Magnetosphere Boundary

Arlington-Alexandria, Monday 1330h J. D. Craven (University of Iowa), Presiding

5N 27

SOME EFFECTS OF EXTERNAL FLOW ON THE MERGING OF MAGNETIC FIELD LINES

R. G. Mitchell, Jr.

R. G. Mitchell is with the Dept. of Space Physics and Astronomy, Rice University, Houston, Tx (77005)

The Sonnerup solution for the merging of incompressible plasmas is extended to allow flow in the x-y plane. In this model, as in the inflow region, as well as inflow fields and plasma densities of unequal magnitudes. Solutions are found for constant inflow as long as the difference between the quantities B_y/B in the two inflow regions does not exceed a critical magnitude. This critical magnitude is a function of the field magnitudes and densities in the inflow regions and is equal to 48 times the Alfvén speed in the inflow region for the case of equal inflow fields and densities. All such solutions satisfy Sanyal's definition of merging, but solutions of the same type in nonradially symmetric geometries. The criteria for such geometries are developed, and supersonic Alfvénic flow in at least one inflow region is found to be necessary but not sufficient. Further, the compressive nature of the shocks in this model are found to be very sensitive to the values of the inflow parameters. A solution is also developed for the case of a vacuum inflow region. This solution allows any flow in the non-vacuum inflow region, although supersonic Alfvénic flow can still result in an unusual geometry.

5N 28

ABSENCE OF A LARGE-SCALE RECONNECTION FLOW AT THE FRONT-SIDE MAGNETOPAUSE

G. Kaarendal

G. Kaarendal is with the Max-Planck-Institut für Extraterrestrische Physik, 8046 Garching b. München, Germany.

Peer Hodgson (Imperial College, London)

Close inspection of the plasma flow near the magnetopause at latitudes substantially below the plasma sheet boundary reveals the existence of a noticeable internal boundary layer for 60% of the magnetopause crossings by HEOS 2. The plasma density is typically twice the solar wind density immediately outside the magnetopause, and the plasma velocities are somewhat less than the external ones. These characteristics can be reconciled with a large-scale reconnection situation, with standing waves initiated at low latitudes as proposed by Levy et al. (1964). It is proposed that this process is of longer duration and can occur at low latitudes as well as at the cusp region where the plasma entry domi­nates. At low latitudes the interaction is characterized by magnetic erosion and mass loss from the magnetosphere; the internal boundary layer is probably a consequence of energy and momentum transfer to the cold magnetospheric plasma component that is convected towards the magnetopause. Strong solar heating parallel to the magnetic field is frequently observed.

5N 29

ON MAGNETIC FIELD LINE RECONNECTION IN AN INVISCID PLASMA

S. R. Habbal

S. R. Habbal is with the Dept. of Physics, Univ. of Cincinnati, Cincinnati, Ohio 45221

A theoretical model of a time-depen­dent merging event is presented in which the re­construction of magnetic field lines at an x-y neutral point is developed. The magnetic field configuration that reproduces such a mechanism is hyperbolic to 10th order and is steady state solutions for the velocity field are obtained analytically. With a highly conducting inviscid plasma, the streamlines in the convection region are essentially the lines stretching out radially in all directions in the x-y plane. In this solution, discontinu­ities occur along the y-direction field along the x-line or separatrices. Furthermore, as one approaches the neutral point, a diffusion region can be identified in which the conduc­tivity is taken to be finite. We will show that the solution for constant B_y/B is not compatible with the requirement that the origin be a stagnation point in the flow. Finally, a field line match the outer region solution. However, if we assume certain spatial variations in B_y/B, a rectangular hyperbolic flow can take place in the differ­ent cases, and a rectangular hyperbolic field line reconnection at the neutral point. In this two-dimensional model, both the density and pressure may be obtained analytically over the x-y plane.

5N 30

APPLICATIONS OF THE SHAPE INTEGRAL METHOD TO CALCULATING MAGNETOPAUSE SHOCKS

F. C. Michel

F. C. Michel is with the Dept. of Space Physics and Astronomy, Rice University, Houston, Tx (77001)

M. A. Pelizzari (Lunar Science Inst., Houston, Texas, 77058)

A set of integral equations have been derived by the author that depend only on the magnetospheric shape and whose properties are entirely determined by the magnetic field source (dipole, typically). The solution is approximated by appropriate fitting functions and the coefficients of these functions are determined by a variational method. These methods seem to converge very quickly with excellent shapes can be obtained with rather few coefficients. Application will be demonstrated for some simple cases and, depending on progress in the inter­nal, we may be able to present results for earth-type magnetosphere models.

5N 31

MAGNETOPOSE POSITION CHANGES DURING SUBSTORMS

R. E. Baker

R. E. Baker is with the Institute of Astrophysics and Planetary Physics, Univ. of California, Los Angeles, Calif. 90024

Reexamination of the physical processes controlling the magnetopause position was undertaken in connection with a study of ULF waves generated by substorms. The magnetopause positions were located using 2 years of OGO-5 fluxgate magnetometer data. A mean undisturbed magnetopause was determined by selecting crossings observed under magnetically quiet conditions and correcting to a standard solar wind pressure with data from Explorers 35 and 35, and Helios. Crossings selected with storms were estimated by correcting the observed magnetopause position for solar wind pressure. In the case of single crossings the observed position was compared with the mean curve above and the change in position occurring in intervals of several minutes to 2 hours the change in position between the first and last crossing was noted. There were sufficient data to permit examination of 70 cases. It was found that an average substorm occurrence interval with a southward component of the IMF was 0.5 hour, and a much longer component (E - F) between 500 keV and 2 MeV. These observations indicate a closed field line structure deep in the magnetosphere since the soft component exhibits a trapped (pancake) pitch angle distribution. The hard component however exhibits net field-aligned streaming. Acceleration events observed in the fire­ball electrons within the distant plasma sheet show the same features as described above, sug­gesting closely related acceleration phenomena.

5N 32

PLASMA AND MAGNETIC CHARACTERISTICS OF THE MAGNETOPOSE ENERGETIC ELECTRON LAYER

C.-L. Meng and K. A. Anderson (both at Space Sci. Lab., University of Calif., Berkeley, Calif. 94720)

K. L. Ackerson and L. A. Frank (both at Dept. of Physics and Astronomy, University of Iowa, Iowa City, Iowa 52242)

The plasma parameters of the energetic electron layer near the magnetopause were exam­ined by using data from the University of Iowa plasma experiment, the Iowa-Ohio-Indiana ion­osphere experiment, and the NASA Goddard magnetopause experiment aboard the IMP-5 satellite. It is found that the observation of the energetic electron layer at the magnetopause (Meng and Anderson, J. Geophys., N.S., 75, 1827, 1970) coincides with a layer of enhanced plasma energy density attributed to increases in the number density and/or averaged energy for both electrons and protons. The energy density usually increases by about a factor of 3 to 5 above the magnetosheath level. The simultaneous magnetic field measurement also reveals the occurrence of enhanced magnetic fluctuations with periods below 200 s, and the decrease of the field magnitude within the layer. This layer is, generally, located immediately outside the magnetic plasmasheet which is defined by the sharp drop of the proton number density.

5N 33

THICKNESS AND INTENSITY CHARACTERISTICS OF THE TAILING MAGNETOPAUSE ENERGETIC ELECTRON LAYER

D. B. Baker

E. C. Stone (both at: Dept. of Physics, Calif. Institute of Technology, Pasadena, Calif. 91125)

Previous work using IMP-8 data has shown the existence of an energetic electron layer adjacent to the magnetopause along the distant magneto­sheath (-15° ≤ L ≤ +40 R_e). Electrons (E > 200 keV) show substantial tailward streaming in this layer and constitute an estimated down­stream energy flow of 10^4 ergs/cm²/sec. The present study shows that average absolute uni­directional intensity in the layer are not strongly dependent on geomagnetic activity as indicated, for example, by the Kp indices; while, on the other hand, the intensity and the peak absolute intensities do appear to be dependent during periods of relative activity. These variations are made of the properties of the layer for specific interplanetary magnetic field (IMF) directions and the IMF strength. The layer for different MP and IMF conditions are computed.

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OBSERVATIONS OF ELECTRON ACCELERATION AND CLOSED FIELD LINES IN MAGNETOSHEATH-LIKE REGIONS

E. C. Stone

D. B. Baker (both at: Dept. of Physics, Calif. Institute of Technology, Pasadena, Calif. 91125)

Using data from the Caltech experiment on IMP-8, it is shown that flux increases of en­ergetic electrons (-30 R_e) at distances from the tail to -35° ≤ L ≤ +10° in the magnetosh­eath regions with magnetosheath-plasma flows have been observed. The characteristics of these include: (1) Strong tailward, unidirectional streaming observed when B_z is southward and when the ionospheric jetting is oriented; (2) Systematic pitch angle distributions when B_z is northward; (3) Moreover, the IMF has the same direction as the tailward streaming region. The differential electron energy spectra with a soft component (E ≲ 1 MeV) below 1 MeV and a much harder component (E > 1 MeV) between 500 keV and 2 MeV. These observations indicate a closed field line structure deep in the magnetosphere. Since the soft component exhibits a trapped (pancake) pitch angle distribution the hard component however exhibits net field-aligned streaming. Acceleration events observed in the fire­ball electrons within the distant plasma sheet show the same features as described above, sug­gesting closely related acceleration phenomena.

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