Evolution of plasmoid in the magnetotail

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The plasmoid observed in the Earth's magnetotail is formed in association with the magnetic reconnection in the near Earth neutral line (NENL) and propagates tailward. Then, the plasmoid interacts with the surrounding plasmas of the plasma sheet at rest and consequently, shows a wide variety of complicated plasma structures. The evolution of plasmoid may be important to understand the plasma heating and the energy transport in the magnetotail.

We investigated extensively the evolution of magnetic and thermal structures of the plasmoid in propagating tailward using the Geotail LEP/MGF data from both statistical and case-study approach.

First, we studied the change in the configuration of the plasmoid using the magnetic and velocity field data. In overall structures, we examined the three dimensional expansion of the plasmoid in propagating tailward and compared the results with the past study (Ieda et al., JGR, 1998). We concluded that the expansion rate in the z direction as well as in the y direction decreases as it propagates beyond X=-60RE. Furthermore, for the local configuration, we found the plasmoid with its front-side magnetic field bend like a 'heart shape' in the distant magnetotail beyond X=-100RE. We statistically analyzed a 'heart shaped' plasmoid by investigating the time series of the magnetic and velocity field when the satellite passes through it. Saito et al., JGR, 1995 identified the slow mode shock with the normal direction consistent with our 'heart shaped' plasmoid. In numerical study, Abe et al., EPS, 2001 reported the nonlinear evolution of plasmoid structure that also supports our results. We will also report how the hollow portion in the 'heart shaped' plasmoid evolves as it propagates tailward.

Second, we focused on the evolution of the thermal structure inside the plasmoid. We concluded that the average temperature inside the plasmoid increases when traveling the near Earth region but it starts to decrease downtail beyond X=-60RE as reported in Ieda et al. Furthermore, our statistical analysis on the temperature distribution inside the plasmoid shows that the plasma temperature in the back-side (near the X-line) of the plasmoid decreases gradually compared with the front-side. This suggests the existence of the energy supply into the plasmoid by the magnetic reconnection process. The investigation on the evolution of temperature and density distribution inside the plasmoid gives us an important clue to understand the growth process of the plasmoid.