Plasma sheet high speed flows

In the late 70s, high speed (several hundreds km/s) plasma flow events were found in the plasma sheet boundary layer, PSBL, of the Earth's mag netosphere (e.g., Lui et al., 1983). The thickness of the layer where the fluxes were seen was about 1-2 Re. Later Baumjohann et al. (1990) and Angelopoulos et al. (1992) showed that the central plasma sheet (CPS) is just as important region for fast flows as the PSBL.

The events are observed near midnight sector and mainly during magnetospheric substorms, although events during quiet times are sometimes seen. Two flow types have been recognized: **Bursty Bulk Flows** (BBF) and **Flow Bursts** (FB). BBFs are enhanced bulk velocity events of order of 20 min in duration (Cao et al., 2006), containing many short-lived (< 10 s) high velocity (400 km/s or more) FBs (note that these time scales agree with many other observations of substorm finestructure).

In the near-Earth region the flows are predominantly earthward, while further downtail they are directed away from Earth. The flow source has been estimated to be at about 20-30 Re tailward from Earth, center being slightly duskward from the tail axis for the tailward flows (e.g., Nagai et al., 1998). The tailward (earthward) flows are associated with southward (northward) magnetic fields; tailward flows with dipolar Bz signatures are called plasmoids. Flows are convection flows near the neutral sheet, and more field-aligned off the neutral sheet. The flows are thought to be associated with magnetotail reconnection processes widely used in substorm models. Latest Geotail observations suggest that the flows start before the typical ground-based onset signatures (Machida, Mukai et al., Nagai, ICS-4 meeting, 1998; Petrukovich et al., 1998). This would indicate that reconnection triggers substorms. However, Meng et al. (ICS-4, 1998) claimed using Polar UV imager that most Pi 2 onsets lag behind auroral breakups by minutes, complicating the already difficult subjetc of substorm timing.

Fast flows are characterized by increased temperatures and decreased densities (plasma bubbles, Chen and Wolf, ?). Furthermore, they are often associated with local magnetic field variability and transient dipolarization. An event with earthward flow of 2000 km/s at x = -13 Re has been shown to be related with a DC electric field of 50 mV/m (Fairfield et al., ICS-3)!

They may also relate to the current disruption (and the formation of SCW) observed closer to the Earth via the braking processes of the flow (Shiokawa et al., 1997). The braking processes can generate

- dawnward inertia current (Haerendel, 1992)
- pileup of northward magnetic flux (Hesse and Birn, 1991)
- FACs due to flow shear (Hasegawa, 1979)

It has also been suggested that the CPS high speed flows may be related to the Pi 2 pulsations indicating substorm activity on the ground (Orr, ICS-3 meeting; Kepko and Kivelson, ICS-4 meeting).

It has been suggested that some specific auroral features within the poleward oval of the double oval structure may be ground based signatures of these flows (Elphinstone, ICS-3 meeting).

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