

Investigation of the Triggering Mechanism of Magnetospheric Substorm by means of 2-1/2D Full-Particle Simulation

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The triggering mechanism of substorm in the Earth's Magnetotail is thought to be closely related to the magnetic reconnection and the tearing mode instability. Recently we proposed a new scheme of the substorm onset called "Catapult Current Sheet Relaxation Model (CCSR Model)" to physically understand the results from statistical analyses of GEOTAIL and THIMIS data. In the results, it can be seen that the local maximum region of the northward magnetic field around $X \sim -17R_E$ are created a few minutes before substorm onset, and the magnetic reconnection occurs at the tailward edge of the enhancement at the time of substorm onset. We investigate a stability of the current sheet by means of particle simulation in order to physically verify the results of the statistical analyses.

We have given a magnetic field structure which is akin to the Earth's dipole magnetic field together with a stretched magnetic field by thin current sheet as a basic initial condition of our simulation. We have started the simulation with such initial condition. In an early stage, the fluctuation of magnetic field which seems to be produced by tearing mode instability has been found at the location tailward of the boundary between dipole-field and current sheet with a distance about one wave length of the tearing mode with a maximum growth rate. Further, we have investigated variations in the development of the instability by adding the local enhancement of the northward magnetic field to the initial current sheet. It was found that such local enhancement of the northward magnetic field enhances the instability in the current sheet. By shifting initial location of the local enhancement, we found that the most rapid development of tearing mode occurred when the tailward edge of the local enhancement and the location of the original tearing mode overlap with each other.

The obtained results suggest that the results of the statistical analyses of the satellite data reflect the tearing mode instability occurring in the thin current sheet with the effect of the convective electric field at the time of substorm onset.

Keywords: Substorm, Tearing instability, Magnetic reconnection