Direction of motion of reconnection X-lines and O-lines at the dayside magnetopause observed by the THEMIS spacecraft

*Yasuto Hoshi[1], Hiroshi Hasegawa[2], Naritoshi Kitamura[2], Yoshifumi Saito[2]

1.Earth and Planetary Sci., Univ. of Tokyo, 2.ISAS/JAXA

Magnetic reconnection at the Earth's dayside magnetopause is a fundamental mechanism that transfers mass, momentum, and energy into Earth's magnetosphere from the solar wind. By this process, the interplanetary magnetic field (IMF) gets interconnected to the geomagnetic field lines at X-line in the magnetopause current layer. Several X-lines can exist in the magnetopause. Time-dependent magnetic reconnection in the presence of multiple X-lines generates a closed magnetic field structure with what is called O-line at the center. Some simulation studies or in-situ observations have suggested that the X-line and O-line can move. This motion is driven by magnetosheath flows or diamagnetic drift of electrons. The direction of this motion is one of the important questions of magnetic reconnection. The direction is inferred from polarity changes of oppositely directed ion jets. Ion jets flow outward from the X-line. The jets from two X-lines can converge toward the O-line between X-lines. When an X-line moves northward, a spacecraft near the X-line would observe a flow reversal from northward to southward, whereas when an O-line moves northward, a flow reversal from southward to northward would be observed near the O-line. This fact suggests that if we would like to know the direction of motion, we need to find the polarity of the flow reversal, as well as its type of structure. O-lines can be distinguished from X-lines by characteristics as described below. O-lines are characterized by an enhancement of the total pressure of order a few nPa, bipolar change of the component of the magnetic field normal to the magnetopause, and bidirectional field-aligned fluxes of heated electrons on the magnetosheath side.

We statistically investigated the direction of motion of the X-lines and O-lines observed at the dayside magnetopause, based on plasma and magnetic field data from the Time History of Events and Macroscale Interactions during Substorms (THEMIS) spacecraft. Five THEMIS spacecraft have observed Earth's magnetosphere since launched in 2007, although THEMIS-B and -C observed the region only until 2010. We used THEMIS data taken in the magnetopause region within the magnetic local time range from 10 to 14 hours. Flow-reversal events with the flow speed exceeding 150 km/s, which is comparable to the local Alfven speed in the magnetosheath, are chosen as candidates and are used to estimate the direction of X- or O-line motion. We discuss effects of the IMF orientation and geomagnetic dipole tilt angle on the dayside magnetopause reconnection.

Keywords: magnetic reconnection, magnetopause, flow reversal

