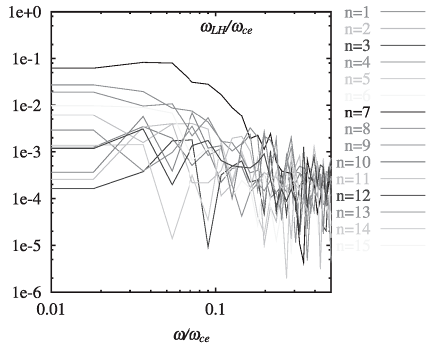
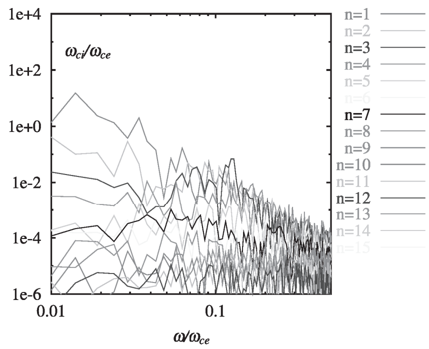


Fig. 1. Contour plot of spatiotemporal evolution (y-t) of Fourier mode of the current density $J_z(n = 0)$ (top), the electric field $E_z(n = 7)$ (middle) and the magnetic field $B_x(n = 1)$ (bottom).

Figure 1 shows the contour plot of spatiotemporal evolution (y-t) of Fourier mode of the out-of-plane current density $J_z(n = 0)$ (top), the electric field $E_z(n = 7)$ (middle), and the magnetic field $B_x(n = 1)$ (bottom), where n is the Fourier mode number in the z-direction



(a) E_z at the periphery of current layer.



(b) B_x at the center of current layer.

Fig. 2. Spectrum.

and the neutral sheet is located at the mid-point of y-axis. Figure 2 shows the spectrum of (a) E_z at the periphery of current layer and (b) B_x at the central region.

In the early period, the mode $E_z(n = 7)$ grows in the periphery of the current layer, where the gradient of the current density is large. This mode $E_z(n = 7)$ is identified as the lower hybrid drift mode (LHD mode) from the spectrum analysis (Fig. 2(a)). As LHD mode grows, the current density in the central region becomes peaked and then a low-frequency electromagnetic instability is excited near the central region (See the bottom figure of Fig. 1). This low-frequency instability, which has a frequency comparable to the ion gyration frequency (Fig. 2(b)), is considered to be the drift kink instability (DKI) and be a possible candidate for anomalous resistivity in the neutral sheet [2,3].

Reference

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4) H. Ohtani *et al*: submitted to LNCL (2005).