



## Multiple cusps during an extended northward IMF

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On March 21- 22, 2001, four cusp-like regions were observed consecutively in about five hours by all four Cluster Spacecraft when interplanetary magnetic field (IMF) is northward with a significant  $B_y$  component. All four cusp-like encounters were characterized by turbulent magnetic fields, high density plasma and stagnant plasma flow. The cusp-like regions are associated with thermalized, bidirectional distributed plasma electron. Combining Cluster and DMSP observations, the first cusp is possibly spatial effect, The other three are temporal effects. The normal velocities  $v_n$  at boundary interfaces (exit from the cusp) are found to be almost three times larger than that at boundary interfaces (entry into the cusp). The present study provides strong evidences that the location of the cusp is oscillating from time to time during northward IMF.

The boundary normal, velocity and timing analysis for six clear boundaries of the last 3 cusps obtained by all four spacecraft indicates that they are most likely caused by the oscillation of the single northern cusp which was shifted back and forth between the dayside magnetosphere/trapping region and the cusp region. Cusp oscillating with a period of 22 min are observed by Cluster satellite in the high latitude region, in the meantime, the cold-dense plasma with fluctuations (20 min period) are observed in the dusk-side of the tail plasma sheet by Geotail satellite. This is consistent with the idea that the high latitude reconnection during northward IMF is the responsible mechanism of the formation of the cold-dense plasma sheet.