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Inner structure of a magnetic island in collisionless reconnection

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Magnetic reconnection is a fast magnetic energy releasing process. It is widely observed in space and laboratory plasma such as solar flares, CME, substorms, tokamak devices etc. In the process of magnetic reconnection, magnetic energy is converted into the thermal and kinetic energy of plasma. When there are two or more X-points, magnetic island is formed. Inside a magnetic island one can often observe nonthermal particles as well as a variety of electromagnetic fluctuations. The origin of microstructures and nonthermal particles in a magnetic island has not been fully understood.

We conducted 2d PIC simulations of magnetic reconnection without guide field using periodic boundary conditions. We currently focus on ion-electron case therefore m_i /m_e=100, Harris current sheet model is adopted with the following conditions, the ratio between the background (BG) density and current sheet (CS) density n_b /n_0=0.2, initial temperature ratio T_i /T_e= 4 for both BG and CS particles. The effective system size is L_X*L_Y=25.6d_i*6.4d_i, where d_i is ion inertial length defined by n_0. A perturbation of magnetic flux is added as an initial condition to trigger a reconnection at (X, Y) = (0, 3.2d_i). In the development of magnetic island, micro-scale fluctuations are grown along the current sheet. The generation mechanism is discussed by carefully estimating parameters of local plasma. The result here is compared with the micro-fluctuations observed by Lu[1]

References

[1] Lu, San, et al, Physics of Plasmas 18.7 (2011).