IMF By-effects on the structure of the near-Earth magnetotail

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The magnetotail, where anti-parallel magnetic field lines exist, is considered to be the important region for triggering processes and dynamical evolution of substorm activities and magnetic reconnection. A number of instabilities related to the magnetic field configurations and plasma distributions have been proposed and discussed for decades in such a two-dimensional current sheet structure. Past satellite observations have revealed that the plasma sheet can be tilted depending on the polarity of the off-plane B_y component of the interplanetary magnetic field (IMF), which comes into the magnetosphere by reconnecting with the magnetospheric field lines at the day side or the high-latitude region of the magnetosphere. On the other hand, recent theoretical studies and the numerical simulations have shown that the existence of the off-plane magnetic field component (guide-field) is important for controlling the critical values of some types of the instabilities and the reconnection rates.

In this study, we use Cluster 2002 and 2006 multi-satellite data with the wider separations (4000km and 10000km), and examine how B_y is observed in the near-Earth magnetotail considering each contribution to the B_y, from the flaring effect, the guide field, and the tilt of the current sheet, separately. By comparing the results with the IMF data and the substorm and fast plasma flow activities, we discuss the IMF effect on the near-Earth magnetotail, and its role to control the current sheet instability. We found that: (1) The appearance of the B_y is well correlated with the Y component of the IMF. Time-delay is very small, and does not depend on the IMF B_z component. (2) The tilt angle of the current sheet is also weakly correlated with the IMF B_y. This signature of the tilt is consistent with the previous observation results. This is more clearly observed associated with the negative B_z of the IMF. Part of the obseved B_y is converted to the normal component of the tilted current sheet, the others become guide field. (3) The guide field is not observed in some of the cases the dipolarization is clearly observed or the multiple substorm activities or successive fast plasma flows are observed.

With the above results, we discuss the penetration processes of the IMF into the near-Earth magnetotail and its role to affect the triggering processes of substorms and magnetic reconnections.