Cluster/Double Star observations of ion beams in the magnetotail

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Simultaneous measurements from the Cluster and Double Star spacecraft offer excellent opportunities for multi-point coordinated studies of plasma sheet dynamics and the acceleration processes acting in the magnetotail. Synchronized orbits and flapping oscillations of the Earth's magnetotail allow near-simultaneous multiple neutral sheet crossings at tailward distances of 16-19 RE and 10-13 RE, respectively. Detailed examination of experimental ion velocity distributions gives the most adequate information about the plasma sheet flows related with magnetotail dynamics. At times misinterpreted as bursty bulk flows, intense earthward streaming and/or counter streaming field-aligned ion beams are often detected during the recovery phase of substorms at the edge of the plasma sheet boundary layer (PSBL) by both missions, with higher velocities as large as 2000 km/s near the lobe/PSBL separatrix. Boundary modulations show a well-defined spatial layering in multiple beamlet substructures that are steady for intermediate time scales (˜30 minutes) and cross-tail distances (˜5 RE). Near its perigee, Cluster can also observe these energy-dispersed beams at mid altitudes (5-7 RE) on auroral field-lines magnetically connected to the magnetotail PSBL. Moreover, examples demonstrate that the ionosphere may be a significant source of multiple latitude-energy dispersed ion beams also bouncing along closed PSBL field lines. All of these structures will be investigated by using a combination of global MHD and large-scale kinetic (LSK) simulations of the magnetotail. Starting from experimental examples it will be demonstrated that the acceleration of PSBL ion beams, their spatial energy dispersion, and their possible substructuring in beamlets is intrinsically related to the nonadiabatic interaction of the plasma with the equatorial neutral sheet, in an extended region located just earthward of the x line.