Acceleration of cold ions at separatrices of symmetric collisionless magnetic reconnection

Evgeny Gordeev¹, Andrey Divin¹, Ivan Zaitsev¹, Vladimir Semenov¹, Yuri Khotyaintsev², and Stefano Markidis³

¹Saint-Petersburg State University, Physics Faculty, Earth’s Physics Department, Saint-Petersburg, Russian Federation (evgeniy.gordeev@yahoo.com)
²Swedish Institute of Space Physics, Uppsala, Sweden
³KTH Royal Institute of Technology, Stockholm, Sweden

Separatrices of magnetic reconnection host intense perpendicular Hall electric fields produced by decoupling of ion and electron components and associated with the in-plane electrostatic potential drop between inflow and outflow regions. The width of these structures is several local electron inertial lengths, which is small enough to demagnetize ions as they cross the layer. We investigate temperature dependence of ion acceleration at separatrices by means of 2D Particle-in-Cell (PIC) simulations of magnetic reconnection with only cold or hot ion background population. The separatrix Hall electric field is balanced by the inertia term in cold background simulations, the effect indicative of the quasi-steady local perpendicular acceleration. The electric field introduces a cross-field beam of unmagnetized particles which makes the temperature strongly non-gyrotropic and susceptible to sub-ion scale instabilities. This acceleration mechanism nearly vanishes for hot ion background simulations. Particle-in-cell simulations are complemented by one-dimensional test particle calculations, which show that the hot ion particles experience scattering in energies after crossing the accelerating layer, whereas cold ions are uniformly energized up to the energies comparable to the electrostatic potential drop between the inflow and outflow regions.