# §19. Fast Electron Inflow Channel of Electron Dissipation Region in Collisionless Driven Reconnection

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In order to investigate dynamical evolution of collisionless driven reconnection we have developed an electromagnetic particle simulation code in a microscopic open system (``PASMO") which is surrounded by macroscopic system [1,2,3]. In this model the interaction between macro system and micro system is expressed by the plasma inflow and outflow through the system boundary.

The plasma inflows can be symmetrically driven from two upstream boundaries by imposing the external electric field in the z direction. The frozen-in conditions of both ions and electrons are satisfied at the upstream boundary. Ion becomes unmagnetized when they enter into ion dissipation region characterized by ion meandering scale, while electrons remain magnetized there [1,4]. The driving electric field works strongly on magnetized electrons and makes electron and ion motions different. Thus, in-plane electrostatic field is generated as a result of charge separation. The out-of-plane electron current grows inside the ion meandering scale though **EXB** drift associated with the in-plane electrostatic field, [1].

When electrons enter into the electron dissipation region characterized by electron meandering scale, they become unmagnetized and the strong electron current evolves there through the acceleration by reconnection electric field. Magnetic energy carried into this region is converted mainly into the kinetic energy of electron outflow in the downstream through collisionless reconnection. Thus, electron outflow velocity (dashed line in Fig. 1) in the downstream can reach the electron Alfven velocity (dot-dashed line) at the inflow edge of electron dissipation region, as shown in Fig.1.

Because the electron Alfven velocity is much faster than the **EXB** drift velocity at the edge, mass conservation law requires a very long electron dissipation region along the outflow direction if its shape is a square and inflow profile is spatially uniform one determined by the **EXB** drift. Figure 2 demonstrates the electron flow pattern in a relatively early phase. High speed electron inflow along field lines appears just outside a magnetic separatrix, which can compensate the loss of electrons in the vicinity of reconnection point. The filed lines along which fast electron inflow exists are tied to the x-boundary. That is, electrons are supplied into electron dissipation region through the field-aligned motion from the x-boundary in addition to the **EXB** drift motion from the y-boundary. It is worthy of notice that the velocity of electron field-aligned motion is much faster than the **EXB** drift velocity, and the size of electron inflow channel is much shorter than the dissipation region length. Thus, field-aligned electron inflow plays an important role in the formation electron dissipation region. In this sense the open boundary condition which is applied to the x-boundary and enables plasmas to move in and out smoothly through the boundary is a key function to describe the fast electron field-aligned inflow.

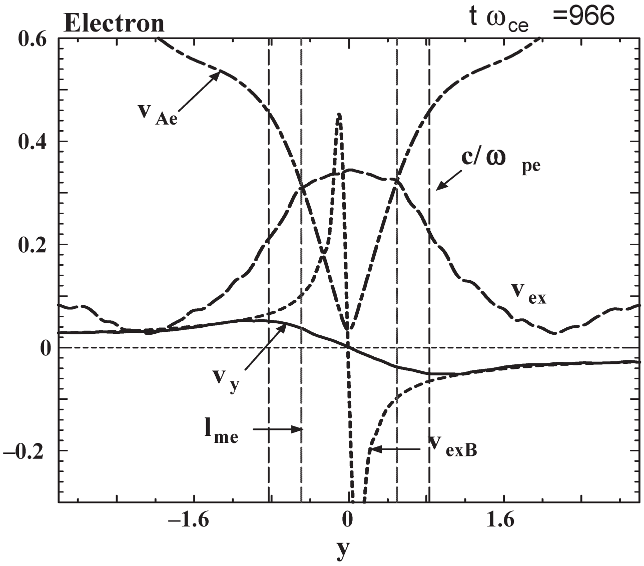

Fig. 1. Spatial profiles of electron velocities along inflow direction at $\omega_{ce}t=966$, where left and right boundaries correspond to the upstream boundaries. .

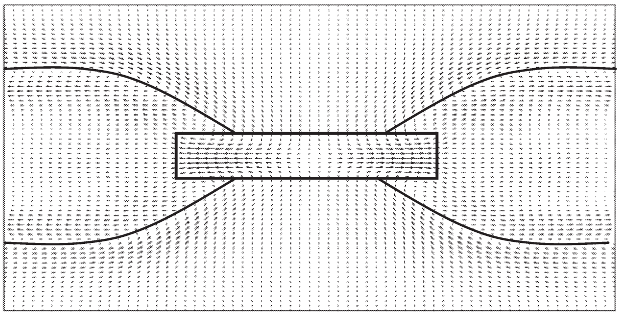

Fig. 2. Vector plots of electron flow velocity in (x,y) plane at $\omega_{ce}t=355$.

Reference

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