Horizontal/vertical Structure of the Magnetotail: An Important Target of the SCOPE Multi-spacecraft Mission

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The Earth's magnetotail has a distinct structure associated with the presence of the magnetic neutral sheet. The small scale-size in the Z direction (i.e. the thinness) of the neutral sheet makes it difficult to establish even the average distribution of magnetic field and plasma parameters (density, temperature, flow velocity, etc.) in the Z direction, which constitute the basic piece of information necessary to study the balance and instability of the magnetotail. Particularly, single spacecraft observations are not suited to the study of the structure in the Z direction, because the time variations in the Z location of the neutral sheet bring about much ambiguity in the interpretation of the spatial structure.

The multi-spacecraft SCOPE mission we are planning now can contribute essentially to the clarification of these problems, if the spatial configuration of the formation flight is properly planned. In this regard, it is notable that the Keplerian motion of the spacecraft, which restricts the temporal changes in the relative positions of the spacecraft, ensures that the two spacecraft closely aligned perpendicular to their orbital plane can remain to be so over the whole orbital period if other effects are neglected. This means that, for the case of SCOPE mission with an equatorial orbit, the Z-alignment of two spacecraft is well conserved both in distance and in angle. This configuration is of course ideal for the study of the structure of the neutral sheet (or the Z-configuration of the plasma sheet).

The porpose of this presentation is two-fold: we first review our latest knowledge of the configuration of the plasma sheet in the Y-Z cross section of the tail, which primarily comes from Geotail observations. We particularly discuss:

(1) A permanent presence of the convective flow toward the neutral sheet irrespective of the IMF direction at locations somewhat distant from the neutral sheet.

(2) A convective flow directed from the tail center towards dawn and dusk flanks along the neutral sheet, which also seems to be IMF-independent.

(3) Convective flow vortices that exist within the Y-Z cross-section of the tail.

(4) Average location of the neutral sheet which is warped as predicted.

(5) Temporal changes in the z location of the neutral sheet and the possible causes for them.

We then discuss the best ways to clarify the physical mechanisms that produce these structures with the SCOPE mission, taking into account the various scale sizes involved in the physics.