In-situ Observations of Reconnection Separatrix Regions in the near-Earth Magnetotail

*Mizuho Araki[1], Masahiro Hoshino[1], Kunihiro Keika[1], Yoshifumi Saito[2]

1. Graduate School of Science, The University of Tokyo, 2. Institude of Space and Astronautical Science

Magnetic reconnection which converts magnetic energy into thermal and kinetic energy of plasmas is an important physical mechanism of plasma heating and acceleration. Particularly in the Petschek-type reconnection, plasma acceleration and heating in the slow-mode shocks formed at the separatrices must be taken into consideration. The structure of the slow-mode shocks in the distant tail of the Earth’s magnetosphere was investigated with in-situ observations made by the GEOTAIL satellite (Saito et.al, 1995). It is observationally suggested that about 10% of the plasma sheet boundary layer (PSBL) is slow-mode shocks. It is, however, not fully understood what determines this percentage and what is the difference in the ion and electron temperature changes between slow-mode shocks and others separatrix regions.
In this study, we utilized multi-spacecraft in-situ observations of separatrix regions at magnetic reconnection in the near-Earth magnetotail (GSM-X is between ˜13 and ˜25RE). We used data obtained from FPI (Fast Plasma Investigation) and FGM (Fluxgate Magnetometer) on board the MMS satellite from June 1, 2017to August 31, 2017. We examined occurrence locations, ion flow directions and velocity of ion flow in downstream regions of observed events. We also examined changes in ion and electron temperatures and the ion-to-electron temperature ratio.

We classified their events into 2 types according to plasma beta in the in-flow regions: below 0.1 or around 1. We term them “lobe reconnection” and “plasma sheet reconnection”, respectively. In the former type, plasmas in the in-flow regions are cold and tenuous. In the latter type, plasmas in the in-flow regions are hot and dense. In both types, we observed increases in ion and electron temperatures increase, but their characteristics are different. In the lobe reconnection, ion temperatures increase from several hundred eV to several keV. In the plasma sheet reconnection, ion temperatures also increase from about 1 keV to several keV. The increase rate of the electron temperature is less than one order of magnitude for both types, smaller than that of the ion temperature; the electron temperature increases up to at most 1 keV. The ion-to-electron temperature ratio in the out-flow regions in both types is about 5 for both types. We then examined changes of the ion-to-electron temperature ratio and found that the changes are consistent with the result reported by Wang et al. (2012).

In this presentation, we will show the results of separatrix crossing events (both lobe and plasma sheet reconnection events) that occur in 2017 and 2018. We will identify whether each of the separatrices is a slow shock or not and how the separatrix conditions affect ion and electron heating. These characteristics will provide insights into heating mechanisms and energy conversion through separatrix regions.

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