Dependence of the ion-to-electron temperature ratio on flow speed in the plasma sheet

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Plasma in the Earth's magnetosphere are heated up to 1-10 keV and stored in the plasma sheet in the magnetotail. The magnetotail plasma can be accelerated by magnetic reconnection, which occurs to release the magnetic field energy. The accelerated plasma are transported both earthward and tailward as fast flows with a speed of several hundred kilometers per second or faster. It has been reported that the properties of plasma sheet plasma such as ion temperature, electron temperature, and the ion-to-electron temperature ratio depend on fast flow conditions and spatially vary [Kaufmann et al., 2005, Wang et al., 2012]. However, it is not well understood how transport and acceleration of the magnetotail plasma depend on mass and/or charge.

In this study, using plasma data obtained from the FPI instrument on board MMS, we first examine the flow speed dependence of the ion-to-electron temperature ratio in the plasma sheet. We use the data for a period from June to August 2017, when MMS was flying in the near-equatorial magnetotail in the region of X_{GSM}<-25R_E and -15R_E<Y_{GSM}<15R_E. We divide observations into three different groups according to flow speed: slow flow event (|V_{ion}|<100 km/s), middle flow event (100 km/s<|V_{ion}|<400 km/s), and fast flow event (|V_{ion}|>400 km/s). We then investigate the occurrence distributions of the plasma temperatures and the ion-to-electron temperature ratio for each group.

The results show that both ion and electron temperatures increase with increasing flow speed. On the other hand, the occurrence distribution of the ion-to-electron temperature ratio does not differ between the three groups. We also investigate differences between earthward flow and tailward flow. For earthward flow events, the trend is similar to the above-mentioned results. For tailward events, ion temperature and the ion-to-electron temperature ratio of fast flow events show larger value than those of any other flow events. We also examine how the ion-to-electron temperature ratio differs between dawn and dusk sides and between high beta (around center of the plasma sheet) and low beta (around boundary of the plasma sheet) regions. No significant differences of the ion-to-electron temperature ratio are seen in both cases. The results may suggest that the mass dependence of plasma acceleration in the magnetotail reconnection is not related to the reconnection rate. We will discuss about what determines the occurrence distribution of the ion-to-electron temperature ratio.