Microinstabilities in a supercritical perpendicular shock revisited

*Shuichi Matsukiyo[1], Takayuki Umeda[2]

1.Kyushu University, 2.Nagoya University

It is considered that reflected ions play decisive roles in the dissipation processes at a supercritical collisionless shock. Local non-equilibrium plasma distribution function in the foot of a perpendicular shock leads to a variety of microscale instabilities. Two of the major instabilities which have been extensively studied for the parameters of typical heliospheric shocks are the electron cyclotron-drift instability and the modified two-stream instability. They have been often discussed separately, because of the large difference in dominant wave frequency between them. Although only a few of the past studies tried to examine the nonlinear evolutions and competing processes of them, the physical parameters used in the past numerical simulations were not realisitic. The relative importance of the instabilities may be a function of ion-to-electron mass ratio as well as the ratio of electron plasma to cyclotron frequiencies, while these two ratios are hard to be simultaneously realistic in a full particle-in-cell simulation due to the limited computational resources.

In this study microinstabilities in the foot of a supercritical perpendicular shock is revisited. We perform a number of local simulations representing a part of the foot region with systematically changing the two ratios, mass ratio and frequency ratio, by using two-dimensional full particle-in-cell code. The foot plasma is assumed to be consist of incoming ions, electrons, and reflected ions. The system size is smaller than ion gyro radius in X, which is parallel to the shock normal, and a few times ion inertial length in Y, which is along a shock surface and the ambient magnetic field. The boundary conditions are periodic in both directions. We will report the results of the simulations in which the mass ratio and the frequency ratio are systematically varied with fixing the local Alfven Mach number, plasma beta, and relative density of the reflected ions.

Keywords: collisionless shock, microinstability, numerical simulation

