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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

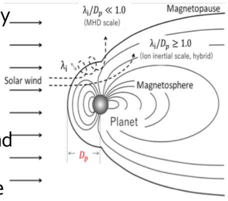
The objective of this research is to understand the dayside magnetopause physics of a small-scale magnetosphere by performing full particle-in-cell three-dimensional simulations. We define Dp as the distance from the dipole center to the point at which the dynamic pressure of the solar wind and the dipole magnetic pressure are equal. To deal with a weakly magnetized airless body interaction with the solar wind, we adopted a body with $\lambda_i/D_p = 1$. We studied the intense electron flux found at the inner magnetopause of the dayside region in the equatorial plane. We also found that it is due to the electron cyclotron motion enhanced by the local electric field, not due to the drift motion as observed in Earth' magnetosphere.

1. Introduction

We focus on the interactions between a weakly magnetized airless body and the solar wind.
Emphasize the kinetic effect

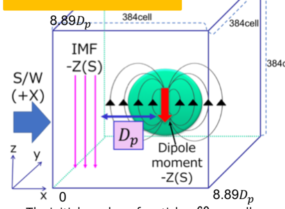
- The body radius $R_b/D_p = 0.60$
- The Ion inertia length $\lambda_i/D_p = 1.0$

D_p: The distance between the dipole center and a position where the solar wind pressure balances the magnetic pressure at the dayside



2. Simulations of Model

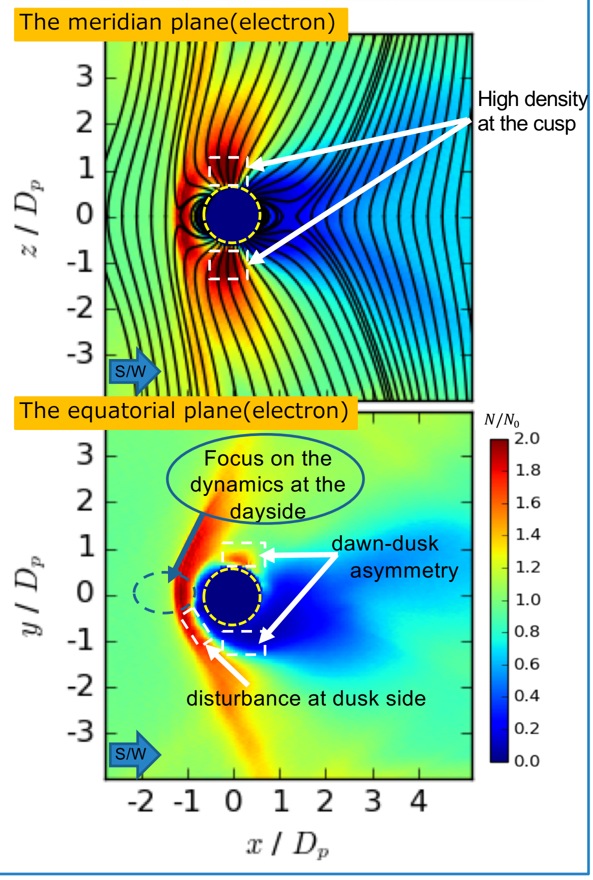
PIC simulation



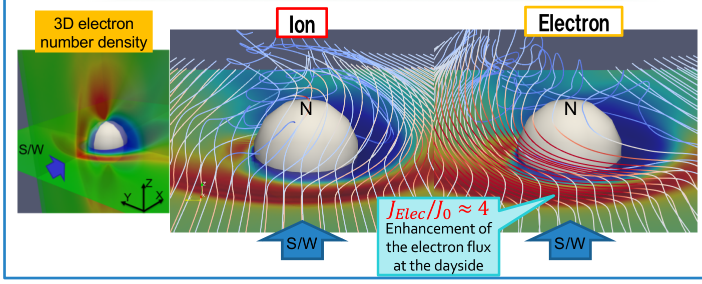
- The initial number of particles: 60 per cell

Plasma parameter		
Mass ratio	m_i/m_e	25
Temperature ratio	T_i/T_e	0.012
The ratio of ion thermal velocity to solar wind	V_{thi}/V_{flow}	0.075
The ratio of electron thermal velocity to solar wind	V_{the}/V_{flow}	3.44
Mach number	V_A/V_{flow}	2.39
Size of sphere R_b	R_b/D_p	0.60
Inertial length λ_i / D_p		1.0

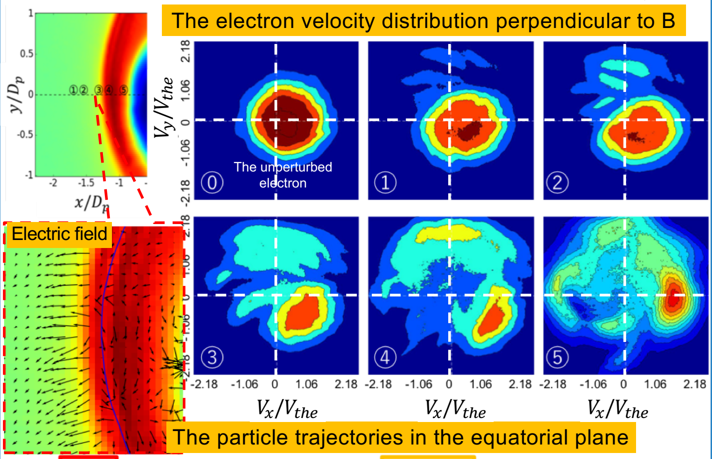
3. Formation of a small magnetosphere

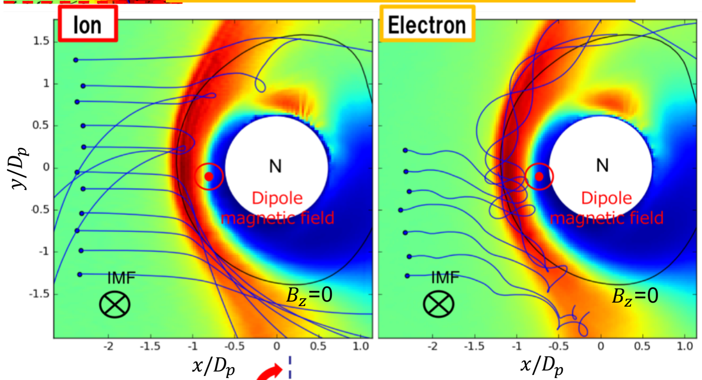


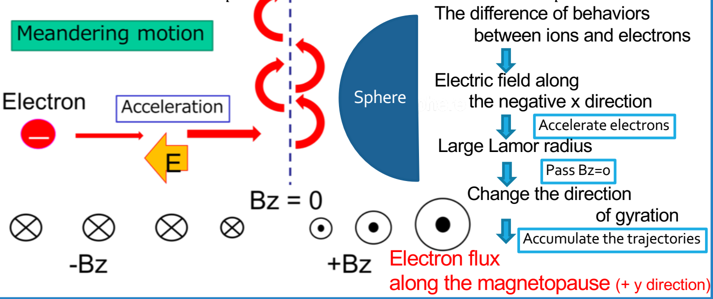
4. Flux of ion and electron in the equatorial plane



5. Dynamics at the dayside







6. Conclusions

- We can perform the small-scale magnetosphere by three dimensional PIC simulations and understand the particle dynamics in the equatorial plane by some analysis (filed data, velocity distributions, and test particle simulations).
- In the case of IMF south, electrons at the dayside magnetopause are accelerated by the electric field at a point where B field changes the direction and its magnitude becomes small.
- The electron flux is intensified along the positive y direction due to the effects of the electron cyclotron motions, not due to drift motions.
- As a future work, we will research the dependency of formation of magnetosphere on the parameters such as mass ratio and λ_i/D_p .