



PIC simulation of quasi-parallel shock: Foreshock structure

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Electromagnetic structure of a quasi-parallel shock is highly complex. From the viewpoint of numerical kinetic simulation, quite large simulation domain is necessary to reproduce a foreshock region where some particles are back streaming almost freely along the ambient magnetic field. This may be a main reason that full particle-in-cell (PIC) simulations of a quasi-parallel shock have been seldom performed, although there are only a few examples.

Here, both ion and electron scale structures of the foreshock in a quasi-parallel shock are investigated by using one-dimensional full PIC simulation with sufficiently large system size (= 2500 ion inertial lengths). The shock parameters are as follows. The Alfvén Mach number is 6.6, upstream ion and electron betas are both 0.5, and the shock angle is 20 deg. The ion to electron mass ratio is 64, the ratio of electron plasma to cyclotron frequency is 12.5. Well developed large amplitude MHD waves, evolution of back streaming ion distribution function, electron scale structure grown in the MHD scale structure, and dynamics of high energy particles are discussed.