サブストーム成長相に見られるマグネトシース内ショックについて(その2)

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A shock wave in the magnetosheath observed in the substorm growth phase (II)

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We already reported that our global MHD simulation detected the fast-mode shock wave in the lower-latitude side to the cusp region in the magnetosheath during the substorm growth phase. This shock appears after the southward turn of the IMF and disappears after the onset of substorm. This shock wave was assumed to be invoked by acceleration of plasmas through release of the magnetic tension caused by magnetic field merging between the solar wind field and the magnetospheric field as well as the laval nozzle effect [Yamauchi and Lundin, 1997] of the magnetosheath.

In this talk, we will report the following facts revealed from the simulation. First, we confirm that the merging occurs at the null point on the magnetopause in the higher-latitude side of the cusp. The magnetic tension is generated not in the vicinity of the merging point, but in the half-way of the separator line connecting the null points in the northern and southern hemispheres. Second, disappearance of the shock is synchronized with the substorm onset because of the high-speed plasma flow in the plasmasheet. This high-speed flow arrives at the dayside cusp-cleft region at the onset. Therefore, the convection of the magnetic field from the dayside to the nightside stops at the onset, which affects the merging in the dayside.

Note that statistical analysis of the plasma flow speed in the external cusp region observed by Cluster tends to be faster in the southward IMF case than in the northward IMF case [Lavraud et al., 2005]. This fact is rather consistent with our simulation result.

As our model employs reduced numerical resistivity, the anti-parallel merging at the null point is clearly reproduced. On the other hand, if some diffusive process works in the magnetosheath, the component merging may occur. In the later case, if the merging occurs in the dayside magnetosheath, acceleration of the plasmas due to release of the magnetic tension still works. Therefore, the shock may appear even this case.

Lavraud, B., A. Fedorov, E. Budnik, M. F. Thomsen, A. Grigoriev, P. J. Cargill, M. W. Dunlop, H. Reme, I. Dandouras, and A. Balogh (2005), High-altitude cusp flow dependence on IMF orientation: A 3-year Cluster statistical study, J. Geophys. Res., 110, A02209, doi:10.1029/2004JA010804.

Yamauchi, M. and R. Lundin (1997), The wave-assisted cusp model: Comparison to low-latitude observations, Phys. Chem. Earth, 22, 729-734.