Numerical simulation on plasma dynamics at the dayside magnetopause in a small-scale magnetosphere

Satoki Oki[1], Hideyuki Usui [1], Wojciech J. Miloch[2], Naoki Terada[3], Kanako Seki[4], Yohei Miyake[1], Manabu Yagi[5], Yuto Katoh[2]

1. Kobe University, Japan 2. University of Oslo, Norway 3. Tohoku University, Japan
4. University of Tokyo, Japan 5. RIKEN Advanced Institute for Computational Science, Japan

Abstract

The objectives of this research are to study a small-scale magnetosphere formed by the interactions between a weakly magnetized small body and the solar wind which carries the interplanetary magnetic field, and to understand the kinetic effects, such as charge separation, cyclotron motions and so on, at the particle level by performing three dimensional particle in simulations. We define D_p as the distance from the dipole center to the point at which the dynamic pressure of the solar wind and the dipole magnetic pressure are equal. When the ratio λ_i/D_p is much smaller than the unity, where λ_i is the ion inertial length, the formation of the magnetosphere can be examined with the fluid plasma approximation. However, when λ_i/D_p becomes close to the unity, the kinetic effect such as finite Lamor radius in plasma cannot be ignored in the formation of the magnetosphere. In order to emphasize the particle kinetic effects, we set $\lambda_i/D_p = 1.0$, and thus we use the EMSES simulator based on the full PIC simulations.

In the simulation, we found (1) asymmetric structures of the plasma density distributions between the dawn and dusk sides in the magnetic equator, (2) electron acceleration in the magnetic equator at the dayside magnetopause, and (3) plasma perturbation at the dusk side of the plasma pause. In this study, we particularly focus on (2) the dayside magnetopause and examined them quantitatively by considering the charged particle trajectories, velocity distributions and the associated local electric fields. The simulation results show the electric field is generated by charge separation between ion and electron dynamics. We found that the electron flux enhancement at the dayside magnetopause is due to the electron cyclotron motion enhanced by this electric field, not due to the drift motions.