Roles of the K-H instability and double-lobe reconnection in LLBL and CDPS formation during a prolonged northward-IMF period

Kanako Seki[1]; Yosuke Matsumoto[2]; Benoit Lavraud[3]; Michelle F. Thomsen[4]; Richard C. Elphic[4]; Toshifumi Mukai[5]; Yoshifumi Saito[6]; Henri Reme[3]

[1] STEL, Nagoya Univ.; [2] SELIS, Nagoya Univ.; [3] CESR; [4] LANL (USA); [5] ISAS/JAXA; [6] ISAS

http://st4a.stelab.nagoya-u.ac.jp/

It is observationally known that the plasma sheet becomes much cooler and denser than usual under prolonged northward interplanetary magnetic field (IMF) conditions [1]. However, the mechanism responsible for the formation of CDPS (cold dense plasma sheet) is still far from understood. The Kelvin-Helmholtz (K-H) instability driven by the velocity shear at the magnetopause has been proposed as a possible mechanism of magnetosheath plasma entry through the LLBL (low latitude boundary layer) [2,3,4]. ``Double lobe reconnection", i.e., reconnection of a magnetosheath flux tube with lobe field at the high-latitude magnetopause in both hemispheres, thereby becoming closed, is also an important candidate process for the dense, thick LLBL formation during northward IMF periods [5].

On the basis of evolution of electron and ion phase space densities (PSDs) from the dayside to the nightside magnetosphere observed by Cluster, GEOTAIL, and LANL-MPA spacecraft during a northward IMF interval on March 16, 2002, we examine the relative importance of the K-H instability and double lobe reconnection for formation of the CDPS.

This event corresponds to one of the CDPS events at geosynchronous orbit during prolonged northward IMF periods [6]. The observations are also compared with results from full-particle simulation of the K-H instability in the magnetized plasma with a density gradient [7].

The results can be summarized as follows:

1. Heated electron signature observed by CLUSTER around dayside magnetopause indicates the ``Double lobe reconnection" indeed took place during the event.
2. Comparison of PSDs in the newly closed flux tube and the dusk-flank LLBL indicates that double lobe reconnection is responsible for formation of the outer-LLBL in the dusk flank.
3. GEOTAIL observed wavy structures in the dusk LLBL, which is consistent with the non-linear phase of K-H vortices.
4. Comparison between PSDs from full-particle simulation and observations in the LLBL suggests that the K-H instability is responsible for the selective plasma entry into the inner-LLBL.
5. Comparison between PSDs at GEOTAIL and LANL-MPA indicates that CDPS material can be injected into inner magnetosphere after southward turning of IMF. However, the magnetic drift may be not negligible and further study is needed.

References:

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