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Scaling of the electron diffusion region in the process of collisionless magnetic reconnection.

Andrey Divin (1), G. Lapenta (1), V. Semenov (2), and D. Korovinskiy (2)

(1) Katholieke Universiteit Leuven, Departement Wiskunde, Centrum voor Plasma Astrofysica, Leuven, Belgium (andrey.div@gmail.com), (2) St. Petersburg State University, 198504, St. Petersburg, Russia

The study of electron diffusion region (EDR) of magnetic reconnection is presented. By means of two-dimensional Particle-in-Cell (PIC) simulations we analyze electron trajectories and make Sweet-Parker-like scaling of EDR. Electrons are magnetized outside EDR and experience Larmor gyration and electron pressure is gyrotropic. In the region of a weak magnetic field near the X-point, where electron motion and magnetic field lines convection decouples, electrons are not magnetized and are accelerated by reconnection electric field. The transition between these two different types of motion manifests itself as appearance of the pressure non-gyrotropy and creates the divergence of electron pressure tensor. This kinetic process supports the reconnection electric field and breaks the froze-in constraint. We approximate the electron distribution function within EDR as a bi-Maxwellian and construct the model of electron non-gyrotropy. Sweet-Parker-like scalings of electron diffusion region are presented. We resolve all typical scales of collisionless reconnection: electron inertial length as a width of EDR and electron Alfven velocity as a peak outflow velocity. Electrons get decelerated at the exhaust region and pull protons up to Alfven velocity, being in accord with PIC simulations. These scalings are checked with the simulation results.