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Magnetic Reconnection and Magnetospheric Convection in the Earth's Magnetosphere

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Magnetic reconnection and magnetospheric convection has closed and complicated relationship.
Dayside magnetic reconnection between the interplanetary magnetic field (IMF) and the geomagnetic field remarkably influences the configuration and dynamics of the earth's magnetosphere. That is, relations between the IMF and geomagnetic field determine where magnetic reconnection favorably occurs, and how the reconnected field lines move. There are fundamental two factors to determine where and how much magnetic reconnection occurs at the magnetopause: The extent to which the IMF and the geomagnetic field are antiparallel and the relative velocity of the reconnected field lines in the direction perpendicular to the magnetic field. The first factor determines where the reconnection occurs while the second determines how the reconnected field lines move. The IMF lines flow radially from the subsolar point in the magnetosheath. Their velocity can easily exceed the local Alfven speed. Therefore, it is not easy to generally separate the reconnection electric field and convection electric field near the magnetopause. It is a reason that the reconnection rate is hard to estimate.

We have used a three-dimensional global magnetohydrodynamic simulation of the interaction between the solar wind and magnetosphere to carry out a systematic investigation of the effects of the orientation of the IMF and dipole tilt on magnetospheric structure and dynamics. The combination of dipole tilt and finite IMF By and Bz leads to complex structures in the magnetosphere with no symmetry planes anymore. Competition between antiparallel reconnection and the relative velocity of reconnected field lines well determines the location of dayside reconnection. It frequently suppresses to occur in the subsolar region because the geomagnetic field is not weakest there. Dayside reconnection maximizes the condition that the fields are antiparallel.

The addition of the Bx component to the IMF adds dawn-dusk and north-south asymmetry to the dayside magnetic reconnection. Reconnected open field lines on the dusk side become relatively straight. They increase the lobe magnetic pressure and compress the plasma sheet. Open field lines on the dawn side are bent sharply and decrease the lobe magnetic pressure. As a result tail reconnection occurs preferably on the dusk side. This tendency is enhanced when the IMF is large and the solar wind Alfven Mach number becomes lower. In such a case, magnetic reconnection frequently occurs in an intermittent and patchy manner. Thus a turbulent structure can be formed in the plasma sheet. The dawn-dusk and north-south asymmetries cause an inclined plasma sheet, rotation of the magnetotail and asymmetric plasma flows in the tail. We demonstrate how reconnection and convection electric fields can be separated in the complicated configuration.