MHDシミュレーションで得られた南IMF時の昼間のmagnetopause構造

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Simulation study of the dayside magnetopause in the southward IMF condition

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The dayside magnetopause is usually determined as a boundary interface where the magnetic pressure in the magnetosphere and the thermal pressure in the magnetosheath are balanced [Hughes, 1995]. Consequently, a thin diamagnetic current sheet flows along the magnetopause. This current produces a sharp deflection of a magnetic field vector tangential to the current sheet in the magnetopause. Indeed, the satellite observations identify the magnetopause as a sharp deflection of the magnetic field [i.e., Paschmann et al., 1979]. Finally, one might think that the magnetopause determined from the force balance relation corresponds to the magnetopause identified from a sharp deflection of the magnetic field. However, this speculation is not confirmed in the solar wind-magnetosphere interface with the magnetic field configuration regulated by the null-separator structure. Here, we investigate the two magnetopauses by using the simulation results.

From the global simulation, it is obtained that the two magnetopauses are located in the place different places. The magnetosphere determined from the force balance appears in the lowermost boundary between the magnetosheath and the magnetosphere. The plasma flow momentum can be ignored in this region. We call this region as the boundary region. On the other hand, the sharp deflection appears in the region next to the boundary region. The plasmas in this region are accelerated by the magnetic tension force because the magnetic field exhibits a kink. We call this region as the acceleration region. The kinked field lines may remind us occurrence of the reconnection in this region.

The electric current flowing in the boundary region is the Chapman-Ferraro current because this current invokes the Lorentz force against the pressure-gradient force. This eastward current connects the load in the boundary region and the dynamo in the lobe region. It is also obtained from analysis of the Poynting flux that the magnetic energy is transported from the lobe region. Next, we need to identify the source of the current causing the magnetic tension in the acceleration region. The simulation indicates that the current flowing eastward in the acceleration region comes from the dynamo in the bow shock. So, we call this current as the bow shock current. At the same time, the simulation indicates that the magnetic energy is transported from the bow shock. As a result, we find that the two magnetopauses correspond to two different current systems. Physical significance of the bow shock current is not so clear yet. In order to understand the significance, we need to investigate the global magnetic field configuration. This issue will be presented in the talk.

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