Simmons, Alisha M. (MSFC-NAS802002)[MAINTHIA]

From: Chandler, Michael O. (MSFC-VP62)
Sent: Tuesday, October 16, 2007 12:31 PM
To: Simmons, Alisha M. (MSFC-NAS802002)[MAINTHIA]
Cc: Summers, Freda G. (MSFC-VP60)
Subject: Re: 1676 request

Abstract:


Michael O. Chandler, Levon, A. Avanov, Paul D. Craven, Forrest S. Mozer, and Thomas E. Moore

We have begun an investigation of the nature of the low-latitude boundary layer in the mid-altitude cusp region using data from the Polar spacecraft. This region has been routinely sampled for about three months each year for the periods 1999-2001 and 2004-2006. The low-to-mid-energy ion instruments frequently observed dense, magnetosheath-like plasma deep (in terms of distance from the magnetopause and in invariant latitude) in the magnetosphere. One such case, taken during a period of northward interplanetary magnetic field (IMF), shows magnetosheath ions within the magnetosphere with velocity distributions resulting from two separate merging sites along the same field lines. Cold ionospheric ions were also observed counterstreaming along the field lines, evidence that these field lines were closed. These results are consistent with the hypothesis that double merging can produce closed field lines populated by solar wind plasma. Through the use of individual cases such as this and statistical studies of a broader database we seek to understand the morphology of the LLBL as it projects from the sub-solar region into the cusp. We will present preliminary results of our ongoing study.

On Oct 16, 2007, at 12:23 PM, Simmons, Alisha M. (MSFC-NAS802002)[MAINTHIA] wrote:

Michael,

I have received your request for clearance on presentation entitled "Observations of a Newly "Captured" Magnetosheath Field Line: Evidence for a "Double Reconnection." It is optional that you provide a brief abstract to accompany your presentation describing the contents of your presentation. If you do not, the Center for Aerospace Information will write an abstract for you. We give you that option to write your own abstract instead of CASI writing one for you. If you wish to provide an abstract, please send ASAP. If I don't hear back from you or receive the abstracts, I will go ahead and finish the process for your 1676 for approval, and allow CASI to write one for you. If you have any questions, please feel free to give me a call. Thanks!

Alisha Simmons
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10/16/2007
Observations of a Newly "Captured" Magnetosheath Field Line: Evidence for "Double Reconnection"

M. Chandler
L. Avanov
P. Craven
(and everyone else associated with TIDE)
Hypothesis: High-latitude magnetic merging can occur on the same field line in both hemispheres.

Consequences: Field lines connected previously to the solar wind become “captured” by the terrestrial magnetic field and become closed “terrestrial” field lines containing magnetosheath plasma. Presents a possible mechanism for the formation of the LLBL and, the cold, dense plasma sheet during northward IMF conditions.

Observations: Lavraud et al., 2005 used Cluster observations of bidirectional, heated electrons to infer the presence of magnetosheath plasma on dayside, closed field lines.
Polar Observations from March 18, 2006

Conditions:
- Polar in the high altitude cusp
- Northward IMF
- Moderately high dynamic pressure

Observations include:
- Overlapping magnetosheath injections
- Long-lived spatial/temporal energy dispersions
- Counterstreaming ionospheric populations
POLAR TIDE/PSI
start time: 03/17/06 20:08:25 UT
stop time: 03/18/06 05:20:02 UT

4 spins averaged
collapse option 2

ranges used for sum:
Obs. energy: 0.32 - 410.62 eV
spin angle: 0.00° - 360.00°
polar channels: 1 - 7

Energy Flux

start time: 03/17/06 20:08:25 UT
stop time: 03/18/06 05:20:02 UT
4 spins averaged
collapse option 2

ranges used for sum:
Obs. energy: 0.32 - 410.62 eV
spin angle: 0.00° - 360.00°
polar channels: 1 - 7

Energy Flux
Pd=8.0; DST = 10; By = 3.0; Bz = 4.0
POLAR TIDE/PSI

start time: 03/18/06 02:50:58 UT
stop time: 03/18/06 02:51:58 UT
no spin averaging
collapse option 2
spin marker at sun pulse

Stops

Energy Flux

Observed Energy (eV)
(assumes Mr.Rat=1)

Spin Angle (deg)

0-373 eV

time 02:51
Re 7.5
Lshell 12.8
mlt 10.4
mlat -40.5
invlat 73.8

s/c potential = 0.0000
attitude: 06031807.cdf
orbit: 06031804.cdf
level-zero: 06031801.dat

instr_sens: no correction
calibration: tide_calib.v6
mass_calibration: mass_calib.v7
ion_mask: 1060317_v2.mask(1.00)

Standby
op TIDE
off PSI
mir stp

plot: 10603180250_0251....sp.q23259.esse.ps
no minimum subtracted

instr_sens: no correction
s/c potential = 0.0000
attitude: 06031807.cdf
level-zero: 06031801.dat

plot: 10603180250_0251....sp.q23259.esse.ps
no minimum subtracted

instr_sens: no correction
s/c potential = 0.0000
attitude: 06031807.cdf
level-zero: 06031801.dat
POLAR TIDE/PSI
start time: 03/18/06 03:10:59 UT
stop time: 03/18/06 03:11:59 UT
no spin averaging
collapse option 2
spin marker at sun pulse

Energy Flux

Stops

Spin Angle (deg)

Observed Energy (eV)
(Assumes MirRad=1)

<table>
<thead>
<tr>
<th>time</th>
<th>Re</th>
<th>Lshell</th>
<th>mlt</th>
<th>mlat</th>
<th>invlat</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>03:11</td>
<td>7.2</td>
<td>11.4</td>
<td>10.3</td>
<td>-37.8</td>
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</tbody>
</table>

hr:mn
Re

hrs
degs
degs

s/c potential = 0.0000
attitude: 06031807.cdf
orbit: 06031804.cdf
level-zero: 06031801.dat

Instrument: no correction
calibration: tide_calib.v6
mass_calibration: mass_calib.v7
lon_mask: 1060317.v2.mask(1.00)

TideJz.v6.1.0
Tue Aug 29 12:57:04 2006
plot: 10603180310..0311..sp.q521 esse.ps
no minimum subtracted
The time-of-flight for a given ion is given by (Burch et al., 1986),

\[
\frac{1}{2} t_f = \left( \frac{m}{2E} \right)^{1/2} \int_0^1 \left[ 1 - \sin^2 a_s B(z) / B_s \right]^{-1/2} dz
\]

where,

- \(a_s\) is the ion pitch angle
- \(B(z)\) is the magnetic field strength at point \(z\)
- \(B_s\) is the magnetic field strength at the injection point.

Assuming \(V_s = V_c\) the time-of-flight, \(t_f\), is related to the time of observations, \(t\), by,

\[
t_f = (t - t_0)
\]

where \(t_0\) is the time of the initial injection.

Thus for zero pitch angle ions \((a_s = 0)\) the following simple relationship between velocity and time applies:

\[
V_{\parallel} = s(t - t_0)^{-1}
\]

where,

- \(V_{\parallel}\) is the speed of the ions parallel to the local magnetic field
- \(s\) is the distance from the initial injection site to the spacecraft.

For this analysis \(V_{\parallel}\) is derived by fitting a Maxwellian distribution to the observations at 180° pitch angle.
$$D_1 = \frac{D_2 V_1}{V_2 - V_1}$$

$$D_2 = 13R_E \Rightarrow D_1 = 11R_E$$
In Figure (a), the magnetic field lines are depicted in the noon-midnight meridian plane. The field lines are shown from the Earth's magnetic equator towards the magnetopause and the magnetosheath boundary layer. The auroral zone is also indicated. Figure (b) shows the magnetic field lines in the dawn-dusk meridian plane, with the field lines extending from the Earth's magnetic equator towards the magnetopause and the magnetosheath boundary layer. The dawn flank and the lobe are shown.
Summary/Conclusions

- Apparent double injection on same field lines
- Counterstreaming ionospheric ions implies closed field lines
- Preliminary analysis suggests “double reconnection” in opposite hemispheres

Problems

- Location of Polar is apparently well inside the magnetopause
- Lack of information on convective motion limits ability to establish time basis

Future

- Waiting for MFE data so that convective motions can be determined
- Will pursue Cluster data where possible
Updated Conclusions

• Reanalysis confirms distances to the two reconnections sites
• Electric field results show a predominantly southward motion of the field lines
• This is not consistent with expected field line motion following post-cusp reconnection

We suggest that it is consistent with a doubly reconnected field line with reconnections sites:

1) in the northern post-cusp region
2) at low-latitude magnetopause