PIC simulation of electron acceleration at quasi-perpendicular collisionless shock: Application to Earth's bow shock

*Fumiko Otsuka[1], Shuichi Matsukiyo[2], Mitsuo Oka[3]

1. NIT, Kurume College, 2. ESST, Kyushu Univ., 3. UC Berkeley

At Earth's quasi-perpendicular bow shock, non-thermal electrons are observed in-situ measurements. The electrons are thought to be accelerated at the shock through the scatterings by electromagnetic waves upstream and downstream of the shock. Oka et al. (2017, 2019) reported in situ evidences of pitch-angle scattering of non-thermal electrons by whistler waves at the Earth's bow shock, by using data provided by the Magnetospheric Multiscale (MMS) mission. However, the detail electron acceleration process remains unclear.

In this study we perform a self-consistent one-dimensional full particle-in-cell (PIC) simulation of a quasi-perpendicular shock to model the Earth's bow shock. The simulation parameters are the Alfven Mach number 7.1, the shock angle 70 degree, plasma beta 0.3, the ion to electron mass ratio 625, and the ratio of electron plasma to cyclotron frequency 10. In the simulation power-law energy distribution of the electron is formed at the shock transition region, and the anisotropic pitch-angle distribution is found in the upstream region of the shock. We investigate the upstream wave properties and the non-thermal electron trajectories to reveal the electron acceleration and scattering processes in detail. The result will be compared with the MMS data at the Earth's quasi-perpendicular bow shock.

Keywords: quasi-perpendicular collisionless shock, electron acceleration, PIC simulation

