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Local structure of the near-Earth magnetotail plasma sheet during tailward flows: A multi-point view

A. Runov (1), W. Baumjohann (1), R. Nakamura (1), Y. Asano (2), I. Voronkov (3)

(1) Space Research Institute Austrian Academy of Sciences, 8042 Graz, Austria (Andrei.Runov@oeaw.ac.at), (2) Tokyo Institute of Technology, Tokyo, Japan, (3) University of Calgary, Calgary, Canada

Bi-polar north-to-south magnetic field variations, observed in association with tailward flows in the magnetotail plasma sheet, are usually interpreted as signatures of a closed magnetic structure (plasmoid or flux rope). Alternatively, the bi-polar variations may be explained in the frame of so called Nightside Flux Transfer Event (NFTE), which implies a locally tailward open magnetic loop. Multi-point measurements are needed to distinguish between the two possibilities.

In this paper we discuss structure of the near-Earth magnetotail plasma sheet within successive tailward flow bursts observed by the Cluster spacecraft on September 15, 2001. The tailward flows were detected during a northward IMF interval, 2.5 hours after a substorm. Each flow burst was associated with local auroral activation and pseudo-breakup signatures, observed by the CANOPUS and NORDSTAR arrays and by the IMAGE satellite. The velocities of the flows, with respect to the spacecraft, were found to be about -300 km/s. The plasma velocity in the deHoffmann-Teller frame did not exceed 0.2 of the Alfvén speed. The magnetic field behavior during the flows were similar including azimuthal turns (dawnward in the northern and duskward in the southern halves of the sheet) and asymmetric north-to-south bipolar variations.

Analysis of multi-point measurements shows a presence of locally tailward open magnetic loops, resembling NFTEs, and current filaments rather than closed plasmoids or flux ropes within the flows. These structures are found to be localized in the cross-tail direction, with the spacecraft crossing their dawn- or dusk-side boundaries. The scale of the structures was estimated to 1.5 R_E.