Magnetosphere Boundary

Arlington-Alexandria, Monday 1330h

J. D. Craven (University of Iowa), Presiding

SM 27

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

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The Sonnerup solution for the merging of incompressible plasmas is extended to allow flow along the field lines in the inflow regions, as well as inflow fields and plasma densities of unequal magnitudes. Solutions are found to exist for such flow as long as the difference between the quantities $B \cdot V$ for 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 4B times the Alfvén speed in the inflow region for the case of equal inflow fields and densities. All such solutions satisfy Vasyliunas' definition of merging, but some classes of solutions have radically altered geometries. The criteria for such geometries are developed, and super-Alfvénic flow in at least one inflow region is found to be necessary but not sufficient. Further, the compressive or expansive 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 field in one inflow region. This solution allows any flow velocity in the non-vacuum inflow region, although super-Alfvénic flow can still result in an unusual geometry.

SM 28

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

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Close inspection of the plasma flow near the magnetopause at latitudes substantially below the polar cusps reveals the existence of a noticeable internal boundary layer for 60% of the magnetopause crossings by HEOS 2. The plasma density is typically an order of magnitude, or so, below the density immediately outside the magnetopause, and the flow velocity is also somewhat lower than the external one. These characteristics can not 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 the merging process is of pulsating nature and can occur at low latitudes as well as in 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 electron heating parallel to the magnetic field is frequently observed.

SM 29

ON MAGNETIC FIELD LINE RECONNECTION IN AN INVISCID PLASMA

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A theoretical model of a time-dependent merging mechanism for the reconnection of magnetic field lines at an X-type neutral point is developed. The magnetic field configuration that reproduces such a mechanism is hyperbolic to lowest order. The steady state solutions for the velocity field are obtained analytically. With a highly conducting inviscid plasma, the streamlines in the convection region are essentially straight lines stretching out radially in all directions in the x-y plane. In this solution, discontinuities occur in the velocity field along the X-lines or separatrix. Furthermore, as one approaches the neutral point, a diffusion region can be identified in which the conductivity σ is taken to be finite. We will show that the solution for constant σ is not compatible with the requirement that the origin be a stagnation point in the flow, nor does the velocity field match the outer region solution. However, if we assume certain spatial variations in σ, a rectangular hyperbolic flow can take place in the diffusion region together with hyperbolic field line reconnection at the neutral point. In this two-dimensional model, both the density and the pressure may be obtained analytically over the x-y plane.

SM 30

APPLICATIONS OF THE SHAPE INTEGRAL METHOD OF CALCULATING MAGNETOPAUSE SHAPES

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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 magnetopause shape is approximated by appropriate fitting functions and the coefficients of those functions are determined from a variational method. These methods seem to converge very rapidly and excellent shapes can be obtained with rather few coefficients. Application will be demonstrated for some simple cases and, depending on progress in the intermin, we may be able to present results for earth-type magnetosphere models.

SM 31

MAGNETOPAUSE POSITION CHANGES DURING SUBSTORMS

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Reexamination of the physical factors 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 33 and 35, and Helos 1. Changes associated with substorms 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 in the case of multiple crossings 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 erosion of the outer magnetosphere occurred during intervals with a southward component of the interplanetary field principally just before or during a rising A_E index. Expansion was found during intervals of falling A_E index or when A_E reached a maximum during multiple crossings. 35 cases were in agreement with the above description, 4 were in disagreement and in 31 cases the changes were so small that no conclusion could be reached. Of the other factors which affect magnetopause position waves on the surface appeared to be most important.

SM 32

PLASMA AND MAGNETIC CHARACTERISTICS OF THE MAGNETOPAUSE ENERGETIC ELECTRON LAYER

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The plasma parameters of the energetic electron layer near the magnetopause were examined by using data from the University of Iowa LEPEDA plasma experiment, the University of California (Berkeley) Medium Energy Particles experiment, and the NASA Goddard magnetic field 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. Res., 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 20.5 seconds and the decrease of the field magnitude within the layer. This layer is, generally, located immediately outside the magnetopause which is defined by the sharp drop of the proton number density.

SM 33

THICKNESS AND INTENSITY CHARACTERISTICS OF THE TAILWARD MAGNETOPAUSE ENERGETIC ELECTRON LAYER

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Previous work using IMP-8 data has shown the existence of an energetic electron layer adjacent to the magnetopause along the distant magnetotail ($-15 \gtrsim X_{SM} \gtrsim -40\ R_E$). Electrons ($E \geq 200$ keV) show substantial net tailward streaming in this layer and constitute an estimated downstream energy flow of 10^{14}-10^{16} ergs/sec. The present study shows that average absolute unidirectional intensities in the layer are not strongly dependent on geomagnetic activity (as indicated, for example, by the Kp indices)while, on the other hand, the thickness of the layer and the peak absolute intensities do appear to be greater during periods of high Kp. Comparisons are made of the properties of the layer for specific interplanetary magnetic field (IMF) directions and the implied energy flows in the layer for different Kp and IMF conditions are computed.

SM 34

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

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Using data from the Caltech experiment on IMP-8, it is shown that flux increases of energetic electrons ($E \geq 200$ keV) at $\sim 30\ R_E$ in low-latitude regions with magnetosheath-like plasma flows have distinct characteristics. These include: (1) Strong tailward, unidirectional streaming observed when B_Z is southward and when intense plasma jetting is tailward; (2) Symmetric pitch angle distributions when B_Z is northward and when strong plasma heating is observed; (3) Differential electron energy spectra with a soft component ($\propto E^{-6}$) below ~ 500 keV and a much harder component ($\propto E^{-3}$) between ~ 500 keV and 2 MeV. These observations indicate a closed field line structure deep in magnetosheath-like regions 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 regions within the distant plasma sheet show the same features as described above, suggesting closely related acceleration phenomena.