# Book of Abstracts

## Magnetospheric Response to Solar Activity

9-12 September 2003, Prague, Czech Republic

NATO Advanced Research Workshop:

**Multiscale processes in the Earth's magnetosphere: From INTERBALL to CLUSTER**

colloquium supported by COSPAR

**Dynamics of the solarwind-magnetospehere interaction**

# Contents



## Multiscale Processes in the Earth's Magnetosphere: From INTERBALL to CLUSTER

### Invited and Solicited Lectures

## Oral Contributions



## Poster Presentations

## Dynamics of the Solar Wind — Magnetosphere Interaction

### Invited and Solicited Lectures



### Oral Contributions

## Poster Presentations

## Foreword

The past forty years of space research have seen a substantial improvement in our understanding of the Earth's magnetosphere and its coupling to the solar wind and interplanetary magnetic field. The magnetospheric structure has been mapped and major processes determining this structure have been defined. A decade ago, it became clear that further progress would require multi-point measurements. Since then, two multispacecraft missions have been launched - Interball in 1995/96 and Cluster II in 2000. The objectives of these missions differed but were complementary: INTERBALL observed larger spatial and temporal scales than Cluster. The huge amount of data returned by the missions has resulted in many scientific papers and more appear each month. However, the number of papers taking advantages of both missions simultaneously is rather small. Thus, one aim of the proposed meeting is to bring the communities connected with both projects together and to initiate a deeper cooperation. The second task of our meeting is to emphasize the role of the solar wind input for magnetospheric processes.

*Zdeněk Němeček*

## A Model for the Turbulence in the Plasma Sheet

*Borovsky, J. E.*
Los Alamos National Laboratory, Los Alamos, New Mexico 87545 USA

The MHD turbulence of the Earth's plasma sheet in the magnetotail has been examined by satellite measurements of magnetic fields and plasma flows. A theoretical analysis of flows in the magnetotail is being used to help investigate the physics of this turbulence. This analysis indicates that the MHD turbulence in the plasma sheet is a very unusual turbulence. The unusual nature results from (1) the very limited range of spatial scales available for MHD flows in the plasma sheet and (2) dissipation of vorticity by magnetosphere-ionosphere coupling. Magnetosphere-ionosphere coupling introduces several unique features to the turbulence: (a) a time dependence to the rate-of-dissipation of a flow, (b) dissipation at all spatial scales, and (c) dissipation rates that depend on the sign of the vorticity. Because this turbulence is unique, it is not easy to utilize knowledge about turbulence to infer the effect of this turbulence on the plasma sheet; this unique turbulence may have unexpected properties and unanticipated consequences. Using a theoretical analysis of flows in the magnetotail, a computational model of the plasma-sheet turbulence is being constructed to study the basic properties of this unconventional turbulence.

## CLUSTER: New Measurements of Plasma Structures in 3D

*Escoubet, C. P.*[1] , Laakso, H.[1] , Goldstein, M.[2]
[1]ESA/ESTEC, SCI-SH, Keplerlaan 1, 2200 AG Noordwijk, The Netherlands ,
[2]NASA/GSFC, Code 692, Greenbelt, MD 20771, USA

After 3 years of operations, the Cluster mission is fulfilling successfully its scientific objectives. The mission, nominally for 2 years, has been extended by another 3 years, up through December 2005. The main goal of the Cluster mission is to study in three dimensions the small-scale plasma structures in the key plasma regions in the Earth's environment: solar wind and bow shock, magnetopause, polar cusps, magnetotail, and auroral zone. During the course of the mission, the relative distance between the four spacecraft is being varied from 100 and 18,000 km to better focus on specific regions of interest. The inter-satellites distances achieved so far are 600, 2000, 100, 5000 km and recently 250 km. The latest results, which include derivation of gradients using the four spacecraft and boundary motions, as well as interferometry, will be presented. The access to data through the Cluster science data system, several public web servers, and the future plans for a Cluster archive will be presented.

## Direct and Indirect Observations of a Patchy-sporadic Reconnection on the Dayside Magnetopause

*Fedorov, A. O.*[1] , Budnik, E. Y.[1] , Louarn, P.[1] , Rème, H.[1] , Dunlop, M. W.[2]
[1]CESR-CNRS, Toulouse, France,
[2]RAL, Didcot, UK

Statistical study of high latitude boundary layer performed on the base of INTERBALL data shows, that 1) observed boundary layer properties can be explained by magnetic reconnections occurred remotely from the spacecraft at the dayside magnetopause, 2) the reconnection should have a patchy and sporadic nature with a strong interconnection between reconnected field lines leading to lines interlink and recuperation of the original configuration. Observations of reconnection region in situ performed by 4 CLUSTER satellites provides good evidence of INTERBALL prediction. We show that reconnection region consists of the mixture of reconnected field lines coming from different reconnection points and containing both accelerated and decelerated magnetosheath plasma. The 3-D structure of such boundary layer is reconstructed in the present paper.

## Magnetosheath Properties and Dayside Magnetic Reconnection

*Fuselier, S. A.*, Petrinec, S. M., Trattner, K. J.
Lockheed Martin Advanced Technology Center, USA

Magnetic reconnection changes character when there is a velocity shear across the current layer. At the magnetopause, the velocity shear develops as one moves from the subsolar region (where the bulk flow of the magnetosheath plasma is low) to high latitudes or on the flanks of the magnetopause (where the bulk flow is high). It is important to consider this shear when investigating properties of reconnection, for example, the difference between component and anti-parallel reconnection. Since a spacecraft rarely goes through a reconnection point or line, it is difficult to determine where a reconnection line is located and therefore how reconnection is changed due to magnetosheath bulk flow. However, remote sensing of the reconnection site and imaging of the cusp aurora are techniques that provide both quantitative and qualitative information on the location of the reconnection site and, using magnetosheath models, the plasma conditions at the site. These techniques are reviewed and examples are provided using a combination of data from Polar, IMAGE, and Cluster.

## Simulations of Foreshock Structures of the Bow Shock and its Interaction With Interplanetary Discontinuities

*Lin, Y.*

Physics Department, Auburn University, Auburn, AL 36849-5311, USA

In the interaction between the solar wind and the Earth's magnetosphere, transient phenomena can be generated at the bow shock through two important methods. (1) Pressure pulses and the associated plasma and field variations can be generated in the foreshock regions by the intrinsic processes of the bow shock, and (2) various transient waves can also be produced by the impact of interplanetary discontinuities on the bow shock. These transient structures can be transmitted through the magnetosheath and interact with the magnetopause. In this talk, two-dimensional (2-D) global-scale hybrid simulations will be shown for the structure of the bow shock and its interaction with interplanetary discontinuities. In the simulation, the bow shock forms by the interaction of the supersonic solar wind and the geomagnetic field. In particular, it will be shown that diamagnetic cavities are generated in the foreshock regions of the parallel and quasi-parallel shocks, where ion beams interact with the incoming solar wind plasma. The cavities convect downstream with the solar wind flow. In later times they can develop into elongated spatial structures along the field lines, both upstream and downstream. For the interaction between an interplanetary tangential discontinuity (TD) and the bow shock, it will be shown that in the cases in which the magnetic field orientations across the TD result in a normal component of the motional electric field pointing toward the TD, a strong hot flow anomaly (HFA) can be generated in the bow shock and the magnetosheath by coherent, gyrating reflected ion beams near the bow shock. The HFA bulges into the solar wind due to an enhancement of the total pressure in the hot cavity, and the magnetopause can expand sunward by as the HFA passes by. The simulation results will also be compared with the satellite observations of foreshock structures and the HFA.

## Propagation of Low Frequency Fluctuations in the Plasmasheet — A CLUSTER Analysis

*Louarn, P.*[1] , Fruit, G.[1] , Budnik, E. Y.[1] , Sauvaud, J.-A.[1] , Lucek, E.[2] , Balogh, A.[2]
[1]CESR/CNRS, Toulouse, France,
[2]Imperial College, London, UK

We analyse the low frequency fluctuations observed by CLUSTER in the plasmasheet with the objective to determine if they may be interpretable as magnetohydrodynamic (MHD) eigenmodes. To that purpose, we investigate a plasmasheet crossing occurring on August 22, 2001, during both quiet and disturbed conditions. The observations are compared with results of a study of the MHD propagation in a Harris sheet. The theory shows that the eigenmodes have periods scaled by a characteristic time, t, equal to the ratio between (1) the thickness of the sheet and (2) the sound speed. Using the 4 CLUSTER spacecraft, we thus estimate the thickness of the sheet and determine this characteristic time. It is compared with the typical periods of the fluctuations that is deduced from a wavelet analysis of the magnetic field and pressure fluctuations. We identify some oscillations that could correspond to MHD eigenmodes. They are intense (10 nT), have a rather short period (20-25 s) and are observed during a substorm onset. They combine both sausage and kink modes with a common spectral peak at $\sim 0.04$ Hz, the sausage oscillations presenting also a secondary peak at 0.13 Hz. Using a complete model of the linear MHD response of the plasmasheet, we theoretically reconstruct the sheet oscillations starting from arbitrary external perturbations and we show that the kink mode (0.04 Hz) and the high frequency sausage mode are perfectly compatible with the MHD model of Harris sheet oscillation.

## Two-point Observations of the LLBL During Intervals of Northward Oriented IMF

*Němeček, Z.*[1] , Šafránková, J.[1] , Přech, L.[1] , Šimůnek, J.[1,2]
[1]Charles University, Faculty of Mathematics and Physics, Prague, Czech Republic,
[2]Institute of Atmospheric Physics, Czech Academy of Sciences, Prague, Czech Republic

The low-latitude boundary layer (LLBL) is encountered at the interface between two plasma regions - the magnetosheath and plasma sheet and thus contains a mixture of both plasma populations. Several mechanisms have been discussed as candidates for a formation of the LLBL. These mechanisms can be divided into magnetic reconnection between the magnetospheric and magnetosheath magnetic fields, impulsive penetration of magnetosheath plasma, and viscous/diffusive mixing of plasma populations at the magnetopause. The observed fluctuations of plasma parameters inside the LLBL are attributed either to transient nature of the phenomena forming the layer or to sweeping of deformations of the magnetopause or inner edge of the LLBL surface along the spacecraft. We are using the INTERBALL-1/MAGION-4 satellite pair separated by several thousands of kilometers in order to distinguish between spatial and temporal changes. The observation of LLBL crossings invoked by sudden changes of upstream conditions shows that even during strongly northward IMF, the LLBL is relatively thin and follows the compression of the magnetopause induced by changes of the solar wind pressure. The dusk LLBL is supplied by high-latitude reconnection in the southern (northern) hemisphere, when IMF $B_Y$ is negative (positive) and lies on open field lines. Observations suggest a presence of surface waves on the inner edge of the LLBL.

## Multipoint Observations of Nonlinear Waves and Isolated Electrostatic Structures in the Earth's Magnetosphere: The CLUSTER Perspective

*Pickett, J. S.*[1] , Chen, L.[1] , Kahler, S. W.[1] , Santolík, O.[1,2] , Gurnett, D. A.[1] , Bell, T. F.[3] , Tsurutani, B. T.[4]

[1]Department of Physics and Astronomy, The University of Iowa, Iowa City, IA, USA,
[2]Charles University, Prague, Czech Republic,
[3]STAR Laboratory, Stanford University, Stanford, CA, USA,
[4]Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, USA

The Cluster Wideband (WBD) plasma wave receiver obtains high time resolution waveforms simultaneously from up to four spacecraft in an approximate 4×19 $R_E$ orbit. We present WBD observations of two types of nonlinear waves: solitary waves referred to as isolated electrostatic structures (IES) and VLF triggered electromagnetic emissions. The IES are observed at all of the boundaries crossed by Cluster as well as along auroral field lines at 5-7 $R_E$. They appear in at least two distinguishable forms, i.e., bipolar (one positive and one negative peak) and tripolar pulses (two positive and one negative peaks, or vice versa). Their amplitudes vary from a few hundredths to nearly 100 mV/m and their time durations vary from a few tens of microseconds to about 5 milliseconds. The triggered emissions are observed within about 20 degrees of the magnetic equator when the Cluster spacecraft are located near the plasmapause at perigee. They are mainly observed in the frequency range 2-6 kHz with fine-structured spectral features, e.g., risers, fallers, S-shapes. Cross spacecraft correlations of both the IES and the triggered emissions are discussed which in some cases can provide a basis for determining the propagation characteristics of the waves.

## The Cusp at Mid-altitude: 3 Years of Cluster-CIS Data

*Pitout, F.*[1] , Escoubet, C. P.[1] , Bosqued, J.[2]

[1]ESA/ESTEC, Noordwijk, The Netherlands,
[2]CESR, Toulouse, France

We present a statistical study of three years of Cluster crossings of the mid-altitude cusp. We compare ion data from the CIS instrument with IMF data from the ACE spacecraft. We first introduce the statistical method used to characterize the IMF with the proper time lag. Then, we classify the cusp crossings with respect to their characteristics and we relate the different classes to the IMF conditions. We among other show that most of the cases of irregular or discontinuous cusps arise from changes in the IMF.

## Langmuir and Electron Solitary Waves at the High-latitude Magnetopause Near the Merging Site

*Popielawska, B.*[1] , Khotyaintsev, Y.[2] , Pickett, J. S.[3] , Farrugia, C.[4] , Kellett, B.[5] , Gustafsson, G.[2] , Stasiewicz, K.[2]
[1]Space Research Center, P.A.S., Warsaw, Poland,
[2]Swedish Institute of Space Physics, Uppsala Division, Sweden,
[3]University of Iowa, Iowa City, IA, USA,
[4]University of New Hampshire, Durham, NH, USA,
[5]Rutherford Appleton Laboratory, Chilton, Didcot, UK

We try to found some coherent scenario that produce turbulent boundary layer at the high-latitude magnetopause crossed by Polar on April 11, 1997, under strong northward IMF. Wave data are very helpful in such a task. E.g., Langmuir waves recorded by Polar PWI instrument occur as dominant waves in the narrow region of electron separatrix bordering the sunward outflow region on the magnetosheath side of the current layer. These waves may be excited by "bump on the tail" instability. Slightly deeper into the outflow region where hot ion beams appear and hot electron beam is denser, Langmuir waves may coalesce into electron solitary waves. On the magnetospheric side we may have bi-stream instability (counterstreaming equally dense hot electron beams and hot ion beam) and it is probably why electron holes are so abundant there. Numerical simulation of magnetic field dissipation in a collisionless thin current sheet predict suprathermal electron production both in reconnection and reconnection-free scenarios. We found that large-scale structures in the boundary layer are more compatible with reconnection scenario, while micro-structures as pin-pointed by WBR wave data fit as well the reconnection free scenario, e.g., of Shinohara et al. (2001, Phys. Rev. Lett.).

## Propagation and Evolution of CMEs in the Solar Wind

*Richardson, J. D.*, Liu, Y.
Center for Space Research, M.I.T., Cambridge, MA, USA

Interplanetary coronal mass ejections (ICMEs) evolve as they propagate outward from the Sun. They interact with the ambient solar wind and move towards internal equilibrium. One difficulty with studying this evolution is that ICMEs have no unique set of identifying characteristics so boundaries of the ICMEs are difficult to identify. We choose two characteristics present in some ICMEs but generally not in the ambient solar wind, high helium/proton density ratios and low temperature/speed ratios, and study the evolution of features with these characteristics. We search the Helios 1 and 2, WIND, ACE, and Ulysses data for ICMEs with these characteristics and use them to study the radial evolution of ICMEs. We also compare the times when large helium/proton density ratios are present to the Cane and Richardson (JGR, 2003) ICME list. We find that most, but not all, times when the helium/proton density ratio is above 0.08 are ICMEs and that ICMEs expand with distance similar to theoretical predictions. Case studies show that a 1-D MHD model does a good job of predicting the radial evolution of ICMEs.

## Solar Wind Interaction with Planetary Magnetospheres

*Russell, C. T.*
University of California Los Angeles, USA

A pressure gradient is needed to slow and deflect the plasma flowing around a planetary obstacle. In the supersonic solar wind the pressure in the gas is too low to deflect the flow. Thus a shock forms to convert the directed kinetic energy into thermal energy. This heated plasma now has sufficient pressure to deflect the flow. In the gas-dynamic approximation the magnetosheath density piles up throughout the subsolar magnetosheath, and along the flanks the plasma accelerates and the density drops. In a magnetized plasma acceleration of the plasma on the inner portion of the magnetosheath can take place across the entire dayside and a plasma depletion layer can form. This problem is adequately treated by magnetohydrodynamics, except that in MHD all solar wind interactions, independent of size, are identical. Our physical intuition should tell us that this is exceedingly unlikely. If we treat the interaction with a hybrid code in which ion motion is followed, we find that the interaction undergoes a series of phase changes as the strength of the dipole changes. The weakest interactions create only whistler waves. Strong dipoles create fast mode and slow mode wakes and stronger dipoles create bow waves and then bow shocks. The first signs of reconnection occurs at surprising small magnetospheres. When the magnetosphere reaches the size of Mercury's, then a dynamically reconnecting magnetospheres is found with flux transfer events and plasmoid formation. In the largest planetary magnetosphere, Jupiter's, reconnection is important but not with the solar wind. At Jupiter reconnection is the process that allows the magnetosphere to dump Io-derived plasma down the tail and return magnetic flux to the inner magnetosphere. Thus like the Dungey model for Earth, Jupiter has plasma circulation in which reconnection plays a key role, but Jupiter has a much, much different engine.

## Dynamics and Origin of Ionospheric Ions in the Earth's Magnetotail

*Sauvaud, J.-A.*
CESR/CNRS, Toulouse, France

The talk presents case studies of the dynamics of the terrestrial ions in the mid-plasma sheet and inside the lobes ($\sim 17 \div 19\ R_E$). The high time resolution measurements of $H^+$, $He^+$, $O^+$ ions made onboard Cluster show that these ions are massively injected into the tail during substorms/storms from the nightside ionosphere and mainly dispersed by time of flight effects; a single oxygen injection being able to account for over 80% of the oxygen population of the mid-tail plasma sheet during storm-time. Inside the lobes, during disturbed times, ionospheric oxygen ions appear as nearly mono-energetic beams, quasi field-aligned, propagating antisunward from the ionosphere, as expected from the "cleft ion fountain". Most of the time, the ionospheric protons are very cold and their distribution function is not fully measurable by a charged spacecraft. However, we show that protons can, at times, acquire a large drift motion, reach energy larger than 30 eV and be directly measurable by the CIS spectrometers. This occurs when large disturbances propagate in the plasma sheet boundary layer during both quiet and disturbed periods. We show that the large, variable, Alfvén waves generated by these plasma sheet disturbances modulate the energy of lobe protons and oxygen ions and inject electromagnetic energy in excess of $15 \times 10^{-3}$ W/m$^2$ down to the polar cap. Deeper inside the PSBL, large electric fields associated with the Earthward stream of plasma sheet particles give enough drift energy to a very cold ionospheric proton population to become fully detectable by the Cluster ion spectrometers.

## Bursty Bulk Flows and Their Ionospheric Footprints

*Sergeev, V. A.*
Institute of Physics and Physical Faculty, St.Petersburg State University, 198504 St.Petersburg, Russia

The bursty flows (BBFs), which provide a major contribution to the Earthward convection in the high-beta plasma sheet region of the magnetotail, are uniformly distributed between 40-50 $R_E$ and the inner magnetosphere, most of them are now confirmed to be the plasma bubbles, the underpopulated plasma tubes with a smaller plasma tube invariant (pVg). Many BBFs are visible due to the associated plasma precipitation, which provides an excellent possibility to monitor their global dynamics by observing the auroral prints (e.g. auroral streamers). Recent studies of associated precipitation, convection and field-aligned currents indicate that a mechanism providing bright optical image of the BBF flux tube is the electric discharge (field-aligned electron acceleration) from the dusk flank of the BBF where the intense upward FAC is generated. Penetration of BBFs to the inner magnetosphere was frequently observed to the distance as close as 6.6 $R_E$ , with indications of flow jet diversion and braking (with associated pressure ioncrease and magnetic field compression). Such interaction also creates long-lived drifting plasma structures, particularly those related to torch and omega-type auroras. Unlike the picture of plasma turbulence, the picture of BBFs emerging from these results corresponds to the powerful (up to tens kV in one jet) sporadic narrow (2-4 $R_E$) plasma jets propagating in the tail as the plasma bubbles, which are probably born in the impulsive reconnection process but filtered and modified by the interchange process.

## Pressure Pulses and Cavity Mode Resonances

*Sibeck, D. G.*
NASA Goddard Space Flight Center, Greenbelt, Maryland, USA,

It has long been known that abrupt changes changes in the solar wind dynamic pressure initiate resonant toroidal oscillations of closed geomagnetic field lines that can be observed by monitors in the magnetosphere and on the ground. The periods of these oscillations should diminish with increasing L-shell. However, ground radars and meridional arrays of ground magnetometers sometimes observe similar discrete periods over a wide range of L-shells. The same periods can be observed on different days. These observations have led to an interpretation of the oscillations in terms of cavity mode resonances, despite the fact that the poloidal oscillations required for cavity mode resonances are rarely observed. Furthermore, the fact that the oscillation propagate antisunward requires the existence of an open waveguide. Recent results invoke both intrinsic solar wind pressure variations and the Kelvin-Helmholtz instability to explain the oscillations. We reexamine previously reported examples to make the case for a direct relationship between the oscillations and pressure pulses generated in the foreshock.

## Interplanetary Discontinuities and Shocks in the Earth's Magnetosheath

*Szabo, A.*
NASA Goddard Space Flight Center, Greenbelt, MD, USA

Gas dynamic work of Stahara and Spreiter in the late 80's has suggested that interplanetary (IP) shocks once entering into the magnetosheath, turning into pressure pulses, maintain their original surface geometry to a very good approximation. This work presents WIND, ACE, IMP 8 and Geotail data observing the same IP shocks in the interplanetary medium and in the Earth's magnetosheath and contrasts them with similar observations for large directional discontinuities. Multiple solar wind observations are necessary to approximate the interplanetary geometry of these discontinuities and shocks because they often significantly deviate from simple planarity. Pressure pulses in the magnetosheath, clearly associated with the IP shocks, could be identified for most shocks analyzed for the time period 1998-2001. However, the magnetosheath signatures of very weak and reverse shocks were often completely washed out. For those shocks that have clearly identifiable signatures in the magnetosheath it is demonstrated that they do not deviate significantly from their interplanetary geometry, unlike directional discontinuities. This result provides observational evidence supporting the Stahara and Spreiter gas dynamic model.

## Counter-streaming Ion Components as Indicator of Multiple Reconnection

*Vaisberg, O. L.*[1] , Avanov, L. A.[1,2] , Smirnov, V. N.[1] , Moore, T. E.[3]
[1]Space Research Institute, Moscow, Russia,
[2]NSSTC/MSFC, Huntsville, AL, USA,
[3]Goddard Space Flight Center, Greenbelt, MD, USA

We analyze ion velocity distributions observed by Interball-Tail at two LLBL crossings under southward and variable magnetosheath magnetic field. These magnetic conditions lead to highly-structured LLBL. D-shape ion velocity distributions were observed within LLBL structures along with other reconnection signatures. Another type of the ion velocity distributions observed within LLBL structures consists of two counter-streaming magnetosheath-type components. We consider two possible scenarios that may lead to development of these counter-streaming ion components: reflection of transmitted magnetosheath ions from the ionosphere and creation of these velocity distributions during formation of the LLBL. We argue that observed counter-streaming component could not be due to ionospheric reflection. The observations of these ion velocity distributions favor the multiple reconnections between magnetosheath and magnetospheric flux tubes.

## Earth's Bow Shock: GD and MHD Aspects

*Verigin, M. I.*
Space Research Institute of Russian Academy of Sciences, Moscow, Russia

Recent rapid increase of Earth's bow shock (BS) observations with the solar wind upstream properties controlled by modern technique (Cluster, Wind) as well as huge number of reprocessed multiyear IMP 8 BS observations, provided possibility for clarification of fine features of this boundary. This possibility nevertheless can not be effectively realized without improvement of approach to BS modeling . Theoretical gasdynamic models are possible to run with present ordinary PC's but they are generally applicable in the cases of high Alfvenic Mach numbers. MHD and kinetic models require significant supercomputer time resources. Such models though constitute a reliable baseline but practically impossible to be used for tracing of instant BS position. In the present talk the predictive features of the modern analytic/empiric/semi-empiric BS models will be discussed and compared. Exact analytic solutions are very important for BS modeling but they are describing only some specific features of the BS surface. Simple empirical models first normalize the data using the relation $r \sim Pd^{(-1/k)}$, $k \sim 6$, that is reasonably valid for the magnetopause but not for the bow shock, and then describe BS surface by a formal second order polynomial function with coefficients being again a polynomial of the Alfvenic/magnetosonic Mach number. These models are applicable only in a region of solar wind parameter variations used for their construction. The semi-empiric modeling approach that implements exact analytic solutions for BS nose shape in low Mach number GD limit, recent exact analytic MHD solution for Mach cone, curved shock MHD Rankine-Hugoniot relations, and results of 3-D MHD calculations. First versions of this approach provide possibility to study the asymmetry of the terrestrial bow shock in the terminator plane as a function of Friedrichs diagram anisotropy, to analyze the subsolar BS position as a function of Alfvenic Mach number and to show that shock tends to approach the Earth when Ma is decreasing and IMF is aligned to solar wind flow, while for non field-aligned flows bow shock moves from the planet. Semi-empiric approach can be especially useful for the identification of exact reasons of unique cases of terrestrial shock observations at extremely large distances from the planet.

## Double Cusp

*Wing, S.*, Newell, P. T., Meng, C. I.
Johns Hopkins University, Laurel, USA

One of the most exciting discoveries in the recent cusp research is the spatially discontinuous cusps that occur under quasi-steady state solar wind and IMF conditions. This has been attributed to the satellite detecting magnetosheath origin plasma that has E×B convected from different merging sites at the magnetopause. It turns out that certain IMF orientations favor the formation of the discontinuous cusps. In particular, two cusps that are separated latitudinally (double cusp) preferentially occur during periods of By dominant IMF. The double cusp has a distinct dispersion signature: the lower latitude cusp has little or no dispersion whereas the higher latitude cusp has dispersion. Since there are far more cusp crossings than magnetopause crossings in the database, this recent discovery provides an unprecedented new opportunity to re-examine the old issues of when and where merging occurs on the dayside. Review of double cusps at low-, mid-, and high-altitudes as well as their implications to merging theories are presented and discussed.

## An Overview of New Concepts Deduced From INTERBALL Solar Wind Investigations

*Zastenker, G. N.*
Space Research Institute, Russian Academy of Sciences, Moscow, Russia

Some new features of the solar wind were found in the INTERBALL project by comparison of the multipoint observations and using high-resolution plasma measurements onboard INTERBALL-1/MAGION-4 satellites. These results allow us to suggest some new concepts about solar wind in several points, namely: (1) dimensions and persistent time of the middle-scale structures, (2) large and very sharp plasma density changes on the borders of the small-scale structures, (3) significant inclinations of many sharp plasma phase fronts, (4) geoeffectivity of the sharp changes of the plasma dynamic pressure, (5) not only magnetic field but also plasma in phase fast variations in the foreshock, (6) large amplitude, low and high frequency plasma and magnetic field variations in the magnetosheath; their origin, dependence on IMF direction and comparison with MHD models.

## Laminar and Turbulent Regimes of Magnetotail Dynamics

*Zelenyi, L. M.*[1] , Milovanov, A. V.[1] , Malova, H. V.[1,2]
[1]Space Research Institute, Russian Academy of Sciences, Moscow, Russia,
[2]Nuclear Physics Institute, Moscow State University, Moscow, Russia

Current sheets observed in a space plasma represent a surprisingly robust structures. Recent "in situ" observations of current sheets in the Earth's magnetotail made by Geotail, Interball and Cluster spacecraft revealed a number of a new physical effects controlling their formation, evolution and disruption. Current sheet (CS) in the Earth's magnetotail are extremely elongated (almost 1D) structures, which expand and shrink depending on the amount of the stored magnetic energy. Correspondingly their thickness is very variable, but at some stages could reach remarkably small values below ion Larmor radius. There are two distinct regions in magnetotail CS. Closer to the Earth at downstream distances $\leq$70 - 100 $R_E$ tail structure is controlled by "remnants" of the Earth's dipole magnetic field: even very small component of magnetic field normal to CS plane is capable to support quasi-stability of configuration until its value is sufficient to keep plasma sheet electrons magnetized. One may consider such sheets as "laminar". Further downstream electrons get unmagnetized , field line loose their identity and system becomes intrinsically "turbulent". Famous, hypothetical X-line, in fact, represents the transition between these two regimes. Magnetic fields at both sides of it have different topologies and only this plasma effect signifies the role of this transition region as of the site of macroscopic reconnection CSs have complicated structure in both regimes. "Laminar sheets" usually consist of multiple layers, where CS is embedded into wider plasma sheet. Current profile is often observed to be bifurcated (splitted on two peaks), which could occur due to trapping of ions within magnetic well of CS. Even more puzzling is the structure of "turbulent" sheets. Although on average this configuration is in equilibrium, but it remains very variable at each given moment of time. We use so called concept of NESS (non-equilibrium steady state) to describe its characteristics. The point is that the properties of the dynamics of current carrying particles should be self-consistently coupled with the properties of multiscale magnetic field structures (= "turbulence") scattering these particles. As a result using the methods of fractal topology we found that the resulting "turbulence" is not space-filling and could be better imagined as an hierarchy of dynamic magnetic clumps with different scales. Theory predicts self similarity of time series of magnetic field variations in certain intervals of temporal scales, the properties of the Fourier spectra of such fluctuations and characteristics of suprathermal power law tails of particle velocity distributions. Interesting that observations made prior to substorm onset indicate that both "laminar" and "turbulent" sheets could become structurally unstable at late stages of CS evolution. Finally we compare the results obtained with the satellite observations of plasma and magnetic fluctuations.

## The Structure of the Magnetospheric Boundary Layers and the Magnetospheric Turbulence

*Antonova, E. E.*
Skobeltsyn Institute of Nuclear Physics Moscow State University, IKI RAS, Moscow, Russia

The concept of the formation of the turbulent wake under the obstacle gives the possibility to explain many features of the plasma dynamics in the magnetosphere of the Earth. The formation of the plasma sheet and tail lobes in accordance with the concept is explained as the result of the large-scale (the dawn-dusk electric field) and medium-scale modes of magnetospheric turbulence interactions. The application of the developed approach to the problem of the boundary layer formation and properties gives the possibility to explain the boundary layer thickness during southward and northward interplanetary magnetic field (IMF) orientations and the dawn-dusk LLBL asymmetry. Theory predictions are compared with the results of experimental observations.

## Low Frequency Waves in the Inner Magnetosheath

*Balikhin, M. A.*[1] , Dunlop, M. W.[2] , Walker, S. N.[1] , Amata, E.[3]
[1]ACSE The university of Sheffield, UK,
[2]RAL, UK,
[3]IFSI-CMR, Italy

Data from the Cluster satellites measured on February, 21st 2001 have been used to identify low frequency waves in the inner magnetosheath. It was shown that in addition the wave modes that are normally observed, such as mirror waves, ballooning modes have been observed for the first time in the magnetosheath.

## Dynamics of Field-aligned Currents and Energetic Particle Fluxes in the Mid-altitude Cusp by INTERBALL -AU, March-April 1997

*Bochev, A. Z.*[1] , Kudela, K.[2]

[1]Solar-Terrestrial Influences Laboratory, Bulgarian Academy of Sciences, 1113 Sofia, Bulgaria,
[2]Institute of Experimental Physics, Slovakian Academy of Sciences, Watsonova 47, Kosice, Slovakia

In this work field-aligned currents (FACs) and energetic particle events in the north mid-altitude cusp and in the surrounding regions have been analysed for a number of cases in March-April 1997. Our analysis is based on measurements by three instruments: the three component flux-gate magnetometer IMAP-3; the electron and ion spectrometers DOK-2 and - PROMICS-3 aboard the INTERBAL - Auroral , radial distance at apogee 4.1 $R_E$ ($R_E$ -Earth's radius), period of 6 hours. We emphasise on: (1) The concentration of FACs in the cusp (collocation of magnetic field disturbances and particle events in the cusp); (2) intense current structures displaced from particle precipitation; (3) cusp energetic particle (CEP) events. We attempt to discuss some possible cause of generation of such events related to direct influence of SW and IMF; a possible relationship between FACs and different types of boundary structures in the exterior cusp; acceleration processes in the cusp. It is believed also that the detected features of FAC and plasma may be related to the state of the ionosphere (equinox near solar minimum).

## Fractal Structure of the Heliospheric Plasma Sheet at the Earth's Orbit

*Eselevich, V. G.*, Eselevich, M. V.

Institute of Solar-Terrestrial Physics, Irkutsk, Russia

An analysis of the data from the Wind and IMP-8 spacecraft showed that a heliospheric plasma sheet represents a set of magnetic tubes with plasma of increased density (N > 10 $cm^{-3}$ at the Earth's orbit). They are endowed with a fine structure over several spatial scales (fractality), from approx. (1.5 - 3.0) degrees [at the Earth's orbit, this is equivalent to 2.7-5.4 hours, or (4 - 8)$\cdot 10^6$ km] to the smallest scale approx 0.025 degree, i.e. the angular size of nested tubes changes nearly by two orders of magnitude. In many cases, total pressure $P = kN(T_e + T_p) + B^2/8\pi$ is virtually constant inside and outside the tubes at any one of the aforementioned scales. Magnetic tubes are quasi-stationary structures. Drift (or diamagnetic) current on the boundary of the tubes is stable to the excitation of random oscillations in magnetized plasma.

## Observations of Stagnant Populations of Mixed Magnetosheath – – Plasma Sheet Ions in the High-latitude Near-Earth Tail

*Koleva, R. T.*[1] , Semkova, J. V.[1] , Fedorov, A. O.[2] , Smirnov, V. N.[3]
[1]Solar-Terrestrial Influences Laboratory, Bulgarian Academy of Sciences, Bulgaria,
[2]Centre d'Etude Spatiale des Rayonnements, Toulouse, France,
[3]Space Research Institute, Russian Academy of Sciences, Moscow, Russia

The transport of mass, momentum and energy from the solar wind into the magnetosphere, as well as the role of the ionosphere in populating the near-Earth tail are still not well understood. It is believed that magnetic field reconnection is one of the more dominant processes of solar wind plasma entry. During intervals of southward IMF reconnection occurs at the dayside magnetopause; during northward IMF high-latitude reconnection poleward of the polar cusp strongly influences the magnetospheric configuration. We discuss several cases of spectral and ion composition measurements in the southern high-latitude near-Earth magnetotail ($-2R_E < X_{GSM} < 2R_E$). Analysed are data from the Low Energy Plasma Composition Experiment (AMEI-2) and the CORALL instrument aboard the high-apogee INTERBALL-1 satellite. Used are $He^{++}$ as a tracer of SW plasma and $O^+$ as a tracer of ionospheric plasma. The distribution functions are reconstructed for the full ion flux. Interplanetary conditions are characterised by persistent northward or slightly variable, with substantial (in most cases) By IMF and low SW pressure. This region is very scarcely populated, most probably on open field lines, positioned between the cusp and the near-Earth plasma sheet and projected to different magnetospheric regions downtail. The magnetic field here is very strong - from 60 nT to 200 nT, and electrons exhibit energies typical for the magnetosheath, plasma sheet electrons are absent. Both SW and ionospheric ions are present. Their fluxes exhibit complex structure bearing the history of ions origin and consecutive acceleration. Constituents of both $He^{++}$ and $O^+$ fluxes display similar pitch angle/energy distributions. Even when fluxes look magnetosheath-like, one can trace $O^+$ in them. From spectral point of view we observe two different, well separated types of ion population: i) STAGNANT plasma - isotropic over all pitch angles. We have observed such plasma both with typical plasma sheet energies above 4 keV/q and with lower energy, around 1 keV/q, very similar to the energy of the ions in the adjacent magnetosheath; ii) plasma moving along magnetic field lines, which could be either upgoing from Earth or counter-flowing fluxes. We observe the same mixture of well separated magnetosheath and plasma sheet population further in the southern tail lobe, at $X_{GSM}$ from -14 $R_E$ to -18 $R_E$ in the dusk sector, but the lower-energy population here is drifting across the field lines. Regions of mixed ion population have been observed at different locations in the magnetosphere on Geotail, ISEE and Wind. These observations imply direct access of magnetosheath ions. The peculiarity of our near-Earth observations is that the stagnant lower (magnetosheath-like) energy ion population contains ionospheric $O^+$ ions, though in small quantity.

## Magnetosheath Compression: Role of Compression Speed and Alpha Particles

*Hellinger, P.*
Institute of Atmospheric Physics, AS CR, Prague, Czech Republic

We study an effect of a slow compression on properties of the magnetosheath plasma: on ion betas and temperature anisotropies. To study a plasma under continuos compression we use hybrid expanding box model. The simulated plasma typically follows a marginal stability path. We investigate a role of a speed (characteristic time scale) of the continuos compression and of a presence of alpha particles. We discuss the simulation results and their relevance to the magnetosheath context.

## A Comparison of Shock Normals

Kravaritis, G.[1] , *Walker, S. N.*[1] , Dunlop, M. W.[2] , André, M.[3]
[1]ACSE, University of Sheffield, Sheffield, UK,
[2]SSD, Rutherford Appleton Laboratory, Didcot, Oxfordshire, UK,
[3]Swedish Institute for Space Physics, Uppsala, Sweden

An accurate determination of the quasi-perpendicular bow shock orientation is crucial for the understanding of the physics that occurs within this boundary region. Using data collected by the Cluster spacecraft from a number of days during the first half year of operations this paper analyses the shock normal directions determined using three different methods. The first set of normals are derived using several shock models. The second set are computed using the coplanarity method based on FGM magnetic field data from the individual Cluster satellites. The final set are computed using multi-spacecraft timings of the shock crossing based on measurements of the EFW probe potentials. The normals for each shock are compared and the results are also analysed with respect to the upstream values of $\theta_{Bn}$ and the shock Mach number.

## Comparison of the Predicted Arrival Times at L1 of 209 Flare Associated Shocks Estimated Using Three Numerical Models With Corresponding Energetic Particle Signatures

*McKenna-Lawlor, S.*[1] , Kecskeméty, K.[2] , Dryer, M.[3] , Smith, Z.[3] , Fry, C.[4] , Kudela, K.[5] , Kartalev, M. D.[6] , Sun, W.[7] , Deehr, C.[7]

[1]Space Technology Ireland, National University of Ireland, Maynooth, Co. Kildare, Ireland,
[2]KFKI Research Institute for Particle and Nuclear Physics, Budapest, Hungary,
[3]NOAA Space Environment Center, Boulder, Colorado, 80305, USA,
[4]Exploration Physics International, Inc., Hunstville, Alabama, USA,
[5]Institute for Experimental Physics, Kosice, Slovakia,
[6]Institute of Mechanics, Acad. G. Bontichev, Str. Bolck 4113, Sofia, Bulgaria,
[7]Geophysical Institute, University of Alaska, Fairbanks, Alaska, 99775, USA

The arrival times at L1 of 209 travelling shocks, some associated with halo CMEs recorded by SOHO/LASCO, were predicted in real time using three numerical models, namely The Shock Time of Arrival Model (STOA), The Interplanetary Solar Propagation Model (ISPM) and the Hakamada-Akasofu-Fry Solar Wind Model (HAFv.2). These predictions have already been compared with the measured signatures of shock arrival contained in MAG and SWEPAM ACE data and it was associatively shown, using skill scores, that the models were all generally successful in predicting shock arrivals. It is here demonstrated that Energetic Particle profiles provide an excellent means of detecting IP shock passage under particular conditions and that such data, consequently, constitute a means of validating shock passage predictions that is complementary to those provided by solar wind plasma and by IMF observations. In addition, a statistical analysis of the success of the various models in predicting shock arrival at L1 using the energetic particle records making up the present sample is presented. Further, the energetic particle records are discussed in the context of several shock parameters (such as nB).

## About Formation of Boundary Layer of the Distant Geotail by the Kelvin-Helmholtz Instability

*Mishin, V. V.*
Institute of Solar-Terrestrial Physics Russian Academy of Sciences, Irkutsk, Russia

We do not take into account solar wind turbulization at the bow shock and in the magnetosheath and therefore we consider the plasma flowing around the magnetosphere to be collisionless one. Thus the considerable boundary layer thickness of the distant tail can not be explained without effective development there of a large scale MHD instability. Miura (1990-2000) has shown, that in case of supersonic velocity difference (which is characteristic for the distant tail) the Kelvin-Helmholtz (K-H) instability can not provide necessary turbulent viscosity owing to a small increment. However he did not take into account a role of oblique perturbations (relative to a velocity direction). Their determinant role in the instability of a supersonic tangential discontinuity was marked back in 1954 by Syrovatsky. Mishin and Morozov (1983), Korzhov et al., 1984, and now Mishin, 2003 showed, that at hypersonic shear flows of finite width in the solar wind and at the magnetopause magnetic pressure and density inhomogeneity reduce effective Mach number several times and accordingly abate stabilizing compressibility effect. Thus most unstable are near sound oblique perturbations. Their increment is 2-3 order of magnitude higher than for longitudinal perturbations. It is shown that the diffusion spreading of boundary of geotail flanks the owing to development of the K-H instability on oblique waves provides typical observing width (about 1-2 radii of the Earth) of boundary layers. Inclusion of the K-H instability at the dayside magnetopause or presence of turbulization at the "magnetosperic inlet": at the bow shock or in the magnetosheath can strengthen this mechanism.

## Characteristics of Magnetospherically Reflected Chorus Waves Observed by CLUSTER

*Parrot, M.*[1] , Santolík, O.[2]
[1]LPCE/CNRS, Orleans, France,
[2]Charles University, Faculty of Mathematics and Physics, Praha, Czech Republic

Chorus emissions are often observed by the STAFF spectrum analyser onboard the 4 satellites of the CLUSTER. This instrument provides the cross spectral matrix of three magnetic and two electric field components. Dedicated software processes this spectral matrix in order to determine the propagation characteristic of these chorus waves. Measurements of the parallel component of the Poynting vector around the magnetic equator indicate that the chorus waves propagate away from this region which is considered as the source area of these emissions. This is valid for the most intense waves observed on the magnetic and electric power spectrograms. But it has been also observed that lower intensity waves propagate toward the equator at the same frequency. Using the wave normal directions of these waves, a ray tracing study has shown that the waves have suffered a Lower Hybrid Resonance (LHR) reflection at low altitudes and now return to the equator at a different location with a lower intensity. The paper present other similar events when WBD data are simultaneously recorded. The WBD experiment provides a much better time resolution and allows to check the nature of the returning waves. It is observed that these waves have still a high degree of polarization even if they started to lose the coherent structure of the chorus elements. They reach the equator with a small wave normal angle which is more efficient for a further amplification. It is explained that these emissions could be a source of hiss.

## The Hourly AL Index Model, Based on the Solar Wind Data

*Petrukovich, A. A.*
Space Research Institute, Moscow, Russia

Statistical investigation of the OMNI solar wind data and hourly AL for 1966-1987 proved dependence of the AL index on the solar wind electric field of the reconnection and viscous interaction, in consistency with the model of the open magnetosphere. The original analysis technique helped to reveal also importance of the previous ionosphere state (ionospheric conductivity). The influence of other potential substorm drivers such as magnetic field variations or solar wind dynamic pressure appears to be insignificant. The average AL was found to grow logarithimically correlation coefficient is 0.75-0.8 with the increase of the electric field input and ionospheric conductivity. A simple scheme forecasting hourly AL values based on the solar wind input measured at L1 is proposed. Various methods of implementing ionospheric preconditioning in a real forecast scheme are discussed. The results of the investigation might be also used to adjust the inputs of neural network prediction algorithms.

## Observation of Z Mode on INTERBALL 2 and CLUSTER Projects and Evaluation of the Electron Density Using the Wave Propagation Characteristics

*Rauch, J. L.*[1] , Decreau, P. M.[1] , Trotignon, J. G.[1] , Lefeuvre, F.[1] , Parrot, M.[1] , Canu, P.[2] , Moguilevsky, M.[3] , Burinskaya, T.[3] , Darrouzet, F.[4] , Vallicres, X.[1] , Le Rouzic, G.[1]

[1]LPCE/CNRS, 3A av. de la Recherche Scientifique, 45071 Orleans cedex 02, France,

[2]CETP/CNRS, Universite Versailles Saint-Quentin-en-Yvelines, 10/12 avenue de l'Europe, F-78140, Vélizy, France,

[3]Institute of Space Research, Profsoyuznaya 84/32, 117081, Moscow, Russia,

[4]IASB-BIRA, B-1180 Brussels, Belgium

INTERBALL 2 and CLUSTER tetrahedron cross various regions where the electron density can be low i.e.: the plasma frequency $F_p$ is less than the electron gyrofrequency $F_{ce}$. Electron population is so weak (less 1 particle per $cm^3$) that the determination of the density is often difficult. Both the MEMO and NVK ONCH experiments onboard the auroral probe INTERBALL 2 perform simultaneous VLF waves measurements in the frequency range from 10 Hz to 20 kHz. Analogic NVK ONCH data are continuously recorded for two components: one electric component $E_y$ and one magnetic component $B_x$. MEMO experiment is able to snap up several time intervals with the full waveform of the three magnetic components and two electric components. The Wave of High frequency and Sounder for Probing of Electron density by Relaxation (WHISPER) performs the measurement of the electron density on the four satellites of the CLUSTER project. The two main purposes of the WHISPER experiment are to record the natural waves and to make a diagnostic of the electron density using the sounding technique. The various working modes and the fourier transforms calculated on board provide a good frequency resolution obtained in the bandwidth 2-83 kHz and a well instrumental adaptability to determine the electron density in various plasma. The natural wave recorded by the both projects (INTERBALL 2 and CLUSTER) exhibit various lower and upper cut-off which correspond at local characteristics frequencies of the wave propagation. A careful examination of the natural wave propagation characteristics can give us information about the plasma dispersion. It is well-known that some regions of the frequency/wave number $(\omega, k)$ domain are forbidden to wave propagation. The limits of these forbidden regions depend strongly of the magnetic field and the plasma density. Reflection and absorption processes take place close to these limits and point out the plasma properties. In particular with the condition $F_p < F_{ce}$ the extraordinary wave propagating with $Z$ polarisation become evanescent and has a cut-off frequency below the plasma frequency. Moreover, at highest frequency, it exists at each $F_ce$ harmonic $n$ a forbidden band between Bernstein mode $F_{qn}$ and a frequency cut-off $Fcon$. The value of theses cut-off frequencies is dependent on the plasma frequency. So, the identification of these limits allows us to deduce electron density estimation The waveform data recorded by INTERBALL and the determination of the $F_{pe}$ given by the WHISPER/CLUSTER sounder are used to understand the VLF waves feature. An interpretation is proposed with the aim to determine an estimation of the local electron density using the natural wave.

## Statistical Investigation of Mirror Type Magnetic Field Depressions Observed by ISEE-1

*Tátrallyay, M.*, Erdős, G.
KFKI Research Institute for Particle and Nuclear Physics, Budapest, Hungary

The occurrence of mirror type magnetic field depressions was investigated in the 10 year long data set measured by the magnetometer aboard the ISEE-1 satellite. The individual mirror type magnetic depressions were located by a self-developed numerical algorithm (including minimum variance calculation). The spatial distribution of the selected more than 33 thousand magnetic field dips was statistically examined in a special parabolic coordinate system. The results of the analysis showed that mirror type depressions most frequently occurred in the magnetosheath around the average location of the magnetopause while the frequency of the events did not grow around the bow shock. Depressions observed at the nose of the magnetopause were larger in average than those observed towards the flanks. No significant dawn-dusk asymmetry was revealed in the number of the observed magnetic field dips. These results do not support the idea that the source of the mirror mode instability is at the quasiperpendicular bow shock. The interplanetary field controls the occurence of the field depressions. When the IMF is of southern direction, magnetic dips occur less frequently and closer to the Earth than in case of northern IMF. This result is in connection with the influence of the IMF direction on the location of the magnetopause.

## Magnetic Clouds of Oblate Shapes

*Vandas, M.*[1] , Romashets, E. P.[2] , Watari, S.[3]
[1] Astronomical Institute, Academy of Sciences, Boční II 1401, 141 31 Praha 4, Czech Republic,
[2]Institute of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Russian Academy of Sciences, Troitsk, Moscow Region, 142092, Russia,
[3]Communications Research Laboratory, 4-2-1 Nukui-Kita, Koganei, Tokyo 184-8795, Japan

There is a growing evidence that cross sections of magnetic clouds (interplanetary magnetic flux ropes) have oblate shapes. It follows from theoretical results as well as from interpretation of in-situ measurements. MHD simulations show that a leading part of a cloud, an apex, has an oblate cross section, and even very oblate in some cases. Interpretations of magnetic cloud observations by non-force-free models, multispacecraft observations, and analyses of the cloud bow shock stand-off distance also indicate that a cross section of some magnetic clouds is oblate. Recently we have found a force-free solution with constant alpha in an elliptic cylinder. It is a direct generalization of the widely used Lundquist constant-alpha force-free solution inside a circular cylinder. Comparisons of this solution and the Lundquist solution with observations will be shown.

# Ion Events Observed by WIND far Upstream From the Bow Shock and by Geotail/IMP-8 Near the Bow Shock and Within the Plasma Sheet

Anagnostopoulos, G. C.[1] , Efthymiadis, D.[1] , Sarris, E. T.[1] , *Vassiliadis, E. S.*[1] , Krimigis, S. M.[2]
[1]Space Research Laboratory, Dept. of Electrical and Computer Engineering, University of Thrace, Xanthi, Greece,
[2]Applied Physics Laboratory, Johns Hopkins University, USA

Simultaneous observations among the Geotail, IMP-8, and WIND spacecraft during periods of energetic particle activity studied previously at WIND only (Mason et al, 1998; Desai et al, 2000) are used to resolve ambiguities between the Leakage and Fermi models as the source of such upstream events. Specifically: (1a) Realtivistic electron and CNO flux enhancements were observed at or near the current sheet by IMP-8 and Geotail before detection of ion events rich in heavy ion species by WIND on days 30-31, 1995, (1b) The CNO bursts were observed during times of a CIR strongly disturbing the magnetosphere ($K_p \sim 4 \div 6$). (2a) Both Solar and magnetospheric energetic particles ($O^+$, electrons) were observed near the bow shock by Geotail during the typical WIND event of day 34, 1995. (2b) Hardening of the ion spectrum (inverse energy dispersion) was observed at the onset of event at IMP-8 as long as the IMF was turning from the radial direction to no-radial directions; no clear velocity dispersion was detected by WIND. (2c) Systematic hardening (inverse velocity dispersion) of ion spectra over the whole energy range 0.05 to 1.00 MeV observed by IMP-8 near the bow shock suggests that the same particle distribution dominated the ion responses during the typical WIND event of day 34, 1995. (3) High energy ions were observed by Geotail upstream from the distant dusk bow shock before detection of energetic ions at WIND (days 33-34, 1995); during most times, the field lines had just been connected to the quasi-perpendicular part of the dusk bow shock. These results suggest that the totality of observations from all three spacecraft can help resolve a number of the ambiguities posed by the analysis of the WIND data alone. In general, magentospheric leakage of energetic particles during highly disturbed periods is shown to be a much more likely source of upstream ions than the Fermi acceleration process.

## Dawn-Dusk Asymmetry and Origin of Energetic Ion Events Near the Earth's Bow Shock

Anagnostopoulos, G. C., *Vassiliadis, E. S.*, Karanikola, I.
Space Research Laboratory, Dept. of Electrical and Computer Endineering, University of Thrace, Xanthi, Greece

The origin of upstream ion events has been a controversial issue in space physics community for almost three decades. Despite a large array of studies, there is not a general consensus on the main acceleration site of upstream ions (because several ion features can be explained by competing models). Either Leakage of magnetospheric particles or bow shock acceleration (via a Fermi acceleration process) have been suggested as candidate principal processes producing the upstream ion events. However, under the spiral IMF configuration, most Fermi acceleration models predict highest ion flux near the dawn quasi-parallel bow shock, whereas leakage model predicts highest flux near the dusk magnetopause/(pre-) noon bow shock. For this reason, in this study we examine the occurrence frequency and the intensity of a large number (2034) of 50-220 keV upstream ion events (observed by IMP-8) as a function of local time, $\Theta - B_n$ angle (between the IMF direction and the normal to the bow shock) and geomagnetic index $K_p$; we also examine the relation of energetic ion events with magnetospheric $> 220$ keV electrons. The statistical results suggest that magnetospheric particles is the main source of the upstream ion events examined.

## Properties of the Distribution of the Magnetic Field and Plasma Pressure in the Plasma Sheet of the Magnetosphere of the Earth and the Problem of the Generation of Field-aligned Currents

*Antonova, E. E.*[1] , Kirpichev, I. P.[2] , Stepanova, M. V.[3]
[1]Skobeltsyn Institute of Nuclear Physics Moscow State University, Russia,
[2]IKI Space Research Institute RAS, Moscow, Russia,
[3]Departamento de Fisika, Universidad de Santiago de Chile, Santiago, Chile

Investigations of the magnetospheric pressure distribution and magnetic field configuration give the possibility to select the mechanism of the plasma pressure gradients along flux tube volume isolines as the main mechanism of the generation of large-scale field-aligned Region 1 currents of Iijima and Potemra. The arguments in the support of this concept are summarized. The configuration of the flux tube volume isolines in the equatorial plane at different IMF conditions is analyzed. It is shown that when IMF $B_z < 0$ closed contours of flux tube volume isolines ("islands" of large flux tube volume values) can be formed. The nature of the medium-scale field-aligned currents is discussed. It is shown that the observed features of the plasma pressure distribution can be considered as the sources of medium-scale field-aligned currents.

## Nonlinear Wave Processes Seen in the Polar Cusp by Prognoz 8, Interball 1 and CLUSTER Satellites

*Bleçki, J. S.*[1] , Savin, S. P.[2] , Parrot, M.[3] , Cornilleau-Wehrlin, N.[4] , Wronowski, R.[1]
[1]Space Research Centre PAS, Warsaw, Poland,
[2]Space Research Institute RAS, Moscow, Russia,
[3]LPCE/CNRS, Orleans, France,
[4]CETP/CNRS/, Vélizy, France

The electric and magnetic fields measurements performed onboard of high orbiting satellites show that the polar cusp is the site of the intensive turbulence. This turbulence plays important role in the transfer energy processes in this region of the magnetosphere. To study the processes of the energy transfer between different modes bispectral and wavelet analysis are used. The results showing the cascade of turbulence and wave–wave interactions will be presented in this discussion.

## Magnetic Cloud and Magnetosphere-Ionosphere Response to the 6 November 1997 CME

*Bochev, A. Z.*[1] , Dimitrova, I. I.[2]
[1]Solar-Terrestrial Influences Laboratory-BAS, Sofia, Bulgaria,
[2]Space Research Institute-BAS, Sofia, Bulgaria

In the present work we analyse the magnetic cloud (MC) at 1 AU on 9 November 1997. The appearance of a hotter and dense part (dense filament), with radial extent $10^6$ km, immediately behind the frontal part of the MC, is a distinctive feature of the event. The INTERBALL - Auroral Probe had a chance to observe field-aligned currents in the mid - altitude magnetosphere during the substorm expansion phase intensification related to the dense filament. We emphasise the appearance of unusual "N"- shape magnetic structure, duration 3 min, amplitude 50 nT between field-aligned current region 1 and the magnetosphere lobe in the late evening hours. Poynting vector flux estimation shows that its magnitude could presumably exceed the Joule heating rate in the ionosphere. Our finding is comparable with the POLAR satellite observations, occurred in close temporal proximity to substorm onset (Keiling et al., 2000). So that the "N"-shape may be a result of a significant amount of wave energy transfer towards the ionosphere. To explain some of the MC features we refer to a model scenario of the 6 November 1997 coronal mass ejection.

## Long Period Magnetic Field Variations Seen by the INTERBALL-AU and POLAR: Case Study

*Bochev, A. Z.*[1] , Dimitrova, I. I.[2] , Nenovski, P. I.[3] , Chi, P.[4] , Palazov, K. I.[5]
[1]Solar-Terrestrial Influences Laboratory-BAS, 1113 Sofia, Bulgaria,
[2]Space Research Institute-BAS, 1113, Sofia, Bulgaria,
[3]Geophysical Institute-BAS, 1113 Sofia, Bulgaria,
[4]Space Science Center, Institute of Geophysics and Planetary Physics, UCLA, U.S.A.,
[5]Solar-Terrestrial Influences Laboratory-BAS, Stara Zagora Depertment, Stara Zagora, Bulgaria

In this work we analyze long period perpendicular magnetic field disturbances/Pc5 pulsations in the north mid-high altitude magnetosphere, seen by the INTERBALL-Auroral and POLAR. We have shown unusual features of these signals: azimuthal oscillations are common as oscillations in the magnetic meridian; the 90-degree rotation of the perpendicular magnetic variation between both spacecrafts during conjunction condition and superposition of transverse variation with large-scale field-aligned currents.

## Attitude Determination for Magion-5 Satellite Using Magnetometer Data Only

*Comisel, H.*[1] , Ciobanu, M.[1] , Blagau, A.[1] , Šimůnek, J.[2] , Chum, J.[2]
[1]Institute for Space Sciences, Bucharest, Romania,
[2]Institute of Atmospheric Physics, Prague, Czech Republic

The attitude of a spin-stabilized satellite has been restituted from dynamical calculations using only three axes measurements of the Earth magnetic field vector. Magion-5 as a small subsatellite with 65 degrees inclination orbit and a perigee of 20000 Km, was intended for carrying out simultaneously measurements with the Auroral Probe main satellite,in the framework of Interball project. In this work we have developed a batch numerical filter to search for the best-fit state parameters and to solve for the solutions of the dynamical and kinematic equations of motion for the satellite in it's own reference system. An overall estimation for the effects of solar pressure, gravity, and magnetic disturbance torques as well as the internal passive stabilization torque has been done. These disturbance effects have been related to the torque-free attitude solutions of a nutating spacecraft. Numerical integration methods based on ordinary differential equations techniques have been tested for the truncation errors and also for their stability in the attitude minimization algorithm. Using the IGRF-95 model of the Earth's magnetic field, an iterative calibration procedure for the measured data was also developed in order to reduce the magnetometer systematical errors. The method was successfully applied for numerously orbits of Magion-5 satellite. The 3-axis attitude errors are estimated to be below 5 degrees (as a worst case). Accurated estimates of the attitude errors have been determined for the two Euler angles derived from calibrated magnetic field data. The third one was compared to the values approximated from processing the solar panel's currents.

## Magnetic Field Structure in the Dayside Magnetosheath

Kaymaz, Z.[1] , *Sibeck, D. G.*[2] , Siscoe, G. L.[3]
[1]Istanbul Technical University, Faculty of Aeronautics and Astronautics, Maslak, 80626, Istanbul, Turkey,
[2]NASA/GSFC, Greenbelt, 20771, MD USA,
[3]Boston University, Center for Sapce Physics, Boston, 02215, MA USA

Using three years of Interball magnetic field measurements, we map the magnetic field geometry of the dayside magnetosheath. We bin the data for different interplanetary magnetic field orientation and solar wind conditions. IMP-8 spacecraft in the nightside magnetosphere revealed that the magnetosphere is dynamically active along the flanks and the magnetospheric sash extends into the high latitudes of the dayside magnetopause (Kaymaz et al., 1992; Kaymaz and Siscoe, 1998; White et al., 1998). Here we search for the similar signatures in the dayside magnetosheath field maps, and especially to see the magnetic field geometry around the cusp region by taking the advantage of Interball's highly inclined orbital features. Results will also be compared with IRM model results, which show agreements with the IMP-8 mapping of nightside magnetosphere.

## DOK-2 Ion Fluxes Upstream From the Bow Shock: Characteristics From 5 Years of INTERBALL-1 Measurements

*Kudela, K.*[1] , Lutsenko, V. N.[2] , Sarris, E. T.[3] , Sibeck, D. G.[4] , Slivka, M.[1]
[1]Institute of Experimental Physics, Slovak Acad. Sci., Watsonova 47, 04353 Kosice, Slovakia,
[2]Space Res. Institute, Russian Acad. Sci., Moscow, Russia,
[3]Demokritos U. of Thrace, Xanthi, Greece,
[4]Laboratory for Extraterrestrial Physics, NASA/GSFC, Greenbelt, MD, 20771, USA

The energetic ion spectrometer DOK-2 on Interball-1 provided energetic ($\sim$ 20 to $\sim$ 600 keV) ion fluxes and spectra for various geomagnetic and interplanetary conditions during the spacecraft's 5 year mission. From April to July in 1996-2000, the spacecraft's apogee lay upstream from the dayside bow shock. We present observations of the diffusive ion flux in the upstream region as a function of energy, magnetic field connection and distance to the position of a model bow shock, solar wind velocity and density, and geomagnetic activity. Measurements by both ion detectors combined into 14 energy ranges are used for the analysis. Although fluxes of ions with energies up to $\sim$ 100 keV depend primarily upon the geometry of the connection to the bow shock, the dependence of fluxes on geomagnetic activity, indicating the important contribution of particles leaking the magnetosphere, increases with the energy. In addition, a review of available data of DOK-2 for the whole interval covered and the way to access them for other studies is listed.

## A Neutral Atom Detector Experiment (NUADU) for the Chinese Double Star Polar Mission

*McKenna-Lawlor, S.*[1] , Balaz, J.[1] , Barabash, S.[2] , Johnsson, K.[2] , Zhenxing, L.[3] , Li, L.[3] , Jin-Bin, C.[3] , Chao, S.[3] , Roelof, E. C.[4] , Brandt, P. C.[4] , Kudela, K.[5]

[1]Space Technology Ireland, National University of Ireland at Maynooth, Co. Kildare, Ireland,
[2]Swedish Institute of Space Physics, Kiruna, Sweden,
[3]Center for Space Science and Applied Research of the Chinese Academy of Sciences, Beijing, China,
[4] Applied Physics Laboratory, Johns Hopkins University, Maryland, USA,
[5]Institute of Experimental Physics, Kosice, Slovakia

Double Star, the first mission to be launched by China to explore the Earth's magnetosphere, will comprise two spacecraft flying in complementary orbits around the Earth. An equatorial spacecraft (DSP-1) is scheduled for launch (December, 2003) into an elliptical orbit ($550 \times 66,970$ km) inclined at 28.50° to the Earth's equator. A polar spacecraft (DSP-2) is scheduled for launch in June 2004 and it will execute a $700 \times 39,000$ km orbit around the Earth at an inclination of 90°. The present paper describes in detail the NUADU (NeUtral Atom Detection Unit)instrument, which is designed to monitor energetic neutral atoms (ENAs)in the Earth's magnetosphere aboard DSP-2. A key objective of this experiment is to perform energetic neutral atom (ENA) imaging of the Earth's Ring Current. The dynamics of the Ring Current define, to a large extent, those space weather conditions that affect technological systems on the Earth and in space. Therefore, Ring Current studies constitute a key element in space weather research. It is anticipated that DSP-2 will operate contemporaneously with the European Space Agency's CLUSTER II Mission, as well as with NASA's IMAGE and TWINS spacecraft, which also feature imaging experiments. By appropriately combining the NUADU records with these multi-point measurements, significant advances in our understanding of the near space plasma can be anticipated. For example, the strength and importance of the electric fields at the inner edge of the Ring Current has only recently been appreciated. Multi-point imaging can monitor the effects on the plasma pressure distribution of these global electric fields. Single point measurements do not provide the coverage required to build a coherent picture of the dynamics of these fields, which now are recognized to be germane in respect of opening up our understanding of the dynamics of the inner magnetosphere as well as of the complexities of M-I coupling.

# Magnetospheric Response in Long Period Geomagnetic Pulsations Under Magnetopause Multiple Crossings Conditions Observed by Interball Tail

*Mishin, V. V.*[1] , Leonovich, A. S.[1] , Nikolaeva, N. S.[2] , Parkhomov, V. A.[3] ,
Soloviev, S. I.[4] , Vaisberg, O. L.[2]
[1]Institute of Solar-Terrestrial Physics, RAS, Irkutsk, Russia,
[2]Space Researh Institute, RAS, Moscow, Russia,
[3]Baikal State University of Economy and Law, Irkutsk, Russia,
[4]Institute of Cosmophysical Research and Aeronomy, Yakutsk, Russia

The properties of long period geomagnetic pulsations observed while Interball Tail recorded multiple crossings on April 13, 1996 (Dempsey et al., 1999) are investigated. The main peculiarities of these pulsations are: 1. ULF wave activities in the Pc5 range are observed in various MLT sectors. Excitation of pulsations does not have clear relationship to the irregular magnetopause crossings. We did not found dependence of pulsations' period on magnetospheric radius, that is characteristic of global pulsations excited by impulses of the solar wind pressure (Mishin et al., 2003). Therefore pulsations under consideration are not the global compressional oscillations. 2. In the evening sector of magnetosphere (18 - 21 MLT) we observed distinct Pc5 pulsations, moving to the East with velocity ∼20 degrees/min and to the North with velocity 3 degrees/min. These pulsations do not change direction of polarisation. These pulsations are not resonant pulsations. 3. The possible mechanism of propagation of non-stationary magnetosonic oscillations from the magnetopause to the Earth is considered. The delay between observations of pulsations between southern and northern ground stations can be explained as follows. The waves propagate in magnetosonic mode in the equatorial channel (Leonovich and Mazur, 1999) and subsequently propagate in Alfvenic mode along geomagnetic field line. It appears that the propagation time of waves increases with magnetic latitude within magnetic shells between magnetopause and plasmapause. As a result, the waves are observed on southern ground stations before they are observed on northern ground stations. The observed eastward motion of pulsations in afternoon sector is explained by tailward drift of oscillations of a magnetopause by the solar wind.

## Local Amplification of Auroral Electrojet as Response to Sharp Solar Wind Dynamic Pressure Change on June 26, 1998

Parkhomov, V. A.[1] , Riazantseva, M. O.[2] , *Zastenker, G. N.*[2]
[1]Baikal State University of Economy and Law, Irkutsk, Russia,
[2]Space Research Institute, Russian Academy of Sciences, Moscow, Russia

Local amplification of auroral electrojet is observed on June 26, 1998 in narrow sector (01-03 hours of magnetic local time) without time delay as response to sharp (during 1-3 min) and large (~10 nPa) changes (increase and decrease) of solar wind dynamic pressure under positive IMF $B_z$-component ($B_z > 0$). The main peculiarities of this event are following: 1. Geomagnetic effects of the DCF current are observed in all MLT sectors (with the exception of narrow sector 23 - 03 MLT) from the polar cap to the equator. 2. Amplification of the west electrojet is observed during 3 hours on the observatory Cape Shmidt. In post midnight sector the electrojet amplification continued for about 20 minutes. 3. During this time the Polar satellite registered the motion of auroral forms from noon dawnward and duskward. Nature of these phenomena is discussed in the report.

## Vertical Plasma Motions and Velocity Fluctuations in the Earth's Magnetotail: Interball-tail Observations

*Petrukovich, A. A.*, Yermolaev, Y. I.
IKI RAS, Moscow, Russia

The Interball spacecraft configuration favors, in contrast to previous experiments, investigation of vertical ion flows (GSM $V_z$). We use measurements of the CORALL instrument for the statistical study of $V_z$ and $V_y$ plasma flows in the mid-tail plasma sheet. In agreement with the previous observations, the mean $V_y$ was positive on the dusk side and negative on the dawn side. When IMF was southward, the mean $V_z$ consisted of the convection flow towards the equatorial plane $\sim$ 7 km/s and the northward flow $\sim$ 8 km/s. When IMF was northward, both components nearly vanished. The velocity variance was much larger than the mean values. The $V_z$ variance maximized on the dawn flank and was always 15-20% smaller than the $V_y$ one. The $V_y$ variance maximized in the pre-midnight sector closer to the neutral sheet. We conclude that velocity fluctuations are composed with the inherent high-beta plasma turbulence contributing to all components, and the BBF-related activity contributing mainly to $V_y$ in the pre-midnight plasma sheet.

## Characteristics and Prediction of Ionospheric Phenomena Behind Ground Effects of Space Weather During the April 2000 Geomagnetic Storm

*Pulkkinen, A.*[1] , Vassiliadis, D.[2] , Weigel, R.[3] , Palmroth, M.[1] , Viljanen, A.[1] , Pirjola, R.[1]
[1]Finnish Meteorological Institute, Finland,
[2]NASA Goddard Space Flight Center, USA,
[3]University of Colorado, USA

Geomagnetically induced currents (GIC) flowing in technological systems on the ground are a direct manifestation of the ground effects of space weather. Due to the proximity of very dynamic ionospheric current systems, GIC are of special importance at high latitudes. In this study, GIC-related characteristics of the geomagnetic storm on April 6-7, 2000, are investigated using geomagnetic data from over 100 magnetometer stations. Different types of current systems were found to cause significant GIC, for example, a sudden storm commencement, intensifications of large-scale electrojets, pulsations, and vortices. In general, the character of GIC events was twofold. On one hand, large GIC can be observed at the same time instant throughout the entire auroral region. On the other hand, spatial and temporal scales related to these events are rather small making the detailed behavior of individual GIC relatively local. In this work the quality and applicability of ground magnetic field perturbation predictions produced by three different state-of-the-art modelling tools are also evaluated. It was found that although the general behaviour of the geomagnetic activity was captured to some extent by the methods, the quality of the predictions was not sufficient for reliable GIC forecasts.

## Behaviour of the Auroral Activity as Function of the Interplanetary Magnetic Field Orientation

*Reshetnyk, V. M.*
Kyiv National Shevchenko University, Kyiv, Ukraine

Variations of polar flux in northern and southern hemispheres are analyzed as a function of interplanetary magnetic field orientation near the Earth. The period since 1978 till 2001 was covered. It is shown that polar flux increases when magnetic field has $B_z < 0$ and $B_y < 0$, and with increasing of the magnitude of the interplanetary magnetic field. We obtained the regular asymmetry of the precipitation: a flux in the Southern Hemisphere is less then in the Northern Hemisphere. The seasonal variations of auroral precipitation intensity are observed too: auroral activity is in maximum near the equinoxes and minimum near the solstices. The similar analysis was provided for auroral image obtained from OVATION base. Result is similar to polar flux in polar region. We obtained the mean auroral pattern for different heliospheric conditions near the Earth. We also produced behaviour of the midnight and midday, morning and evening sectors as a function of the interplanetary magnetic field orientation. It was obtained the behaviour of the auroral activity with IMF in heliocentric system.

## Three-dimensional CLUSTER Observations of Continuous High Latitude Reconnection on the Duskside Magnetopause

*Retino, A.*[1] , Bavassano - Cattaneo, M. B.[2] , Marcucci, M. F.[2] , Vaivads, A.[1] , André, M.[1] , Pallocchia, G.[2] , Khotyaintsev, Y.[1] , Rème, H.[3] , Moebius, E.[4] , Klecker, B.[5] , Carlson, C.[6] , McCarthy, M.[7] , Korth, A.[8] , Lundin, R.[9] , Balogh, A.[10]

[1]IRF-U, Uppsala, Sweden,
[2]IFSI, Rome, Italy,
[3]CESR, Toulouse, France,
[4]University of New Hampshire, Durham, NH, USA,
[5]MPE, Garching, Germany,
[6]University of California, Berkeley, CA, USA,
[7]University of Washington, Seattle, WA, USA,
[8]MPAe, Lindau, Germany,
[9]SISP, Kiruna, Sweden,
[10]Imperial College, London, UK

We report CLUSTER observations of accelerated ion flows either in the antisunward-duskward-southward or in the sunward-dawnward-northward direction under mainly northward interplanetary magnetic field near the duskside high latitude magnetopause. The accelerated flows are due to high latitude reconnection occurring tailward of the cusp, the reconnection site being consistent with the observed interplanetary magnetic field conditions ($B_x > 0$, $B_z > 0$). Convincing evidence that these flows are caused by reconnection at the magnetopause is obtained from the tangential stress balance test and from the presence of "D-shaped" distribution functions of magnetosheath ions transmitted across the magnetopause. The jets are recorded by the spacecraft during about four hours suggesting that reconnection occurs continuously during that time. The accelerated flow directions during four hours suggest the existence of a rather stable and close X-line. During this time there is a change in the interplanetary magnetic field $B_y$ direction that changes the magnetopause configuration from low-shear to high-shear. The change in the magnetic shear seems not to affect the position of the X-line which is in agreement more with component merging rather than antiparallel one. The sub-Alfvenic flow observed throughout all the event in the magnetosheath next to the magnetopause, possibly due to the presence of a plasma depletion layer, is consistent with a stable X-line moving in a limited region over the magnetopause. Finally the flow reversals observed by SC/3 on a time scale of a few minutes suggest some passages of this spacecraft close to the ion diffusion region. We present results of a detailed study for one such event.

# P/Halley Ionosphere and Spatial Distribution of Some Constituents

*Stoeva, P. V.*, Werner, R., Guineva, V. C.
Central Solar-Terrestrial Influences Laboratory, Bulgarian Academy of Sciences, Stara Zagora District, Bulgaria

Cometary ion composition in the coma is of great importance for determining the original composition of the nucleus. A lot of spectroscopic measurements of ions were made during the last three decades. The comparative analysis of onboard measurements obtained during VEGA 1 and 2, Giotto and Suisey encounters with P/Halley shows that it is worth to continue investigations and clear up the conclusions especially in small scale where a lot of discrepancies appear. Two-dimensional composed (Stoeva et al., 2003) images of the inner coma on the sunward side derived from data obtained by the Three-Channel Spectrometer on board VEGA 2 show the spatial distribution of P/Halley ions at the time of its last apparition in March 1986. The $H_2O^+$, $CO_2^+$ and $OH^+$ from the heavy ions group have been investigated in details and the $OH$ and $NH$ radicals are studied for comparison. The integral intensities in kR are plotted versus the projected distance to the nucleus. All the composed images show a jet-like or peaked structure. An increasing of the integral intensity at about 11000 km from the nucleus - specific to conditions existing in comet Halley at the time of encounter with Space stations (K. Swami, 1997) is also observed. Radial profiles of $H_2O^+$, $CO_2^+$ and $OH^+$ ions are very similar. The intensity at distances up to ~8000 km slowly decreases. At distances greater than 10000km, in the collision dominated region a 1/p dependence approximately fits the data. Iion(p) dependence can be compared with that obtained by Giotto HIS (High Intensity Spectrometer) data (Balsiger et al., 1986). Most of the information regarding $H_2O^+$ is expected to come out of its spatial distribution (Fink, 1986). In the composed image, $H_2O^+$ ion (9 March 1986) forms peak at the nucleus and two jets - one to the Sun and the other perpendicular to it - like neutrals do. $H_2O^+$ ion has the strongest emission in comparison with the other ions - about 2000 kR. The monochromatic composed image of the $CO_2^+$ ion has a peaked structure and a jet-like distribution along the diagonal of the image. It is well outlined that maximal intensities are displaced from the nucleus towards the Sun. This may be due to the destruction of $CO_2^+$ ions by reactions with neutral molecules (mainly $H_2O$) in the inner coma (Huebner and Giguere, 1980). The $OH^+$ ion and the $NH$ radical are examined simultaneously in order to distinguish the emissions, which have very similar spectral structure. $OH^+$ ionosphere of the Halley comet is with peaked structure. The comparison with NH image shows that the spatial distributions are different and the intensities of $NH$ are higher. The composed image of $OH$ radical - the supposed main parent of $OH^+$ - shows that its distribution is rather uniform than that of the $OH^+$ ion. Results of this work can contribute to the understanding of processes in the inner coma, or improving the models of Solar wind - comet interaction in small scale.

## Anisotropy of Proton Fluxes in Neutral Sheet Region Measured by the DOK-2 on INTERBALL-1

*Slivka, M.*, Kudela, K.
Institute of Experimental Physics, Slovak Academy of Sciences, Košice, Slovakia

Anisotropy of proton fluxes measured by DOK-2 spectrometer on Interball-1 in energy range between 20 and 40 keV in the time of four satellite crossings on December 3, 1996, November 28, 1997, November 19, 1998 and December 5, 1998 are discussed. The bipolar proton fluxes structure was observed in all investigated energy range interval. All studied events were measured in the time of quiet geomagnetic field with predominate $B_x$ component and in the time of growth phase of small geomagnetic substorm, when the Interball-1 satellite was situated in plasma sheet region and crossed neutral line in distance about 26 $R_E$ in both earthward and tailward directions. Changes of proton energy spectra in the time of these crossings were observed too. These facts where compared with prediction of NENL model of substorm, which expect the neutral line generation folowing by the reconnection of magnetic field lines.

## Cusp as a Source of Upstream Energetic Ions

*Chen, J.*, Fritz, T. A.
Center for Space Physics, Boston University, 725 Commonwealth Avenue, Boston, MA 02215 USA

On June 28, 1999, the WIND spacecraft (near L1) observed a sudden increase (by more than one order of magnitude) of the solar wind pressure at about 4:45 UT and an upstream ion event at 5:23-5:45 UT, the INTERBALL-1 spacecraft located upstream of the bow shock (X=22.4 $R_E$, Y=-15.7 $R_E$, Z=6.25 $R_E$ in GSE) measured an upstream ion event from 5:16 UT to 6:00 UT, while the POLAR satellite at 7 hours magnetic local time detected an energetic particle event in the high-altitude region associated with turbulent diamagnetic cavities from 5:12 UT to 6:30 UT, which is unexpected by current MHD models for a duskward IMF. Energetic oxygen ions of both ionospheric origin and solar wind origin were observed by the POLAR during this event period. The energetic ions (up to 4 MeV) and the associated turbulent magnetic field are very similar to what found in the high-altitude dayside cusp region. Bow shock is not the main source of energetic ions in upsteam event since their intensities are independent of the bow shock geometry, solar wind velocity and pressure. The similar shapes of ion energy spectra between upstream and cusp suggest a same energization process. Turbulent cusp electrical field with an amplitude up to 120 mV/m was observed. A resonant acceleration mechanism is suggested. The event onset was first detected in the cusp, then near the bow shock, and then in far upstream, suggesting that these upstream energetic ions most likely came from the cusp.

## Acceleration and Transport of Magnetospheric Plasmas by ULF Waves

*Chen, L.*
Department of Physics & Astronomy, University of California, Irvine, CA 92697-4575, USA

A self-consistent kinetic theory of acceleration and transport of magnetospheric plasmas by ultra-low-frequency (ULF) waves has been developed based on the nonlinear gyrokinetic equations. The present theory, allowing realistic magnetic field geometries, arbitrary wave polarizations, and finite Larmor radii, is thus very general and should have wide applications in magnetospheres where wave-particle interactions are important. As an example, wave-induced particle transport coefficients across the dayside magnetopause will be discussed. (Work supported by US DOE and NSF Grants.)

## Basic Theory for a Magnetospheric Substorm

*Calvert, W.*
Kirkwood Community College, Cedar Rapids, Iowa, USA

A substorm is found to be produced the onset and latitudinal expansion of the incoming electron precipitation that produces the aurora during a substorm, where the resulting current causes the accompanying dipolarization of the Earth's magnetic field. This theory, which is referred to as the precipitation model, thereby explains the basic features of a substorm and predicts that the incoming electron precipitation during a substorm must be the basic cause of a magnetospheric substorm. The details of this theory and its relevance to magnetospheric measurements will be described.

## Energy Coupling to Solar Wind Pressure Pulses in MHD Simulations

*Lopez, R. E.*[1] , Wiltberger, M.[2] , Hernanadez, S.[1] , Lyon, J.[3]
[1]Dept. of Physics, University of Texas at El Paso, El Paso, TX, USA,
[2]NCAR/HAO, Boulder , CO, USA,
[3]Dept. of Physics, Dartmouth College, Hannover, NH

Using 3-D MHD simulations of the magnetosphere, we have run several test cases to investigate the effects of dynamic pressure variations on energy coupling between the solar wind and the Earth's magnetosphere. For low values of southward interplanetary magnetic field (5 nT) the dissipation of solar wind energy due to joule heating, the polar cap potential, and the magnitude of field-aligned currents is insensitive to differences in solar wind dynamic pressure. However, when the IMF is strongly southward (10 nT or greater), all of these quantities depend significantly on solar wind dynamic pressure. We will also present examples of density pulses in the solar wind and show that such pulses increase the reconnection rate, which we are able to directly determine by calculating the value of the potential along the open-closed field line boundary.

## Ion Transport Through the Turbulent Magnetopause: Calculations of the Distribution Function Moments

*Greco, A.*[1] , Taktakishvili, A.[2] , Zimbardo, G.[1] , Veltri, P.[1] , Zelenyi, L. M.[3]
[1]Dipartimento di Fisica, Universita' della Calabria, Italy,
[2]Center for Plasma Astrophysics, Abastumani Observatory, Georgia,
[3]Space Research Institute, Moscow, Russia

A numerical study of magnetosheath ion motion in the magnetopause current sheet in the presence of magnetic fluctuations is reported. Test particles are injected at the magnetosheath side only. The magnetic field turbulence is modelled as a power law spectrum in phase space, which reaches maximum intensity in the center of the magnetopause current sheet, and decreases towards the magnetosheath and magnetosphere boundaries, creating magnetic islands. The number of particles entering the magnetosphere, reflected from the magnetopause and flowing away from the flanks is computed, as a function of the fluctuation level of the turbulence and of the magnetic field shear parameter. All those quantities appear to be strongly dependent on the fluctuation level, with the number of particles entering the magnetopause increasing with the fluctuation level. We calculate particle density, bulk velocity in the three directions and temperature. It appears that temperature and bulk velocity are increasing in the direction normal to the magnetopause, while density is decreasing, in a qualitative accordance with the observations. We also study the influence of variable injected ion flux velocity on the moments of particle distribution function.

## Source Positions for Energetic Particles Responsible for the Fine Dispersion Structures: Numerical Simulation Results

*Lutsenko, V. N.*[1] , Kirpichev, I. P.[1] , Grechko, T. V.[1] , Delcourt, D. C.[2]
[1]Space Research Institute RAS, Moscow, Russia,
[2]Centre d'Etude des Environnements Terrestre et Planetaires, Vélizy, France

More than 400 events with fine dispersion structures (FDS) in energetic particle spectra were observed in DOK-2 experiments on Interball-1 and -2 spacecrafts in auroral regions. The discovery of these structures appeared possible due to recordly high energy resolution of the spectrometer used. We showed earlier that these structures are result of gradient-curvature drift of ion and electrons after their pulse injection (acceleration) in the night side of the magnetosphere. The analysis of dispersion structures allowed to find the injection time with the accuracy of 10 s. In this work we studied possibilities of numerical backward particle motion simulation to find source positions for two FDS events. The results are compared with other spacecrafts and ground stations observations.

## Electromagnetic Ion Cyclotron Waves and Magnetosonic Waves Observed by the CLUSTER Satellites Within the Plasmasphere

*Marouan, Y.*[1] , Lefeuvre, F.[1] , Cornilleau-Wehrlin, N.[2]
[1]LPCE/CNRS, 3 A Av de la Recherche Scientifique 45071 Orleans cedex 2, France,
[2]CETP/UVSQ, 10-12 Av de l'Europe, 78140, Vélizy, France

Electromagnetic Ion Cyclotron waves (EMIC) and Magnetosononic waves (MSW) observed in the equatorial regions of the plasmasphere by the four CLUSTER satellites are studied in the objective to improve wave models used in physical radiation-belt models. Data analyses are performed on each satellite. They include the production of power spectrograms of the magnetic wave fields and the estimation of propagation characteristics (degree of polarisation, sense of polarisation, wave normal direction, ellipticity). Several characteristics of prime importance for the development of wave models are pointed out. They concern : the lower cut-off frequencies of MSW and EMIC waves, the evolutions of the harmonic structure of MSW waves in the course of the propagation towards lower L values, the localisation and the amplitude of the R mode waves that may interact with energetic electrons, and the distribution in K vectors of these emissions. Comparisons are made with results obtained from the GEOS, CRRES and AKEBONO satellites.

## Near-Source and Remote Observations of Kilometric Continuum Radiation From Multi-spacecraft Observations

*Menietti, J. D.*, Anderson, R. R., Pickett, J. S., Gurnett, D. A.
Dept. of Physics and Astronomy, University of Iowa, Iowa City, Iowa, USA

Kilometric continuum (KC) radiation was first identified from Geotail plasma wave observations. Past authors have shown that this emission has a frequency range that overlaps that of the auroral kilometric radiation (AKR), but is characterized by a fine structure of narrow-bandwidth, linear features that have nearly constant or drifting frequency. This fine structure is distinct from AKR. KC also apparently has a distinct source region probably associated with the low-latitude inner magnetosphere, consistent with direction finding and ray tracing results. We present new observations of KC obtained by the Polar and Cluster plasma wave instruments in the near-source region. These observations show intense electrostatic and less intense electromagnetic emissions near the magnetic equator at the plasmapause. Simultaneously, Geotail, located at 20 to 30 $R_E$ in radial distance, observes KC in the same frequency range. These data support a possible mode-conversion source mechanism near a region of high density gradient. High resolution data obtained from wideband receivers on board both Polar and Cluster show closely-spaced bands of emission near the magnetic equator that may be due to many nearby independent sources of EM emission perhaps associated with density fluctuations or cavities in the plasmasphere.

## Three Decades of Bow Shock Observations by IMP-8 and Model Predictions

*Měrka, J.*[1,2] , Szabo, A.[1] , Richardson, J. D.[3] , Narock, T. W.[4]
[1]NASA Goddard Space Flight Center, Laboratory for Extraterrestrial Physics, Greenbelt, Maryland, USA,
[2]On leave from Charles University, Faculty of Mathematics and Physics, Praha, Czech Republic,
[3]MIT, Center for Space Research, Cambridge, Massachusetts, USA,
[4]L-3 Communications Analytics Corporation at NASA/GSFC, Laboratory for Extraterrestrial Physics, Greenbelt, Maryland, USA

During almost three decades of operation, the IMP-8 satellite collected an extensive amount of both plasma and magnetic field measurements. The entire dataset has been searched for all Earth's bow shock crossings observed by IMP-8. For most of these crossings, complete upstream interplanetary magnetic field and solar wind parameters, measured by the same spacecraft, were recorded in order to test empirical models predicting the bow shock position as a function of upstream parameters. We will compare the observed bow shock locations with those predicted by various models and discuss the models' accuracy and their validity under extreme IMF and solar wind conditions. Furthermore, we will address the issue of possible long-term effects, for example the solar cycle dependency, on the Earth's bow shock.

## Magnetopause Dynamics Modelling

*Romashets, E. P.*[1] , Vandas, M.[2] , Nagatsuma, T.[3]
[1]Institute of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation of Academy of Sciences, Troitsk, Russia,
[2]Astronomical Institute, Academy of Sciences, Praha, Czech Republic,
[3]Communication Research Laboratory, Tokyo, Japan

There are many reliable phenomenological and theoretical methods to model conditions on outer and inner sides of magnetopause during quiet and disturbed periods. We present here, in this paper, an approximate analytical description of magnetic field distribution between a bow shock and magnetopause, and on the inner side of magnetopause. The approach is the following: (i) the field near the Earth's surface, $R = R_E$, is equal to one of inclined dipole located at the center, $R = 0$; (ii) on magnetopause the normal component of $B = \mathrm{curl} A$ is zero; (iii) on the bow shock the normal component is continuous. The solution obtained in coordinates of paraboloid of rotation is a function of dipole orientation and of distance to the bow shock, which, in turn, is determined by solar wind parameters.

## Reconstructions of the Magnetotail Current Sheet Structure Using Four-point Cluster Measurements

*Runov, A.*[1] , Sergeev, V. A.[2] , Nakamura, R.[1] , Baumjohann, W.[1] , Volwerk, M.[1] , Vörös, Z.[1] , Asano, Y.[1] , Zhang, T.[1] , Balogh, A.[3] , Rème, H.[4]
[1]Institut für Weltraumforschung der ÖAW, Graz, Austria,
[2]Institute of Physics, St. Petersburg State University, St. Petersburg, Russia,
[3]Imperial College, London, UK,
[4]CESR/CNRS, Toulouse, France

During the 2001 tail-season Cluster's apogee (of 19 $R_E$) traversed the magnetotail from the post-midnight to the pre-midnight sector. The average distance between the Cluster tetrahedron barycentre and the nodes of the tetrahedron was greater than 500 km, and the maximum interspacecraft separation was approximately 1800 km. These values give the range of spatial structure scales which may be resolved using four-point measurements. A reconstruction of the current sheet spatial structure, including a current density profile, performed by application of linear gradient/curl estimator technique for intervals of repeating fast neutral sheet crossings. In this paper we discuss the current sheet structure for a few selected intervals of fast intensive vertical motion of the sheet (flapping), during which Cluster repeatedly crosses the neutral sheet. The magnetic field curl, curvature, gradient scales are investigated. We found examples of thin current sheet, (half-thickness of 1000 km) wiht current density maximum in the center ($B_x = 0$), as well as examples of off-center or bifurcated current sheets.

## Fine Structure of the Source Region of Storm-time Chorus

*Santolík, O.*[1,2] , Gurnett, D. A.[2] , Pickett, J. S.[2]
[1]Charles University, Faculty of Mathematics and Physics, Praha, Czech Republic,
[2]Dept. of Physics and Astronomy, University of Iowa, Iowa City, Iowa, USA

We investigate the fine structure of storm-time chorus using the high-resolution data of the WBD instruments onboard the Cluster spacecraft. Whistler-mode chorus is observed in its source region close to the geomagnetic equator at a radial distance of 4.4 Earth radii. We examine both the spatial and temporal variations of wave amplitude. Chorus is found to have a correlation length between 60 and 200 km in the plane perpendicular to the terrestrial magnetic field. The temporal fine structure of chorus wave packets consists of subpackets of a variable length from a few milliseconds to a few tens of milliseconds.

## Magnetosheath Interaction With High Latitude Magnetopause: Flow Chaotization and Multi-scale Reconnection

*Savin, S. P.*[1] , Zelenyi, L. M.[1] , Skalsky, A. A.[1] , Song, P.[2] , Amata, E.[3] , Buechner, J.[4] , Bleçki, J. S.[5] , Avanov, L. A.[1] , Borodkova, N. L.[1] , Consolini, G.[3] , Farrugia, C.[6] , Fritz, T. A.[7] , Lutsenko, V. N.[1] , Maynard, N.[8] , Nikutowski, B.[4] , Panov, E.[1] , Pickett, J. S.[9] , Rauch, J. L.[11] , Romanov, S. A.[1] , Sauvaud, J.-A.[10] , Smirnov, V. N.[1] , Stasiewicz, K.[12] , Trotignon, J. G.[11] , Yermolaev, Y. I.[1]

[1]Space Research Institute, Profsoyuznaya 84/32, Moscow, 117810, Russia,
[2]University of Massachusetts Lowell, Lowell, MA, USA,
[3]Interplanetary Space Phys. Inst., CNR, Roma, Italy,
[4]Max-Planck Inst. Aeronomie, Katlenburg-Lindau, Germany,
[5]Space Res. Center, Warsaw, Poland,
[6]U. N. Hampshire,
[7]Boston U., USA,
[8]Mission Res. Corp, Nashua, NH, USA,
[9]U. Iowa, USA,
[10]CESR, Toulouse, France,
[11]LPCE, Orleans, France,
[12]IRF-U, Uppsala, Sweden

We present a statistical and two case studies of magnetosheath interaction with the high-latitude magnetopause on the basis of Interball-1 and other ISTP spacecraft data. We discuss those data along with recently published results on the topology of cusp-magnetosheath transition and on the roles of nonlinear disturbances in the mass and energy transfer across the high-latitude magnetopause. For sunward dipole tilts a cusp throat is magnetically open for the direct interaction with incident flow that results in creating of a turbulent boundary layer (TBL) over an indented magnetopause and downstream of the cusp. For antisunward tilts the cusp throat is closed by a smooth magnetopause; demagnetized “plasma balls” (with scale $\sim$ few $R_E$, an occurrence rate of $\sim$ 25% and trapped energetic particles) present a major magnetosheath plasma channel just inside the cusp. The flow interacts with the “plasma balls” via reflected waves, which trigger a chaotization of up to 40% of upstream kinetic energy. These waves propagate upstream of the TBL and initiate amplification of the existed magnetosheath waves and their cascade-like decays during downstream passage throughout the TBL. The most striking feature of the nonlinear interaction is an appearance of magnetosonic jets, accelerated up to Alfvenic Mach number 3. The characteristic impulsive local momentum loss is followed by decelerated Alfvenic flows, modulated by the TBL waves, a momentum balance conserves only on time scales of the Alfvenic flows ($\sim$ 15 minutes). Wave trains at $\sim$ 1.3 mHz (i.e. $\sim$ the Alfvenic period) are capable of synchronizing interactions throughout outer and inner boundary layers. The sonic/Alfvenic flows control the TBL spectral shape and result in non-Gaussian statistical characteristics of the disturbances consisting of fluctuation intermittency. We suggest that the multi-scale TBL processes play at least a comparable role to those by reconnection remote from the cusp in the solar wind energy transformation and population of the magnetosphere by the magnetosheath plasma. The TBL transforms the flow energy including deceleration and heating of the flow downstream the cusp.

## Theory of Three-Dimensional Alfvenic Reconnection

*Song, Y.*

School of Physics and Astronomy, University of Minnesota, Minneapolis, MN 55455, USA

Most traditional reconnection models describe large scale, quasi-steady processes occurring in a specific, two-dimensional configuration. However, observations have revealed that reconnection is a three-dimensional dynamical process occurring in a patchy and sporadic manner involving the energization of charged particles.

In active cosmic plasma regions, nonlinear MHD wave mode conversion become crucial. For example, during the impinging of fast mode wave packets on a current sheet at the magnetopause or in the magnetotail, the fast mode wave packets can be nonlinearly converted into shear Alfven wave packets. In this process, the localized breakdown of the frozen-in condition is a consequence of the interaction between the fast mode wave packets and the current sheet. It is also a necessary condition for further irreversible nonlinear evolution of the MHD wave packets.

Nonlinear MHD wave mode conversion can be considered as a three-dimensional Alfvenic reconnection process, where the generated shear Alfven wave packets carry energy, momentum, magnetic twist and angular momentum away from the reconnection site. This process corresponds to a reactive, rather than a resistive, transport process. The Poynting flux of electromagnetic energy flowing into the reconnection region is converted not only into the Joule heating, the kinetic energy of plasma flows and the accelerated particles, but also into electromagnetic energy associated with the Alfven wave packet. The three-dimensional Alfvenic reconnection process is related to the generation of an inductive parallel electric field. Approximate conservation of magnetic helicity and cross helicity leads to the formation of charge holes and/or the energization of charged particles on current sheets.

The threshold for the onset of the three-dimensional Alfvenic reconnection is roughly determined by the antiparallel components of the magnetic field on each side of the current sheet and the kinetic energy carried by the fast mode wave packets. Therefore, it depends not only on the IMF and solar wind dynamical pressure, but also on plasma beta. Under large beta conditions, the energy lost to compression of the plasma leads to a decrease in the radiation of Alfven waves and consequently a suppression of the reconnection process, as indicated by spacecraft data.

## Multi-point Statistical Analysis of Magnetic Turbulence in the Plasma Sheet

*Vörös, Z.*[1] , Baumjohann, W.[1] , Nakamura, R.[1] , Runov, A.[1] , Volwerk, M.[1] , Zhang, T.[1] , Balogh, A.[2] , Klecker, B.[3] , Rème, H.[4]
[1]Institut für Weltraumforschung der ÖAW, Graz, Austria,
[2]Imperial College, London, UK,
[3]Max-Planck-Institut für Extraterrestrische Physik, Garching, Germany,
[4]CESR/CNRS, Toulouse, France

Magnetic turbulence associated with bursty bulk flows or flow reversals represents a transient phenomenon in the plasma sheet. Its description in terms of second- or higher-order statistics is therefore restricted to short intervals during which the processes are statistically stationary. Using the multi-point Cluster measurements we perform a statistical analysis of magnetic turbulence and describe the spatial structure of turbulence in the inner plasma sheet. We discuss a possible scenario for multi-scale coupling processes in which the observed turbulence characteristics can play a decisive role. We show that the magnetic turbulence exhibits statistical anisotropy relative to the direction of the local magnetic field. In perpendicular direction a gradual transition towards two-dimensional turbulence is observed.

## Statistic Study of Geomagnetic Storm Dependences on Solar and Interplanetary Events

*Yermolaev, Y. I.*[1] , Yermolaev, M. Y.[1] , Zastenker, G. N.[1] , Zelenyi, L. M.[1] , Petrukovich, A. A.[1] , Sauvaud, J.-A.[2]
[1]IKI RAS, Moscow, Russia,
[2]CESR, Toulouse, France

Within the framework of the "Space weather" program, 25-year sets of solar x-ray observations, measurements of plasma and magnetic field parameters in the solar wind and Dst index variations are analyzed with the purpose of revealing the factors rendering the greatest influence on development of magnetospheric storms. Value of correlation between solar flares and magnetic storms ($\sim$40%) practically does not exceed a level of correlation of random processes. Furthermore it was not possible to find out any dependence between importance of solar flares and value of magnetic storms. In accordance with literature the coronal mass ejections (CME) in $\sim$60% cases result in storms with Dst < -50 nT but SOHO data on halo-CME for time interval 1996-2000 show that geoeffectiveness of CME is about 40%. The most geoeffective interplanetary phenomena are magnetic clouds (MC) which, as many believe, are interplanetary manifestations of CMEs and compressions in the region of interaction of slow and fast streams in the solar wind (so-called Corotating Interaction Region, CIR): About 2/3 of all observed magnetic storms. For storms with -100 < Dst < -60 nT the numbers of storms from MC and CIR are approximately equal, and for strong storms with Dst < -100 nT the part of storms from MC is considerably higher. In summary the problems of reliability of a prediction of geomagnetic disturbances on the basis of observations of the Sun and conditions in the interplanetary space are discussed.

## The Magnetosheath Structure at High Latitudes

*Asadchy, A. Y.*, Skalsky, A. A.
Space Research Institute, Russian Academy of Sciences, Moscow, Russia

The magnetosheath region is that of the very importance to study the Solar-terrestrial relations. Variations of plasma parameters occuring in the interplanetary media impact the terrestrial magnetosphere being modified in the region locating between the magnetopause and bow shock. The paper is dedicated to a comparison between gasdynamic model of the solar wind flow around the Earth's obstacle and in-situ observations in the terrestrial magnetosheath. It is shown that the fast and slow magnetosonic transitions are inherent to the magnetosheath region at high latitudes.

## Orientations of Correlated Wind and Ace Solar Wind Features

Ashmall, J., *Lazarus, A.*, Kasper, J.
Center for Space Research, MIT, Cambridge, USA

Comparison of correlated features when Wind's $Y_{GSE}$ location is in the range $\pm 300$ $R_E$ shows clearly that the normals to the fronts of such features are not radial. The normals tend to be perpendicular to the Parker spiral. Since interplanetary shocks are prominent solar wind features in the same period, we compare shock normals and front normals.

## Storm Time Changes in Total Electron Content in Ionosphere

*Beloff, N.*[1] , Denisenko, P. F.[2] , Ivanov, I. I.[2] , Maltseva, O. A.[2] , Gough, M. P.[1] ,
Klimov, S. I.[3] , Nozdrachev, M. N.[3] , Alleyne, H. S.[4] , Bates, I.[4]
[1]Space Science Centre, SciTech, University of Sussex, UK,
[2]Institute of Physics, Rostov State University, Russia,
[3]IKI RAN, Moscow, Russia,
[4]ACSE, University of Sheffield, UK

Results are presented from the topside HF-sounding experiment onboard the low orbiting station MIR. This experiment was carried out at night time in both quiet and disturbed ionospheric conditions, in particular during the 14.11.98 storm. The main quantitative description of the ionosphere from the MIR sounder is the total electron content (TEC) below the MIR orbit. TEC was obtained using sections of topside ionogram that contain only the traces of signals reflected from the Earth's surface. The technique used allowed us to observe a wave disturbance of medium scale TID type with characteristic size of about 450 km along the geomagnetic latitude. Another interesting fact is that after a series of relatively strong storms the main ionospheric trough on 14.11.98 was detected at an abnormally low geomagnetic latitude (about 43 degrees).

## Magnetosphere in the Interplanetary Magnetic Cloud With a Large $B_Y$-component

*Bojanowska, M.*
Space Research Center, P.A.S., Warzsaw, Poland

Several cases are analyzed of “twisted” magnetosphere immersed in the magnetic cloud with a large $B_Y$-component. Using simultaneous magnetic and plasma data from widely separated two spacecraft (Interball, Polar, Cluster) and satellite images of the auroral oval (Polar, IMAGE), we try to reconstruct the real configuration of the inner magnetosphere and compare it with magnetospheric models T96 and T01. In general, IMF BY seems to penetrate the inner magnetosphere much more efficiently than predicted by both models, especially at high-latitudes near the cusp.

## Large and Sharp Solar Wind Dynamic Pressure Variations as a Source of Geomagnetic Field Disturbances in the Outer Magnetosphere (at the Geosynchronous Orbits)

*Borodkova, N. L.*[1] , Zastenker, G. N.[1] , Riazantseva, M. O.[1] , Richardson, J. D.[2]
[1]Space Research Institute of Russian Academy of Sciences, Moscow, Russia,
[2]Center for Space Research, MIT, Cambridge, Massachusetts, USA

We present a comparison of the large and fast (less then 10 minutes) solar wind dynamic pressure changes, observed by INTERBALL-1, with the disturbances in the magnetospheric magnetic field magnitude measured by the GOES-8, 9, 10 geosynchronous satellites. During the time interval from 1996 to 1998 more then 100 solar wind events were selected for the statistical study and detail consideration. It was shown that fast and large solar wind pressure changes are responsible for the fast variations of the geomagnetic field magnitude in the outer magnetosphere. Several interesting events are presented and discussed. In each case the signs of both these disturbances are the same. It was shown that time delay between pressure change and its geomagnetic response is significantly controlled by the inclination of the pressure front to the Sun - Earth line. Amplitude of geomagnetic field variations strongly depends on the location of the GOES satellite relatively noon meridian, reaching the maximum value near the noon.

## Surveying of the Polar Cusp Geometry and its Plasma Properties — — Two Years of CLUSTER Observations

*Budnik, E. Y.*[1] , Lavraud, B.[1] , Fedorov, A. O.[1] , Grigoriev, A.[2] , Rème, H.[1] , Dunlop, M. W.[3]
[1]CESR/CNRS, Toulouse, France,
[2]IRF, Kiruna, Sweden,
[3]RAL, Didcot, UK

Two years of observations of high-latitude magnetopause by CLUSTER allow to define the geometry of the “diamagnetic cavity” of the exterior cusp for different conditions in the solar wind. To provide a such statistics the special coordinate system based of the Tsyganenko-96 magnetic field model was applied. The dayside and nightside boundary was defined by plasma temperature and number density and magnetosheath-cusp boundary was defined by plasma velocity gradient. All plasma parameters were surveyed inside the external cusp region to describe its general statistical properties. This work was performed as a base for future investigation of fundamental problems of cusp physics.

## Nonlinear Dynamics of Charged Particles in Double-humped Current Sheets

Delcourt, D. C.[1] , *Malova, H. V.*[1,2,3] , Zelenyi, L. M.[3]
[1]Centre d'etudes des Environnements Terrestres et Planetaires-CNRS, Saint-Maur des Fausses, France,
[2]Nuclear Physics Institute, Moscow State University, 119992, Moscow, Russia,
[3]Space Research Institute, RAS, 117810, Profsoyusnaya street 84/32, Moscow, Russia

The dynamics of charged particles in the double-humped current sheets (CSs) that develop during the late growth phase of substorms is investigated. The attention is focused on particles for which the adiabaticity parameter $\kappa$ (defined as the square root of the minimum curvature radius to maximum Larmor radius ratio) is of the order of unity. In the case of simple parabolic field reversal the magnetic moment scattering may be described as the result of a single perturbation of the gyromotion by an impulsive centrifugal force. The double-humped structure of the current sheet leads to two successive centrifugal perturbations. In a single-humped CS the systematic enhancement of magnetic moment jumps at small pitch angles is characteristic. In contrast, in double-humped CS the repeated application of three-branch pattern can lead to magnetic moment damping for particles that previously experience enhancement and vice versa. The gyrophase gain is found to play a critical role in the net magnetic moment change. In particular, $kappa \simeq 1$ limit (which is characterized by strong scattering in single-humped CSs) may have quasi-adiabatic behavior with negligible variation of the magnetic moment in double-humped current sheets.

## Comparison of a New Magnetosphere-magnetosheath Model With Interball-1 Magnetosheath Plasma Measurements

*Dobreva, P. S.*[1] , Kartalev, M. D.[1] , Shevyrev, N. N.[2] , Zastenker, G. N.[2]
[1]Institute of Mechanics BAS, Sofia, Bulgaria,
[2]Space Research Institute RAS, Moscow, Russia

We report a testing with real satellite data of the earlier developed in the Institute of Mechanics of the Bulgarian Academy of Sciences numerical, databased 3D model of the system magnetosphere – magnetosheath. The model is a result of a self-consistent solution of two tasks: (i) Chapman-Ferraro problem for an arbitrary 3D magnetopause with application of data based internal magnetic field system, taken from the Tsyganenko magnetosphere model; (ii) 3D numerical solution of the magnetosheath in gasdynamical approach. The positions and shapes of the shock wave and the magnetopause are results of the solution and the appropriate application of the Rankine -Hugoniot conditions on both magnetosheath boundaries . The input parameters for the model are the solar wind plasma and magnetic field parameters, Dst index, and the Earth's dipole position. Ion flux measurements in the magnetosheath from Interball-1 satellite were compared with model predictions. We used several magnetosheath crossings from the magnetopause (MP) to the bow shock (BS). For these cases simultaneous WIND data served as a solar wind and interplanetary magnetic field monitor. Dst indexes were taken from the Kyoto database. An appropriate procedure was applied for normalizing data values and space distances. Some comparisons with the results of analogical procedure, based on the well known Spreiter's et al. gasdynamic model are also presented. A satisfactory coincidence with the observed plasma flux behavior along the trajectory, as well as of the BS and MP positions is obtained in several cases. The discussed results seem to be rather optimistic about the model capabilities. It is worthy to note that this idealized single-fluid model is not supposed to describe the large level of the plasma and magnetic field variations in the magnetosheat.

## The Influence of a Local Magnetic Shear on the Low-latitude Magnetopause

*Dušík, S.*, Šafránková, J., Němeček, Z.
Charles University, Faculty of Mathematics and Physics, Prague, Czech Republic

The magnetopause is a boundary layer that separates the magnetosphere from an interplanetary space, where all processes are controlled by solar activity. The position and shape of the magnetopause depend on the solar wind dynamic pressure, direction and magnitude of the interplanetary magnetic field. The magnetopause can be divided into several regions. From view of magnetospheric physics, one of the most important regions is the low-latitude boundary layer (LLBL) that allows to transport of the mass and energy from the solar wind to magnetosphere. From satellite measurements made up to now it follows that parameters of the LLBL are considerably variable, so there are still many questions about forming of the LLBL and relations between upstream and LLBL parameters. In present contribution, we used data from Magion-4, Interball-1 and Geotail satellites. The monitor of solar wind parameters was the Wind satellite. We concentrated on two tasks: a statistical study of low-latitude magnetopause crossings and a case study of few events using two closely separated spacecraft. The main aim of a statistical study was to analyze an influence of a local magnetic shear across the magnetopause, as a high shear can indicate a local reconnection process that would erode the magnetopause. On the other hand, from two-point measurements, we could analyze the shape and position of inner and outer edges of the LLBL and we could discuss their movement as a function of variations of solar wind parameters.

## ULF Waves Observed by CLUSTER Upstream of the Bow Shock on 3 April 2001

*Erdős, G.*[1] , Balogh, A.[2] , Daly, P.[3] , Kecskeméty, K.[1] , Tátrallyay, M.[1]
[1]KFKI Research Institute for Particle and Nuclear Physics, Budapest, Hungary,
[2]Imperial College, London, UK,
[3]MPAE, Katlenburg-Lindau, Germany

Detailed analysis of magnetic field and energetic particle data during the outbound multiple bow shock crossings on 3 April 2001 is presented. The interplanetary magnetic field turned southward during the event, confirmed by ACE measurements. The RAPID instrument onboard CLUSTER recorded a significant enhancement in the flux of energetic protons and ions. Upstream of the bow shock the magnetic field was turbulent, with large variations both in magnitude and direction. We have performed a timing analysis by the four CLUSTER spacecraft to obtain the phase velocity of the waves. The velocity of the waves varies between about 450 km/s to about 150 km/s, which is compared to the scale length of the field disturbances. A possible evolution of ULF waves to shocklets is discussed.

## Bifurcated Current Sheet: Model and Observations

*Génot, V.*[1] , Mottez, F.[2] , Fruit, G.[1] , Louarn, P.[1] , Sauvaud, J.-A.[1] , Balogh, A.[3]
[1]CESR, Toulouse, France,
[2]CETP, Vélizy, France,
[3]Imperial College, London, UK

Cluster observations have recently confirmed previous Geotail observations that the magnetotail current sheet can present a bifurcated structure with two off-centre current peaks. We show in this paper that such a structure may be described by a kinetic tangential equilibrium which is an exact solution of the Vlasov-Maxwell equations. A tangential equilibrium is characterized by a bulk plasma velocity and magnetic field perpendicular to the density and/or temperature gradient direction. The particle distribution functions are the sum of an infinite number of elementary functions parametrized by a vector potential. The model is consistent with Cluster observations of a plasma density plateau between the current peaks and the typical size and amplitude of the current distribution. We characterize the model particle distribution functions leading to the formation of bifurcated current sheets and compare them with Cluster data.

## Solar Rotation and Solar Wind – Magnetosphere Coupling

*Georgieva, K. Y.*[1] , Kirov, B. B.[1] , Javaraiah, J.[2]
[1]Solar-Terrestrial Influences Laboratory at the Bulgarian Academy of Sciences, Bulgaria,
[2]Indian Institute of Astrophysics, India

Magnetospheric response to solar wind forcing is highly dependent on the components of the interplanetary magnetic field (IMF) at the Earth's orbit. IMF configuration is described by Parker's Archimedian spiral model under the assumptions of a purely radial solar wind with a constant velocity emanating from a uniformly rotating Sun. In-situ measurements confirmed this general picture, but a systematic deviation from the predicted IMF winding angle was found, supposedly exhibiting an 11-year periodicity. We account for the nonuniform solar rotation and compare observed IMF azimuthal component to the one calculated from Parker's formula with the measured equatorial solar rotation rate.We find that the difference between the calculated and measured By has a clear 22-year dependence on the solar polarity cycle, matching the 22-year periodicity in solar rotation rate. An important element of the solar dynamo which is responsible for the solar magnetic field is the solar differential rotation. We compare the different periodicities in the variations in the latitudinal rotation gradient of the two solar hemispheres and show that the interplanetary magnetic field which is an extension of the solar coronal field, is related to the differential rotation in the more active solar hemisphere. One feature related to solar differential rotation that is persistently different in the two solar hemispheres is the prevailing magnetic helicity, which is carried to the Earth by magnetic clouds preserving the helicity of the source region of their origin. The reaction of the magnetosphere to magnetic clouds is supposed to be determined mainly by the presence or absence of a prolonged period of southward IMF component. We show that it also depends on the helicity of the clouds, and compare the effects of right- and left-handed magnetic clouds in the northern and southern polar regions.

## The Spatial Structure of Beamlets According to CLUSTER Observations

*Grigorenko, E. E.*[1,2] , Fedorov, A. O.[3] , Sauvaud, J.-A.[3] , Budnik, E. Y.[3] , Zelenyi, L. M.[2] , Rème, H.[3] , Dunlop, M. W.[4] , Penou, E.[3]

[1]Skobeltcyn Institute of Nuclear Physics MSU, Moscow, Russia,
[2]Space Research Institute RAS, Moscow, Russia,
[3]Centre d'Etudie des Recherchers Rayonnements, Toulouse, France,
[4]RAL, Didcot, UK

We present the CLUSTER observations in the plasma sheet boundary layer from its first and second seasons in the magnetotail (summer and fall 2001, 2002). Statistical and case studies of bursty (1-2 min) fast earthward moving ion beams (beamlets) show that the spatial structure of beamlet is the "kink-like" (in X-Y plane) lobe magnetic field line distortion propagating earthward with high velocity. The observed features of such structure are as follows: 1) although this structure has pronounced velocity along X it also forces beamlet to move toward -Y with velocity about -150 km/s both in southern and nothern lobes; 2) the variation of magnetic field strongly corresponds to variations of the ion velocity; 3) ion energy dispersion is absent or small inside the beamlet; 4) cold lobe ions accelerated (along -Y) are often observed together with beamlets. These properties could be explained as follows: 1) observed magnetic field structure may be formed due to reconnection in the distant tail and may be dragged earthward along with the acceleration ions; 2) the short time interval of beamlet registration is explained by observation of just a part of the structure because of its convection along -Y; 3) the absence of the dispersion is explained by difference in the time of life and the time of beamlet observations.

## Relationship Between High-energy Particles and Ion Flux in the Magnetosheath

*Hayosh, M.*[1] , Šafránková, J.[1] , Němeček, Z.[1] , Kudela, K.[2] , Zastenker, G. N.[3]

[1]Charles University, Faculty of Mathematics and Physics, Prague, Czech Republic,
[2]Institute of Experimental Physics, Slovak Academy of Sciences, Kosice, Slovakia,
[3]Space Research Institute RAS, Moscow, Russia

The magnetosheath is a turbulent region bounded by the bow shock and magnetopause. This region was a subject of numerous studies in past years because its plasma and magnetic field interact with the magnetosphere. In spite of tremendous effort, our understanding of basic magnetosheath processes is still rather limited. The gasdynamic description of the magnetosheath provides a basic insight on the spatial distribution of the magnetosheath parameters. MHD models can qualitatively describe an influence of the interplanetary magnetic field (IMF) but neither of them can take into account kinetic effects connected with a presence of high-energy particles. The role of reflected and accelerated particles in the upstream region is now well known in terms of wave excitation and creation of disturbances like hot flow anomalies or foreshock cavities. However, the situation is much more complicated in the magnetosheath because energetic particles observed in a particular point can come from several sources. We are using a set of INTERBALL-1 observations of the magnetic field, total ion flux, and flux of energetic particles with motivation to find the mutual connection among the mentioned quantities. Our results suggest that the presence of high-energy particles influences the total ion flux only weakly. On the other hand, the coupling between high-energy particles and the ion flux and/or magnetic field fluctuation level seems to be stronger.

## Nonducted Propagation of Chorus Emissions and Their Observation

*Chum, J.*, Jiříček, F., Šmilauer, J.
Institute of Atmospheric Physics, Bocni II/1401, 14131 Praha 4, Czech Republic

Chorus emissions are one of the most intense electromagnetic waves of whistler mode observed in the Earth's magnetosphere. They are generated near the magnetic equator plane and consist of more or less regularly repeating rising (falling) tones. In this article we focus on the propagation of this emission from the source region. Based on plasma density measurement and recent satellite observation, we show that chorus emissions may in many cases propagate obliquely to magnetic filed lines. We study the influence of initial wave normal angle distribution on the chorus propagation and chorus ray bundle width using the ray tracing method at different frequencies. As the initial dimension of the source, we aply the published values of the transverse dimension (with respect to magnetic field) of correlated emission in the source region ($\sim 100$ km) and the longitudinal extent of the source ($\sim 2000$ km). We conclude that the merging of ray bundles at different frequencies defines the frequency bandwidth of the emission, which can be observed at particular point. We estimate that the initial spread of $\sim 10°$ is sufficient so that the typical bandwidth $\sim 1$ kHz could be observed. We also show that there may be regions, where ray bundle focuses for particular frequency and particular initial wave normal spread, leading thus to enhanced energy density at this frequency. In the experimental part, we show examples of the observation of nonducted propagating emission recorded on MAGION 5 satellite.

## The Coupled Kelvin-Helmholtz and Tearing Mode Instability in the Magnetopause Layer — MHD approach

*Ivanovski, S. L.*, Kartalev, M. D.
Institute of Mechanics, Bulgarian Academy of Sciences, Bulgaria

We report further development of the earlier proposed numerical scheme for simulating a coupled Kelvin-Helmholtz and tearing mode instabilities in a simplified model of magnetopause layer. Time-dependent two-dimensional MHD approach is utilized for incompressible viscous and conductive flow. An attempt is made for more realistic simulation of the magnetopause mixing layer: the axes of the sharp changes of gasdynamic and electromagnetic parameters are supposed to be shifted. It seems that this approach permits more realistic interpretation of the transient events, registered by ground-based magnetometers. This concerns especially the velocity of the observed phenomena.

## Multi-scale and Regularity/Irregularity Aspects of Magnetospheric Dynamics in Artificial Neural Networks

*Jankovičová, D.*[1,2] , Vörös, Z.[1,3]
[1]Geohysical Institute of SAS, Slovak Republic,
[2]Institue of Atmospheric Physics, Acad. Sci. Czech Republic, Prague, Czech Republic ,
[3]Space Research Institute, Austrian Academy of Sciences, Schmiedlstrasse 6, 8042 Graz-St.Peter, Austria

Input-output modelling studies of solar wind-magnetosphere coupling (SWMC) have shown that superior predictor performance was achieved when the information on multi-scale or regularity/irregularity properties of solar wind and magnetospheric processes was incorporated into local-linear filter (Ukhorskiy et al., JGR, 10.1029/2001JA009160,2002) or artificial neural network (ANN) prediction schemes (Voros and Jankovicova, NPG,9,425-433,2002). In this study we use a layered back-propagation neural network model with feedback connection for one-step (one minute) and multi-step prediction of AE-index from PCN-index and high-latitude geomagnetic observatory time series. Local singularity and intermittence measures for input parameters are introduced and their influance on predictor performance is studied. We show that the consideration of multi-scale and regularity/irregularity features of time series improves the performance of ANN. The results have important implications for understanding of multi-scale and nonlinear features of SWMC. The method also allows a reconstruction or estimation of AE-indices during periods when data availability is limited.

## Two-point Study of the Bow Shock Motion

*Jelínek, K.*, Šafránková, J., Němeček, Z., Jeřáb, M.
Charles University, Faculty of Mathematics and Physics, Prague, Czech Republic

It has been found that both shape and position of the bow shock are determined mainly by the dynamic pressure and Mach number of the incoming solar wind. However, the bow shock is highly dynamic boundary and its motion results in a fact that the spacecraft scanning this region can observe a single boundary crossing as well as many multiple crossings. Intervals of multiple bow shock crossings, often lasting over intervals from minutes to hours, are currently interpreted in terms of bow shock motions with respect to the observing spacecraft. In the present contribution, we examine the changes of the bow shock position. Our analysis is based on single bow shock as well as series of multiple bow shock crossings simultaneously observed by two closely separated spacecraft (MAGION-4/INTERBALL-1). Into our data set, we included also the cases when one spacecraft observed bow shock crossings, whereas the second one moved in the solar wind or in the magnetosheath. We estimate a typical bow shock velocity and we study radial expansion/compression of the bow shock surface.

## A Study of the Bow Shock Locations

*Jeřáb, M.*[1] , Němeček, Z.[1] , Šafránková, J.[1] , Jelínek, K.[1] , Měrka, J.[1,2]
[1]Charles University, Faculty of Mathematics and Physics, Prague, Czech Republic,
[2]NASA Goddard Space Flight Center, Laboratory for Extraterrestrial Physics, Greenbelt, Maryland, USA

The presence of the bow shock in front of an obstacle immersed into a supersonic flow of the collisionless plasma has been theoretically predicted and experimentally confirmed more than 40 years ago. However, in spite of a great effort of theoreticians and experimenters, we are still not able to predict the bow shock location under varying upstream conditions with a sufficient accuracy. Gasdynamic and MHD models cannot account for kinetics effects, whereas the kinetic models can be used only to studies of particular phenomenon due to a limited computer capacity. Models based on fits of an experimental data usually expect that the bow shock location is a simple function of several upstream parameters as the solar wind dynamic pressure, upstream Mach number, and direction or magnitude of the interplanetary magnetic field. Since the bow shock location would be determined by the downstream parameters, these models implicitly assume that these parameters are unambiguously determined by the upstream conditions. The uncertainty of the bow shock prediction is usually attributed to the uncertainty in determination of an upstream state or to an irregular bow shock motion. We have accumulated a large set of bow shock crossings observed by INTERBALL-1, MAGION-4, GEOTAIL, IMP-8, and CLUSTER-2 spacecraft and complemented this set with upstream measurements of WIND with motivation to test present experimental models and find major sources of their uncertainties. A particular attention was devoted to simultaneous observations of two closely spaced spacecraft (INTERBALL-1 and MAGION-4) that can, in a high degree, eliminate the uncertainty of the bow shock location under particular upstream conditions. Our effort results in an improvement of present models.

## SAR-Arc Characteristics in the Region of Ring Current Dissipation and During Polarization Jet Development

*Khalipov, V. L.*[1] , Gubsky, V. F.[1] , Afonin, V. V.[1] , Bondar, E. D.[2] , Stepanov, A. E.[2]
[1] Space Research Institute, Moscow, Russia,
[2]Institute of Cosmophysical Research and Aeronomy, Yakutsk, Russia

Electron temperature variations measured by AUREOLE 3, DE 2, COSMOS 900 and INTERCOSMOS 24 in the F - region of the ionosphere during different phases of magnetospheric disturbances are analyzed and classified. (1) Intense electron heating up to 6000 K and higher inside the latitudinal band of 5 - 8 degrees is connected to ring current energy dissipation and is observed during recovery phase of large magnetic storms. This electron heating causes the formation of classical SAR-arcs. (2) In other structures of 2 - 3 degrees latitude width electron temperature is enhanced up to 3000 - 3500 K. Formation of these structures is associated with initiation of substorm activity and can coincide with a start of storm main phase. In these structures the frictional heating of plasma due to strong electric field is operated. (3) The effect of electron heating in excess of 6000 K when the solar wind shock impacts on the magnetosphere of the Earth was experimentally revealed using the AUREOLE 3 measurements in subauroral ionosphere. The solar wind energy transfer from the magnetopause to the inner magnetosphere could be provided by kinetic Alfvenic waves. For the first time this possibility of energy dissipation in the terrestrial magnetosphere was considered theoretically by Hasegava and Mima (J. Geophys. Res., 83, 1117, 1978).

## The Features of the Ion Plasma Pressure Distributions in Near Earth Plasma Sheet

*Kirpichev, I. P.*[1] , Antonova, E. E.[2] , Lutsenko, V. N.[1] , Pisarenko, N. F.[1] , Yermolaev, Y. I.[1]
[1]Space Research Institute RAS, Moscow, Russia,
[2]Skobeltsyn Institute of Nuclear Physics, Moscow State University, Russia

Simultaneous data of CORALL and Dok-2 observations give the possibility to restore the plasma pressure distribution on the geocentric distances 8 - 15 $R_E$ with rather high accuracy. Some features of the obtained plasma pressure profiles are analyzed. The value of the anisotropy of the plasma pressure is estimated. The obtained profiles of the plasma pressure are compared with Tsyganenko-2003 tail plasma pressure model.

## Experimental Study of the Mechanism of Polarization Jet Formation

*Khalipov, V. L.*[1] , Stepanov, A. E.[2] , Bondar, E. D.[2]
[1]Space Research Institute, Moscow, Russia,
[2]Institute of Cosmophysical Research and Aeronomy, Yakutsk, Russia

Long-lasting ground based measurements of a polarization jet (PJ) by the latitudinal chain of ionospheric stations in Yakutia ($3 < L < 5$; MLT = UT + 9 h) and by 5 subauroral Russian stations and energetic ion observations by AMPTE/CCE in 1984 - 89 were analyzed. 25 cases were found when PJ was recorded simultaneously with the AMPTE/CCE observations. The data comparison shows that at least in the considered cases of strong magnetic substorms, PJ was accompanied by strong injection of ions with the energy of $\sim 20 \div 50$ keV and intensity of $\sim 10^6$ cm$^{-2}\cdot$sec$^{-1}\cdot$ster$^{-1}\cdot$keV$^{-1}$. Close to the injection region in the near midnight sector no ion dispersion was observed, but in the evening sector nose events were detected. Measurements by ionosondes at different longitudes show that the westward velocity of the front of PJ development is close to the gradient drift velocity of 20 keV ions (forming nose events). Thus, the physical mechanism of PJ formation due to energetic ion injection during a strong substorm burst is experimentally confirmed. PJ was observed equatorward from the region of energetic ion penetration into the inner magnetosphere but not in the gap between the injected ions and plasma sheet. PJ develops almost along constant invariant latitude covering a sector 4.00 - 6.00 MLT. This suggests that electric field responsible for the PJ formation is of thermoelectric origin. For the recorded ion energies the PJ electric field can be as high as 50 - 100 mV/m. The position of equatorial ion injection boundary in more than 180 orbits of the AMPTE/CCE satellite for different levels of geomagnetic activity is analyzed. The form of the boundary does not depend on local time and is also located along invariant latitude in sector 18.00 - 02.00 MLT.

## "Obstanovka" Experiment Onboard International Space Station — — The Use for Space Weather Research

*Klimov, S. I.*[1] , Korepanov, V. E.[2] , Lissakov, Y. V.[1] , Lapshinova, O. V.[3] , Sorokin, I. V.[3] , Belyaev, S. M.[2] , Stanev, G. A.[4] , Kirov, B. B.[5] , Georgieva, K. Y.[5] , Gough, M. P.[6] , Alleyne, H. S.[7] , Balikhin, M. A.[7] , Lichtenberger, J.[8] , Ferencz, C.[8] , Szego, K.[9] , Szalai, S.[9] , Bodnar , J.[10] , Juchiewicz, J.[11] , Stasiewicz, K.[12]

[1]Space Research Institute (IKI), RAS, Moscow, Russia,
[2]Lviv Centre of Institute of Space Research (LC ISR), Lviv, Ukraine,
[3]RKK ENERGIA, Korolev, Moscow reg., Russia,
[4]Space Research Institute, BAS (IKI BAS), Sofia, Bulgaria,
[5]Laboratory of solar-terrestrial interactions, BAS (STIL), Sofia, Bulgaria,
[6]Space Science Centre, University of Sussex, UK,
[7]Department of Automatic Control & Systems Engineering, University of Sheffield, UK,
[8]Space Research Group, Eotvos University (SRG), Budapest, Hungary,
[9]Space Research Institute, HAS (KFKI RMKI), Budapest, Hungary,
[10]BL-Electronics BT, Solymar, Hungary,
[11]Space Resaerch Center, PAS (SRC), Warsaw, Poland,
[12]Sweden Institute of Space Physics (SISP), Uppsala, Sweden

The evolution of the dynamic processes in magnetosphere and ionosphere leads to the appearance of a set of electromagnetic (EM) phenomena, which may be a part of the space weather disturbances. The realization of the electromagnetic monitoring onboard the International Space Station (ISS) environment needs both the working out of the observation methodology and the design of corresponding experimental equipment. The methodology of electric and magnetic measurements onboard spacecraft was developed intensely at early stages of space investigations, also with input of the authors of the present proposal. But some theoretical problems connected with super-large body's interaction with space plasma, charges and noise of active experiments influence estimation still wait their investigation. As the result this study will allow to compile the requirements to the Plasma-Wave Complex (PWC) of scientific instrumentation for wave and plasma parameters measurements in ISS environment — the goal of OBSTANOVKA (ENVIRONMENT in English) experiment in the frame of Russian segment of ISS. PWC composed from multiple units, which are integrated into two blocks installed outside ISS and the third one (BSTM) inside ISS.
List of Instruments: Unit (Responsible Institute)
Combined wave sensor - CWD-1, CWD-2 (LC ISR), Flux gate magnetometer - DFM-1 (IKI), Flux gate magnetometer - DFM-2 (LC ISR), Langmuir probe - LP-1, LP-2 (STIL), Spacecraft potential monitor - DP-1, DP-2 (IKI BAS), Plasma discharge stimulator - SPP (IKI), Correlating Electron Spectrograph (10eV - 10KeV) CORES (Sussex University), Radio Frequency Analyzer - RFA (SISP; SRC), Signal Analyzer and Sampler - SAS3 (SRG), Data Acquisition and Control Unit - DACU-1, DACU-1 (KFKI RMKI; Sheffield University), Block of Storage of Telemetry Information - BSTM (inside ISS) (KFKI RMKI; Sheffield University), Grounding support equipment - GSE (KFKI RMKI; SRC).

## Ultra Relativistic Electrons in the Inner Magnetosphere Observed Aboard Mir Space Station During 1991

Koleva, R. T.[1] , Dachev, T.[1] , *Semkova, J. V.*[1] , Tomov, B.[1] , Matviichuk, Y.[1] , Lemaire, J.[2] , Petrov, V.[3] , Shurshakov, V.[3]

[1]Solar-Terrestrial Influences Laboratory at the Bulgarian Academy of Sciences, Bulgaria,
[2]Belgian Institute for Space Aeronomy, Belgium,
[3]Institute of Biomedical Problems, Russian Academy of Sciences, Russia

After the great magnetospheric disturbance on March 24, 1991 a shock injected ultra relativistic electron belt was formed in the gap between the inner and outer radiation belts. LIULIN dosimeter-radiometer, which worked aboard MIR space station since September 1989 till April 1994 observed this new belt till the middle of 1993. In the time interval between the end of CRRES mission - October 1991- and the launch of SAMPEX mission, the LIULIN data seem to be the only evidence for the evolution of the new electron belt. The aim of this presentation is to analyze the day-to-day variations during 1991 of the electron flux with energies above 10 MeV, as measured at low altitudes by LIULIN. Pitch-angle scattering during magnetospheric disturbances is the probable source of the observed flux intensification.

## Results of in Flight Operation of Scientific Payload on Micro-satellite "Kolibri-2000"

*Klimov, S. I.*[1] , Afanasyev, Y. V.[2] , Grachev, E. A.[3] , Grigoryan, O. R.[3] , Gruchin, V. A.[1] , Lysakov, D. A.[3] , Nozdrachev, M. N.[1] , Romanov, S. A.[1] , Savin, S. P.[1]

[1]Space Research Institute of RAS, Moscow, Russia,
[2]Mag-Sensors, Russia,
[3]Institute of Nuclear Physics, Moscow State University, Moscow, Russia

The results of the "Kolibri-2000" measurements on the orbit near International Space Station will be submitted in this paper which include the ionosphere reaction at April 2002 events address understanding of the coupling and feedback in the Sun-Earth interaction. For research of influence on ionosphere of processes of April 14-24, 2002 occurring on the Sun we shall consider a change of participated particles, magnetic and electrical field in moderate geomagnetic conditions 07-09 April, 2002, observable on the "Kolibri-2000". Data processing carried out during flight and their physical interpretation have shown, that accepted during development and tests the "Kolibri-2000" of a measure on maintenance of high electromagnetic cleanliness are completely confirmed in flight. It has ensured measurement of magnetic and electrical fields with sensitivity, in the appropriate ranges exceeding the levels achieved in a number of the specialized international projects, for example INTERBALL. The examples of registration of electrons with Ee > 600 keV onboard MS "Kolibri-2000" clearly shown that difference between count at 07 April and 22 April may be up to 5-6 times. In the capacity of, as "indicator" describing a disturbance level of ionosphere, parameter B50 (spectral density fluctuation of a magnetic field at frequencies 50-60 Hz). The characteristic factor of change B50 is some increase of intensity at INV.Lat > 50°. During Sun activity a intensity of B50 together with other magnetic and electrical parameters, measured on the "Kolibri-2000", are increased in some times.

## Compressional Signatures Observed at Geosynchronous Orbit at the Times of Transient Events

*Korotova, G. I.*[1] , Sibeck, D. G.[2] , Singer, H. J.[3] , Rosenberg, T. J.[4]
[1]IZMIRAN, Troitsk, 142190, Moscow Region, Russia,
[2]GSFC/NASA, Greenbelt, MD 20771 USA,
[3]SEC/NOAA, Boulder, CO USA,
[4]IPST, University of Maryland, College Park, MD USA

We present the results of a statistical survey of geosynchronous magnetic field observations at times when transient events occurred in high-latitude ground magnetograms. We began by identifying magnetic impulsive events observed in South Pole ground magnetograms during the period from 1995 to 1999, and then used the GOES-8, GOES-9 and GOES-10 spacecraft to identify corresponding signatures in high time resolution geosynchronous magnetometer observations. We determined the dependence of the event's spatial extent, velocity, and direction of propagation in the magnetosphere on local time. Wind, Geotail, Imp-8 and Interball solar wind observations indicate that the IMF orientation controls the direction of transient event motion near local noon. Most transient events correspond to abrupt shifts in the IMF towards or away from a radial orientation.

## In Situ Observations of Low-density Regions Inside the Plasmasphere

*Kotova, G. A.*[1] , Bezrukikh, V. V.[1] , Verigin, M. I.[1] , Šmilauer, J.[2]
[1]Space Research Institute, Russian Academy of Sciences, Moscow, Russia,
[2]Institute of Atmospheric Physics, Czech Academy of Sciences, Prague, Czech Republic

Thermal plasma measurements performed on MAGION 5 (subsatellite of INTERBALL 2) in the plasmasphere of the Earth are analyzed in conjunction with simultaneous solar wind data and ground-based ionospheric measurements in quiet geomagnetic conditions, during and after geomagnetic storms. In situ satellite observations reveal the existence of depleted regions (MLT width $> 3$ hours) in the plasmasphere that extend out from L$\sim$3. These observations well correspond to voids or bite-out regions found by the IMAGE spacecraft. Possible reasons for the formation of low-density regions are discussed.

## A Study of Particle Flows in Hot Flow Anomalies

*Koval, A.*, Šafránková, J., Němeček, Z.
Charles University, Faculty of Mathematics and Physics, Prague, Czech Republic

Hot Flow Anomalies (HFAs) are distinct disturbances of the solar wind flow observed often in the bow shock vicinity. Both experiment and theory suggest that these disturbances are created at the intersection of the bow shock and tangential discontinuity of the interplanetary magnetic field (IMF). The discontinuity is swept along the bow shock by the solar wind flow and thus the resulting HFA containing hot, tenuous, and deflected plasma can be found not only in the subsolar region but they are frequently observed on the flanks. Although originating at the bow shock, HFA features can be found far downstream in the magnetosheath. We have identified several HFAs in measurements of the INTERBALL-1 and MAGION-4 spacecraft and analyzed them in order to find a relationship between the deflected particle flow inside HFA cavities and orientations of original IMF discontinuities. The events were identified in the solar wind as well as in the magnetosheath. Our results show that, beside the dominant plasma motion connected with the sweeping of the discontinuity, a significant component directed along the discontinuity can be found. This suggests a highly elongated shape of the HFA cavity.

## Burst-like Precipitations of Particles in the Polar Cap

*Kovrazhkin, R. A.*[1] , Vladimirova, G. A.[1] , Glazunov, A. L.[1] , Sauvaud, J.-A.[2]
[1]Space Research Institute, Profsouznaya str., 84/32, 117810, Moscow, Russia,
[2]Centre d'Etitude Spatial des Rayonnements, BP4346, 310029, Toulouse, France

Particle bursts at extremely high latitudes were observed at INTERBALL-2. Such bursts are observed both in ions (0.1 - 10 keV) and in electrons (0.02 - 0.5 keV). The analysis has shown that the bursts tend to be formed in the morning MLT hours during the substorm recovery phase or just after the substorm termination, i.e., in less or equal to 60 min after the substorm. Interpretation of bursts related to dynamical processes in the tail of the magnetosphere is presented.

## Correlation of Simultaneous Ion Spectral Gaps Observed at Two Satellites of the INTERBALL Project

*Kovrazhkin, R. A.*[1] , Vladimirova, G. A.[1] , Glazunov, A. L.[1] , Yermolaev, Y. I.[1] , Sauvaud, J.-A.[2]
[1]Space Research Institute, Profsouznaya str.84/32, 117810, Moscow, Russia,
[2]Centre d'Spatial des Rayonnements, BP4346, 310029, Toulouse, France

Events of ion spectral gaps (ISG) observations at different altitudes from simultaneous measurements at INTERBALL-1 and INTERBALL-2 satellites are investigated. On the basis of the data from these two satellites the energy ranges of ISG, as well as their similarity and distinction, are analyzed. ISG formation mechanizms both in the inner magnetosphere and on the different altitudes are discussed.

## Intermittency in the VLF/ELF Emissions: Experimental Features and Theoretical Explanations

*Kozelov, B. V.*[1] , Titova, E. E.[1] , Trakhtengerts, V. Y.[2] , Jiříček, F.[3] , Tříska, P.[3] , Manninen, J.[4]
[1]Polar Geophysical Institute, Apatity, Russia,
[2]Institute of Applied Physics, Nozhny Novgorod, Russia,
[3]Institute of Atmospheric Physics, Prague, Czech Republic,
[4]Observatiory of Sodankyla, Finland

We review recent experimental results characterizing the time intermittency in VLF/ELF emissions. The MAGION-5 satellite and ground-based observations show a power-law distribution of time intervals between bursts of the VLF/ELF emissions (chorus elements) [Kozelov et al., 2001, 2002]. The power-law region is also found for the amplitude distribution [Kozelov et al., 2001]. A possible theoretical explanation of these results and some other features of the VLF/ELF emission involves the backward wave oscillator (BWO) regime as that responsible for chorus generation [Trakhtengerts, 1999]. The BWO-like oscillator ensures the absolute instability (or extremely high growth rate) of VLF wave generation. Estimations of the growth rate for VLF chorus elements, as obtained from the Magion 5 satellite data, support this explanation [Titova et al., 2003]. However, the magnetospheric turbulence causes permanent noise fluctuations of the space plasma characteristics. Hence so-called "on-off" intermittency regime could occur if the noise component drives the BWO-like regime near the generation threshold. A power-law distribution of the time intervals between the chorus elements is a manifestation of the intermittency regime. A related numerical model and some applications to the case studies are discussed.

## Systematic Analysis of Whistler-mode Emissions Observed by Cluster in the Low-latitude Magnetosphere

*Macúšová, E.*, Gereová, K., Santolík, O., Němec, F.
Charles University, Faculty of Mathematics and Physics, Prague, Czech Republic

We present a statistical study of whistler-mode emissions below 4 kHz observed by the spectrum analyzers of the STAFF-SA instruments on board the Cluster spacecraft. We have analyzed all the data intervals where the spacecraft were close to their perigee during the first two years of operation (2001 - 2002). We examine the power-spectral density, polarization, and propagation properties of observed waves. We mainly focus our attention to the emissions of whistler-mode chorus. Based on the large data set of measurements of the Poynting flux we confirm that the source of chorus is located close to the equatorial plane. We further investigate the propagation of chorus from the source region.

## Wave Magnetosphere Response to the Passage of a Front Edge of an Interplanetary Magnetic Cloud

*Kozyreva, O.*[1] , Kleimenova, N.[1] , Schott, J. J.[2]
[1]Institute of the Earth Physics, Moscow, Russia,
[2]Ecole et Observatoire des Sciences de la Terre, Strasbourg, France

We have analyzed several strong magnetic storms produced by the passage of the interplanetary magnetic cloud to the Earth's magnetosphere. The ground based magnetic data have been used to study the wave response of the Earth's magnetosphere to magnetic cloud arrival. We focus on the initial phase of a magnetic storm, associated with the passage of the sheath region of heated and compressed ambient plasma of the magnetic cloud front edge. This sheath is located between the forward shock and a cloud leading edge. The analysis showed that generally the initial phase of a storm is characterized by very poor wave magnetic activity inside the magnetosphere. However, strong IMF and ion density variations on the front edge of a magnetic cloud often trigger a magnetic substorm and geomagnetic Pi3 range ($f \sim 1 \div 3$ mHz) pulsations at the polar cap near the footprint of the open/closed field lines border. The dynamic spectra and wavelet structure of the polar Pi3 pulsation and IMF fluctuations showed a certain similarity. We suppose that ground pulsations, observed at polar latitudes, may be referred to the direct penetration and nonlinear transformation of the interplanetary hydromagnetic waves into the polar cap. Another possibility can be attributed to the wave generation at ionosphere altitudes by the oscillations of the substorm electron precipitation related to field aligned currents. A cloud leading edge arrival and magnetic storm main phase onset shifted the geomagnetic pulsation activity into the inner magnetosphere. The daytime magnetosphere pulsations may be attributed to the well-known field line resonance and the evening - morning pulsations - to wave processes associated with a substorm development.

## Radio-noises of the Mid-latitude Ionosphere in the Magnetically Conjugated Region of the Solar Eclipses

Musatenko, S. I., *Choliy, V. Y.*, Oltsik, Y. O.
Kyiv National Shevchenko University, Ukraine

Ionosphere disturbances generated with solar eclipse reveals itself at any point of the ionosphere thickness. The lunar shadow passage through the ionosphere manifests itself in the radio-noises of partially ionized ionosphere plasma. From the measuring of the ionosphere radio-noises during the total and partial phases of the solar eclipses and the analysis of the ionosphere-magnetosphere coupling, it was found that the lunar shadow effect should be detected not only in the total or partial phase but in the corresponding magnetically conjugated region in opposite hemisphere as well. The visible features in the magnetically conjugated region should be supplied with Alfven and magneto-sound waves, generated with ionosphere inhomogeneity (lunar shadow). During the interaction of the waves with the particles near the top of the magnetic field line (L $\sim$ 2.1) some of the particles were turned into the lost cone and then precipitated into both magnetically conjugated regions. For the measuring the mobile antenna complex for meter wave was used along with low-noise modulating radiometer with small registration constant (t=0.001 s), sampling rate was chosen as 200 Hz (sampling period $\sim$0.005 s). The measurement of ionosphere radio-noises of the northern hemisphere was done during the southern hemisphere eclipses of June 21, 2001 and Dec 04, 2002 in the point of observations where the phases of the magnetically conjugated eclipses were 0.68 and 0.85 accordingly. Helio and geomagnetic conditions were quiet: S was $\sim$25 and $\sim$20 accordingly. Both eclipses had projected into observational points during transitional periods of the day. Namely, the 2001's eclipse had been attaching to the evening terminator, but the 2002's eclipse had been detaching from the morning one but in magnetic conjugated point of observation (e.g. in northern hemisphere, in point of observation). The similar effects were observed during both eclipses but weren't during control days. They are: 1) increasing radio-noise micro-bursts density (10-40 ms) or their groups (1-2 s) with intensity up to 10-22 W/m$^2$Hz, 2) radio-noise fluctuations at the level 10-23 W/m$^2$Hz , 3) rare features in the spectrum of custom flicker-noise (S(f) $\sim$ 1/fa) interpreted as observations of the short-living ($\sim$5 min) magnetosphere resonator were observed in the time of shadow cone movement across the antenna's beam. Microbursts are interpreted as impulse particle precipitations, but fluctuations as diffuse ones. Comparison of the results of two eclipses with different partial phases shows us that the maximal effect in the ionosphere radio-noise should be observed along the projection of the full phase strip. The eclipses took part in quiet conditions, but in serious geomagnetic disturbances (S >30-35) the effects may diffuse. Another cause of the diffusion is solar flares. Both eclipses took place near the solstices.

## Drift Impulse Particle Precipitations in the Midlatitude Ionosphere

Musatenko, S. I., Kurochka, E. V., *Choliy, V. Y.*, Reshetnyk, V. M.
Kiev Shevchenko University, Ukraine

Decimeter range brightness temperature of the ionosphere radio-noise under the quiet conditions is about few Kelvin units. Under the perturbations the temperature may increase by ten or even hundred times. Time parameters of the radio-noise bursts may differ from the fractions of microseconds to several hours depending on the disturbance. The disintegration of the ring current after strong geomagnetic storms reveals itself during a week or more. From Nov 19 till Dec 14, 2000 the experiments were taken place on the investigation of drifting impulse precipitations of the particles in mid-latitude ionosphere (L$\sim$2.1) with time resolution $\sim$ 0.005 sec and using previously developed method. Total amount of time spent in the main experiment was 200 hours while control period lasted 180 hours. The micro bursts were detected in the radio-noise (t$\sim$10-40 ms, flux$\sim$10-22 W/m$^2$Hz) shifted with time for a few bounce periods. The drift of the precipitated particle beams along the longitude is one possible interpretation of the results. It turned out that particle beams may preserve own stability and dissipate their energy step-by-step during several bounce periods between magnetically conjugated points. The space-time subdivision of the bursts was done: the electron precipitation drifted towards east but proton ones towards west. It was shown that density of the radio-noise drift bursts increases sharply after geomagnetic disturbances, namely the hourly number of the events is 0.2 - 0.3 when the conditions are quiet (SKp $<$ 20) and 1.0 - 1.5 within light disturbance (SKp$\sim$35). Different time lag of the bursts maximum against maximum of Kp and Dst was determined: 6-8, 12-16 and 24 hours. There are three maximums of the drift events determined during the daily variations. They are morning (02-07 LT), daytime ($\sim$14 LT) and evening ones (17-18 LT). Drift bursts of the radio-noise are interpreted as mid-latitude precipitation of the electron beams (energy $\sim$50-150 keV) and proton ones (energy 50-150 MeV) with the violation of the third adiabatic invariant. In the considered case the longitude drift for single oscillation between magnetically conjugated points was more than 50 km. This value is much more than that for the situation where the third adiabatic invariant is preserved (units of kilometers). The micro bursts analyzed are wide band signals. The only mechanism for supporting the signal is bremsstrahlung during the ionization of the neutral atmospheric components by electrons. The protons undergo the recharging in the upper atmosphere and precipitate as high energy hydrogen atoms. Another ionization take place later during the collisions in the middle and lower atmosphere with emitting of single electron ($\sim$10 eV). In both cases the emanation of the radio-waves is provided by accelerated electron.

## Precipitation of the Energetic Protons as a Result of the Violation of Adiabatic Invariants

Musatenko, S. I., *Musatenko, K. S.*
Kyiv National Taras Shevchenko University, Ukraine

It is shown that in the middle latitudes (L 2) microbursts of the radio noise of the ionosphere in the USW range can be stipulated by precipitations of the energetic protons with energy E=50-150 MeV (Musatenko S.I. Geomagnetism and Aeronomy, to be published). The mechanism of the emission caused by this phenomenon may be bremsstrahlung that happens due to charge exchange and electron roughing from the neutral hydrogen atoms (Bozhkov A.I., Osipov N.K. Geomagnetism and Aeronomy, 1971, V.11, N6, p.1021). Precipitations of protons with mentioned energies trapped by magnetic field of the Earth can occur in disturbed and undisturbed conditions as a result of the violation of adiabatic invariants (Ilyin V.D., Ilyina A.N. Plasma Physics, 1982, v.8, p.148-154). In the context of the existing model nonadiabatic behavior may be caused by: - Arnold diffusion; - modulation diffusion; - global stochastic instability. The theory of the specified phenomena is developed in the single-particle approach, which does not take into consideration collective effects. In order to provide the flux of the radio noise, forming of the beams of energetic protons is needed. One of the possibilities of their generation is the Arnold instability that occurs as a result of interaction between principal resonances of the system. For the particle in geomagnetic field this is possible due to cooperation of the larmor, bounce oscillations and higher harmonics of the drift oscillations. It may occur only for quite high-energetic protons (E>50 MeV). For generation of the beams of such particles, the existence of their enough number is necessary (flux S$\sim 10^8 - 10^{10}$ part/cm$^2$). Whereas the theory is developed only in the single-particle approach and requires verification by cosmic and ground-based experiments. Thus it is needed to develop a theory of nonadiabatic movement of the proton beams and electron beams.

## The Development of the Magnetospheric Substorm and its Influence on the Magnetopause Motion

*Nikolaeva, N. S.*[1] , Borodkova, N. L.[1] , Klimov, S. I.[1] , Nozdrachev, M. N.[1] , Romanov, S. A.[1] , Parkhomov, V. A.[2] , Yermolaev, Y. I.[1]
[1]Space Research Institute RAS, Moscow, Russia,
[2]Irkutsk State Economy Academy, Irkutsk, Russia

The time evolution of the magnetospheric substorm was considered, and the substorm influence on magnetopause motion at the low latitudes was evaluated for the event 1997, February 10. For this purpose the plasma and magnetic field data, which were obtained from 4 satellites, such as WIND, Interball-1, Geotail, GOES8, were compared with magnetometer measurements on ground based stations. As result of analisys it was shown that during the substorm the release of the magnetotail energy was initiated from current sheet disruption in near Earth region, but the neutral line formation was occurred through a few minutes after this disruption. Almost simultaneously with substorm beginning the series of 4 quasiperiodical magnetopause crossings was observed by Interball-1 satellite at dusk side of low latitude magnetosphere. There were considered the various causes of the observed magnetospheric boundary motion, such as variation of solar wind parameters, the magnetic field merging, the K-H instability, and the sustorm activity. It was shown that only the last observed boundary crossing consistents with measured variation of solar wind parameters, and that during the formation of the substorm current wedge there was observed the short time motions of the magnetospheric boundary. The evaluation of K-H instability pointed that the significant part from the observed fast magnetopause crossings can be well explained by wavy boundary motion connected K-H instability. The K-H instability may be initiated in processes of magnetic field reconnection partly connected with the magnetospheric substorms.

## Cluster Observations of Equatorial Noise Below the Lower Hybrid Frequency

*Němec, F.*, Santolík, O., Gereová, K., Macúšová, E.
Charles University, Faculty of Mathematics and Physics, Prague, Czech Republic

We report results of systematic measurements of equatorial noise below the local lower hybrid frequency. Our analysis is based on the entire data set collected by the STAFF-SA instruments on board the Cluster spacecraft during the first two years of operation (2001 - 2002). We identify the equatorial noise emissions by selecting data with nearly linearly polarized magnetic field fluctuations, observed within 10 degrees of the geomagnetic equator. For each of the cases we find parameters of a gaussian model of the power-spectral density as a function of the geomagnetic latitude. Additionally, we use gaussian models for low, middle and high frequencies separately. Variations of wave parameters with the radial distance, magnetic local time and frequency are investigated.

## Precursors of Magnetospheric Substorm in Pulsating and Diffuse Auroras

*Osipenko, S. V.*, Safargaleev, V. V.
Polar Geophysical Institute, Apatity, Russia

We examined substorms started under the disturbed conditions, when diffuse or pulsating auroras remained on the sky after previous auroral activity. It is shown that in such cases poleward moving multiple arc-like forms are observed in the background luminosity. We connect these forms with MHD waves propagating inside the magnetosphere and initiated by changes of the parameters of interplanetary medium. We have analyzed the dispersion equation for these waves, which takes into account the curvature of magnetic field lines, the presence of smooth gradient of plasma pressure and the boundary conditions on the conjugated ionospheres. We estimate the spatial characteristics of the waves, which are close to those for the multiple auroras. Assuming the waves to be responsible for the magnetic reconnection in the magnetotail, we think that the multiple arc-like forms observed in diffuse or pulsating auroras before the auroral breakup may be the ionospheric trace of a substorm trigger.

## The Density Transition Scale at Quasi-perpendicular Collisionless Shocks — Hybrid Simulations

*Páral, J.*[1] , Somr, J.[1] , Trávníček, P.[1] , Bale, S. D.[2]
[1]Institute of Atmospheric Physics, Academy of Sciences, Prague, Czech Republic,
[2]Space Sciences Laboratory and Department of Physics, University of California, CA USA

The dependence of the shock thickness on the shock Mach number and the upstream proton beta have been subject of several studies. We carry out a parametric study of several numerical experiments in two dimension using standard hybrid code. We take the advantage of the fact, that in a numerical experiment whole shock front is available. A hyperbolic tangent is fitted to each density transition along the shock front to obtain a measure of the mean value of the shock thickness and a typical error of this value caused by natural perturbations of the shock front. We find the dependency of the shock thickness on the wide range of shock's Mach number and and upstream proton beta and compare these results with Cluster II observations.

## Quasi-periodic ELF/VLF Wave Emissions in the Earth's Magnetosphere: Comparison of Satellite Observations and Modeling

*Pasmanik, D. L.*[1] , Demekhov, A. G.[1] , Trakhtengerts, V. Y.[1] , Titova, E. E.[2] , Santolík, O.[3,4] , Jiříček, F.[4] , Parrot, M.[5]
[1]Institute of Applied Physics, Russian Academy of Sciences, Nizhny Novgorod, Russia,
[2]Polar Geophysical Institute, Apatity, Russia,
[3]Charles University, Prague, Czech Republic,
[4]Institute of Atmospheric Physics, Prague, Czech Republic,
[5]LPCE/CNRS, Orleans, France

Case study of quasi-periodic (QP) ELF/VLF hiss emissions observed onboard Freja, and Magion 5 satellites is performed. Properties of QP events are compared with parameters of energetic electrons and cold plasma, and other available data. Possible scenarios of formation of these emissions are discussed on the basis of self-consistent simulations of the cyclotron instability employing the information obtained experimentally. It is shown that the generation regime of self-sustained pulsations can explain consistently our data set. In particular, this numerical model is capable to explain such features of the dynamic spectrum of QP emissions as an increase in the frequency drift rate of during generation of a single element of QP emission, the alteration of QP elements with different frequency drift rates, and some other. Comparison of the observations and simulations makes it possible to specify the ranges of the parameters that are missing in the observations. We also discuss the relationship between QP hiss emissions and discrete VLF emissions observed simultaneously in space.

## INTERBALL-1 Observations of Plasma and Energetic Particle Fluxes Upstream of the Earth's Bow Shock

*Přech, L.*[1] , Šafránková, J.[1] , Němeček, Z.[1] , Kudela, K.[2]
[1]Charles University, Faculty of Mathematics and Physics, Prague, Czech Republic,
[2]Institute of Experimental Physics, Slovak Academy of Sciences, Kosice, Slovakia

This study is a continuation of our recent statistical examinations of solar wind plasma fluctuations in the Earth's foreshock and their relationship to measurements of energetic protons (cca 25 keV) fluxes under different solar wind and interplanetary magnetic field conditions. Now we study in more detail the influence of more energetic particles (cca 50 and 100 keV) and their angular distribution. We compare the intervals of upstream observations outside of the foreshock and inside the foreshock of different strength. We discuss possible physical explanations of observed phenomena.

## The Solar Wind Plasma and Interplanetary Magnetic Field Discontinuities Connected With the Sharp and Large Changes of the Ion Flux

*Riazantseva, M. O.*[1,2] , Zastenker, G. N.[2] , Richardson, J. D.[3]
[1]Skobeltsyn Institute of Nuclear Physics, Moscow State University, Moscow, Russia,
[2]Space Research Institute, Moscow, Russia,
[3]Center for Space Research, MIT, Cambridge, MA, USA

This work is concerned to the features of the sharp (less than 10 min) and large (up to several times) solar wind ion flux changes, which were investigated on the basis of the simultaneous plasma and magnetic field measurements by INTERBALL-1 and WIND spacecraft. The behavior of other parameters (solar wind bulk velocity and temperature, and interplanetary magnetic field (IMF)) during these changes was carefully investigated. According this analysis the classification of all kinds of observed disturbances was carried out. It was selected several basic groups of the events with different bulk velocity and IMF behavior. For some of these groups of our classification it was made an attempt to compare them with well known MHD discontinuities. We present examples of each kind of MHD discontinuities and examples of some ion flux changes that is not easy to describe as MHD discontinuities.

## Interplanetary Plasma Disturbances Caused by a CME Propagation

*Romashets, E. P.*[1] , Vandas, M.[2]
[1]Institute of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation of Academy of Sciences, Troitsk, Russia,
[2]Astronomical Institute, Academy of Sciences, Praha, Czech Republic

A method for calculation of magnetic field and plasma parameters around coronal mass ejections is presented. The system of MHD equations is solved everywhere outside the CME. Magnetic field is found analytically before calculation of plasma parameters. Velocity field — from frozen-in equation. The system of equations for density and temperature is solved analitycally and used for interpretation of plasma observations in interplanetary space. The solution is applicable for slow and fast CMEs, for the arbitrary angle between velocity and magnetic field at infinity.

## Plasma Turbulence as Source of Broad Band Ionospheric Plasma Emissions

*Rothkaehl, H.*[1] , Goldstein, P.[2] , Bleçki, J. S.[1] , Klos, Z.[1]
[1]Space Research Center PAS, Bartycka 18A, 01-716 Warsaw, Poland,
[2]The Andrzej Soltan Institute for Nuclear Studies, Hoza 69, 00 681 Warsaw, Poland

The broad band electrostatic as well as electromagnetic plasma waves detected in the top side ionosphere were investigated since the first measurements in situ were performed on the board of low orbiting satellite. The polar cusp being a region of the free access of the solar wind into the inner magnetosphere is also the site of turbulent plasma flow. Strong wave activities associated with these beams are manifested by VLF and HF modes. The plasma emissions detected in the main ionospheric trough also indicated the region of strong plasma turbulence. On the other hand the Earth ionosphere undergoes various man-made influences and as a consequence a disturb plasma region over populated area are observed. The aim of this paper is to discuss the morphological property of plasma emissions in VLF and HF frequency range and mechanism responsible for increase the background plasma radiation related to the region of plasma turbulence.

## Dayside Magnetosheath: Numerical MHD Modelling and Observations

*Samsonov, A.*
St. Petersburg State University, Institute of Physics, Russia

The dayside magnetosheath has been observed by ISEE 1-2, Interball, Cluster spacecraft. There are a few numerical 3-D MHD models which reproduce main features of a quasi-stationary flow. But many questions are still open. It is unclear yet how the magnetosheath profiles change in the case of a southward IMF in comparison with a northward IMF, how the magnetopause magnetic reconnection influences the magnetosheath flow, and how the magnetosheath downstream of a quasi-parallel bow shock differs from the magnetosheath downstream of a quasi-perpendicular bow shock. Moreover, the upstream solar wind conditions are very variable with many variations of the IMF direction, therefore the magnetosheath can not be stable during a spacecraft crossing in most cases. And, thus, it is difficult to compare observed magnetosheath profiles with results of a stationary numerical model. In this work, we present a non-stationary numerical 3-D MHD model which has been used for predictions of temporal variations of MHD parameters in the magnetosheath taking into account upstream solar wind observations. A few magnetosheath crossings by ISEE and Cluster have been studied, and many observational features there have been reproduced with the model.

## Modeling the Generation Conditions of Magnetospheric Pc1 Emissions

*Semenova, N. V.*[1] , Isaev, S. V.[2] , Demekhov, A. G.[3] , Yahnin, A. G.[1] , Yahnina, T. A.[1]
[1]Polar Geophysical Institute, Apatity, Russia,
[2]Radiophysical Research Institute, Nizhny Novgorod, Russia,
[3]Institute of Applied Physics, Nizhny Novgorod, Russia

According to the bouncing-wave model for generation of magnetospheric Pc1 emissions, the generation is possible if the total two-hop gain of an ion-cyclotron wave (ICW), taking into account possible losses, exceeds the unity. In this report, we study the behavior of the total ICW gain comprising the cyclotron amplification A near the equatorial plane due to resonant wave-particle interactions and losses due to the wave reflection from conjugate ionospheres. We calculate the total gain G for different local times and seasons at different latitudes. The reflection coefficients in the northern and southern hemispheres are calculated using the IRI ionospheric model. For calculations of the Alfven wave amplification, recently published equatorial cold plasma density model is used. To select the favorable conditions for the ICW generation, we apply the constraint G>1. Using this constraint, the generation frequencies as well as the regions of most probable generation in MLT-CGLat coordinates are found. Their seasonal dependence is also considered. We compare the model predictions with known features of the Pc1 pulsations and discuss their similarities and differences. This paper was supported by the RFBR grant 01-05-64437 and 03-05-06072 for young scientists.

## A Possible Source of the Dayside Pc1 Magnetic Pulsations Observed at High Latitudes

*Serebryanskaya, A. V.*[1] , Safargaleev, V. V.[1] , Koustov, A. V.[2] , Lester, M.[3] , Pchelkina, E. V.[1] , Vasilyev, A. N.[1]

[1]Polar Geophysical Institute, Fersman Str.14, Apatity, 184200, Russia,
[2]University of Saskatchewan, 116 Science Place, Saskatoon, SK S7N 5E2, Canada,
[3]University of Leicester, University Road Leicester LE1 7RH, UK

Induction magnetometer observations at the observatory Barentsburg (Spitsbergen archipelago) are combined with data of two other magnetometers located in Scandinavia and the Kola peninsula. We consider eight intervals with very large negative IMF Bz component. For these events, the cusp is expected to be strongly shifted equatorward of its statistical position so that the Barentsburg magnetometer to be located well inside the polar cup. For all cases the DMSP data indicate that the Barentsburg magnetometer was indeed inside the polar cap, whereas the two other magnetometers were collocated with the ionospheric projections of either the cusp, llbl or bps. Magnetic pulsations in the Pc1 frequency range were observed around the local noon and only in the polar cap. In two cases, for which SuperDARN convection data were available, the Pc1 activity correlated well with the intervals of large-scale convection reconfiguration, due to which the magnetic flux tubes drifting from the cusp tailward were crossing the location of Barentsburg. The convection reconfiguration seemed to be caused by a decrease in the IMF By component. We argue that the Pc1 pulsations were associated with the plasma depletion layer within the magnetosheath where, due to the anisotropy of the plasma, the IC instability can be excited. After reconnection, the flux lines with the unstable plasma turn out to be connected to the Earth's ionosphere and the IC waves were seen on the ground as Pc1 bursts.

## Some Features of the Plasma Flow in the Magnetosheath Behind Quasi-parallel and Quasi-perpendicular Bow Shocks

*Shevyrev, N. N.*, Zastenker, G. N.

Space Research Institute, Profsouznaya Str. 84/32, 117997, Moscow, Russia

Variations in the ion flux and magnetic field magnitude in the undisturbed solar wind, the foreshock and the magnetosheath have been examined by simultaneous measurements on INTERBALL-1, WIND and ACE spacecraft. The very high time resolution of INTERBALL-1 measurements allowed us to observe variations of these parameters in the range of frequencies 0.01 Hz-1 Hz. This made possible to reveal the high positive value of the correlation of the ion flux and magnetic field magnitude in the foreshock and to identify these variations as fast magnetosonic waves. The parameters of the magnetosheath in this range fluctuate with the very large amplitude and are subjected to extremely intensive variations even during the "quiet" conditions in the solar wind. It was found, that during the quasi-parallel orientation of interplanetary magnetic field (IMF) to the bow shock normal (when "theta Bn" angle <45 deg.) an increase in the amplitude of variations in the ion flux and magnetic field is observed not only ahead of the bow shock (in the foreshock region), but also behind of it, i.e. in the magnetosheath. "Theta Bn" angle turned out to be the value, which most of all affects the character of the turbulent flow of plasma in the magnetosheath, and sometimes also to values of the plasma parameters themselves. The application of a spectral analysis also made it possible to show substantial differences in the properties of variations in the ion flux and magnetic field magnitude in the undisturbed solar wind, foreshock and the magnetosheath (separately for the quasi-parallel and quasi-perpendicular conditions of the bow shock).

## Langmuir Wave Decay in the Terrestrial Foreshock: Evidence Based on CLUSTER WBD Observations

*Souček, J.*[1,2] , Dudok de Wit, T.[2] , Krasnoselskikh, V.[2] , Pickett, J. S.[3]
[1]Institute of Atmospheric physics, Prague, Czech Republic,
[2]LPCE/CNRS, Orleans, France,
[3]University of Iowa, Iowa City, USA

In this study we used the high-frequency electric field data from the WBD instrument of CLUSTER to investigate the occurrence of non-linear decay of Langmuir waves in the Earth's foreshock. The typical electric field waveform observed in the foreshock contains a superposition of several waves with frequencies close to $\omega_p$ often accompanied by bursts of ion-acoustic waves at lower frequencies. Such observations were often interpreted in terms of the parametric decay. Our analysis of foreshock electric field data shows that the frequency of the ion-sound wave is well correlated with the difference between the frequencies of the two strongest high frequency waves in the spectrum and that this correlation becomes more pronounced for higher amplitude Langmuir waves. This finding represents a strong argument in favor of the non-linear three wave decay scenario.

## ULF Wave Measurements on Board the Magion-4 Subsatellite: Monochromatic Wave Events Observed Near the Magnetopause Regions

*Teodosiev, D. K.*[1] , Nenovski, P. I.[2] , Hristov, P. T.[1] , Koleva, R. T.[3] , Vojta, J.[4] ,
Tříska, P.[4] , Chum, J.[4] , Shibaev, I.[5]
[1]Space Research Institute, Bulgarian Academy of Sciences, 6 Moskovska str., 1000, Sofia, Bulgaria,
[2]Geophysical Institute, Bulgarian Academy of Sciences, 3 G. Bonchev, 1113, Sofia, Bulgaria,
[3]Solar- Terrestrial Influences Laboratory, Bulgarian Academy of Sciences, 3 G. Bonchev, 1113, Sofia, Bulgaria,
[4]Institute of Atmospheric Physics, Bocni II., 14131, Prague, Czech Republic,
[5]Institute of Terrestrial Magnetizm, Ionosphere and Radiowave Propagation, Russian Academy of Sciences, Troitsk, Moscow Region, 142092, Russia

Our study is based on complete data set from ULF electromagnetic measurements carried aboard the Magion-4 subsatellite of the Inerball-1 spacecraft, when the high-latitude near-Earth magnetotail and magnetopause regions were encountered. The ULF wave activity is characterized by two types of spectra: a) monochromatic events of frequency ∼0.33 Hz located within the magnetopause and b) turbulent events of broadband spectrum having discrete bursts with minute duration. The former appear rarely and under northward IMF conditions. The frequency of these monochromatic ULF events seem stable while their intensity if modulated have non-stable period of one to two minutes. The characteristics of the monochromatic ULF events are reminiscent to 3 seconds period ULF events observed at bowshock environment. Observed monochromatic waves have the same period but they are located entirely at magnetopause region and could partly be observed in the edge of magnetosheath. The second type of ULF activity — the broadband (turbulent) spectrum arises usually under southward IMF conditions. Several possible generation and propagation mechanisms for the observed ULF waves are briefly proposed. The emergence of monochromatic ULF events at magnetopause region at frequency below the ion cyclotron frequency is associated with anysotropic ion fluxes flowing just inside the magnetopause.

## Hybrid Simulations of the Interaction Between Solar Wind Flow and the Hermean Magnetosphere

*Trávníček, P.*, Hellinger, P.
Institute of Atmospheric Physics, Academy of Sciences, Prague, Czech Republic

We will examine the magnetosphere of Mercury using global three dimensional hybrid plasma simulations. Hybrid simulations treat ions as particles and electrons as a fluid. Having ions as particles allows ion kinetic behavior and waves to be included in the physical treatment of the plasma as compared to magnetohydrodynamic (MHD) modeling that treats the plasma as a single magnetized fluid and does not include such kinetic effects. Kinetic effects are essential for understanding magnetospheric physics. Hybrid simulations scale to the ion inertial length and thus on a global scale are somewhat limited in spatial extent compared to an MHD simulation. Hermean magnetosphere is estimated to be only a few times the planetary radius, it can fit within a hybrid simulation system. The overal structure of the interaction between a magnetized obstacle in the solar wind flow is determined by few basic parameters (namely the solar wind density, background magnetic field, and the speed of solar wind, and also the strength of the magnetic dipole of the obstacle and its radius). The structure of the interaction of the solar wind flow with Mercury is to a large extend unique when compared to other planets. For example, the magnetic moment of the Mercury is over 1000 times smaller than that of the Earth and also the solar wind is stronger nearby Mercury than at Earth's vicinity. The typical magnetosperic scales are comparable to the ion gyroradii and hence kinetic effects are important for the overall structure of the interaction between the Hermean magnetospere and the solar wind. In this paper we shall focus on the study of the overal structure of the bow shock and magnetosheath formed in front of Mercury. We shall examine the magnetosphere of the Mercury and we make qualitative comparison of the results with the measurements of the Mariner 10 spacecraft.

## Space Weather Effects on the MAGION-4 and MAGION-5 Solar Cells

*Tříska, P.*, Chum, J., Czapek, A., Hruška, F., Šimůnek, J., Šmilauer, J., Truhlík, V., Vojta, J.
Institute of Atmospheric Physics, Acad. Sci. of the Czech Republic, 141 31 Praha, Czech Republic

The MAGION-4 (58.7 kg) and MAGION-5 (68.5 kg) satellites were launched as part of the INTERBALL mission into high elliptical orbits with apogee about 200,000 km and 20,000 km, respectively, and with initial perigee close to 800 km. The mechanical structure and the solar array configuration used for the two s/c were practically identical. The solar array consists of 18 solar panels of the size 195×195 mm. Most of them are deployed almost perpendicularly to the s/c spin axis pointed toward the Sun. Currents and temperatures of all the solar panels were regularly measured and recorded as part of the spacecraft housekeeping data. The Volt-Ampere characteristics of the solar panels were measured periodically. This data was used to evaluate the solar array degradation during the mission. A relatively strong degradation of the solar array was observed on MAGION-5 in comparison with MAGION-4. This fact can be explained by the difference between the two orbits. The MAGION-5 s/c crosses the radiation belts 8 times per day whereas the MAGION-4 only 2 times per 4 days. The existing experimental data refers to the period of increasing and high solar activity with enhanced occurence of strong solar events. The evaluation of the data set covering a period of 6 years has shown that solar proton events can have an almost immediate negative effect on the solar array efficiency. However, in the case of MAGION-5 the major role in the solar cells degradation plays the long-term effect of the radiation belts.

## Variability of Electron Temperature in the High Latitude Inner Magnetosphere

*Třísková, L.*, Truhlík, V., Šmilauer, J.
Institute of Atmospheric Physics, Prague, Czech Republic

Using the Interball-2 and MAGION-5 data, the variability of electron temperature ($T_e$) in high altitudes (10000-19000 km) and invariant latitudes $50 - 60°$ has been studied. A second, warmer, electron population was found. Probability of its occurrence increases with altitude and is greater at night than during the day hours. Manifestation of solar and geomagnetic activity in the Te distribution is shown. For comparison, behavior of the warmer electron population in mid-latitudes ($30 - 40°$ INVL) and in the altitude of 16000-19000 km is also presented.

## Fresh Plasma Injection Into Ion Spectral Gaps

*Vladimirova, G. A.*[1] , Kovrazhkin, R. A.[1] , Glazunov, A. L.[1] , Sauvaud, J.-A.[2]
[1]Space Research Institute, Profsouznaya str., 84/32, 117810, Moscow, Russia,
[2]Centre d'Etitude des Rayonnements, BP4346, 310029, Toulouse, France

The burst filling-up of ion spectral gaps has been found for the first time in the INTERBALL-2 data. The analysis of some series of consecutive orbits (with 6 h interval) evidence that the ion spectral gaps filling occur during the substorm development. Such events are related mainly to the particle arrival into the morning sector of the magnetosphere. They may indicate the penetration of fresh plasma into the ion spectral gap.

## Ion Dispersion in the High-altitude Cusp: Spatial or Temporal Features?

*Šimůnek, J.*[1,2] , Němeček, Z.[2] , Šafránková, J.[2] , Přech, L.[2]
[1]Institute of Atmospheric Physics, Czech Academy of Sciences, Prague, Czech Republic,
[2]Charles University, Faculty of Mathematics and Physics, Prague, Czech Republic

Structured dispersion patterns of the ion precipitation in low- and mid-altitude cusp regions have been reported by many authors. These patterns are interpreted either as temporal features in terms of the pulsed reconnection model or as spatial changes caused by a combination of the particle velocity with the convection of magnetic field lines. It is generally expected that the spatial dispersion is predominantly observed in lower altitudes where the spacecraft crosses a wide range of geomagnetic coordinates in a short time, whereas the high-altitude spacecraft observes temporal changes because it stays nearly on the same field line for a long time. We have analyzed several passes of the Interball-1/Magion-4 satellite pair through the high-altitude cusp and found that both temporal and spatial dispersion effects are important even in the magnetopause vicinity. Our investigations suggest that beside already reported latitudinal dispersion, the longitudinal dispersion can be observed during intervals of sufficiently high east-west magnetic field component.

## Seasonal Variations of the Pc1 Frequency in Auroral Zone

*Yahnina, T. A.*[1] , Yahnin, A. G.[1] , Demekhov, A. G.[2] , Manninen, J.[3] , Kultima, J.[3] , Kangas, J.[3]
[1]Polar Geophysical Institute, Apatity, Russia,
[2]Institute of Applied Physics, Nizhni Novgorod, Russia,
[3]Geophysical Observatory Sodankyla, Sodankyla, Finland

Long-term observations of the EMIC waves (geomagnetic pulsations Pc1) in Sodankyla Geophysical Observatory (SGO, L=5.2) showed that the pulsation frequency exhibits seasonal variations. The frequency has a tendency to increase during spring and autumn. To explain these variations we used particle precipitation data from low-orbiting NOAA-12 satellite. It has been shown (Yahnina et al., GRL, 2000; Yahnina et al., Cosmic Research, 2002) that localized precipitation of energetic protons mark the field line of the region where the particles interact with the EMIC waves. We showed that variations of the pulsation frequency associate with variations of proton precipitation latitude, that is distance of the wave source from the Earth. In turn, the seasonal behavior of the source distance is associated with seasonal variations of geomagnetic activity. The satellite observations of proton precipitation were used also for interpretation of so-called multi-band Pc1 events. We showed close relationship between multi-frequency Pc1 spectra and simultaneous existence of several sources of the EMIC waves in the magnetosphere.

## Comparison of CME and Solar Flare Geoeffectiveness

*Yermolaev, Y. I.*, Yermolaeva, I. F.
IKI RAS, Moscow, Russia

The comparison of methods and results of analysis of phenomena on the Sun, in the interplanetary space and the Earth's magnetosphere shows that besides the methods used in each of areas the large importance for research of all chain of solar-terrestrial physics has also a way of comparison of phenomena in various areas or direction of data tracing. For research of geoeffectiveness of the solar and interplanetary phenomena (i.e. their abilities to generate the magnetic storms on the Earth) it is necessary originally to select the phenomena, respectively, on the Sun or in the solar wind and then to compare the phenomenon with event at the following step of chain. Thus the obtained estimations of CME influence on the storm both directly (by one step "CME ⇒ Storm") and by multiplication of probabilities of two steps ("CME ⇒ Magnetic cloud, Ejecta" and "Magnetic cloud, Ejecta ⇒ Storm") are close to each other and equal 40-50%. This value strongly differs from results 83-100% obtained by search of back tracing correlation which characterizes not geoeffectiveness of CME and a probability to find the appropriate candidates among CME for magnetic storms. The obtained value 83-100% are not confirmed by the two-step analysis of sources of storms as at steps "Storm ⇒ Magnetic cloud, Ejecta" and "Magnetic cloud, Ejecta ⇒ CME" values are (25-75)% each of which is less than the factor obtained by the one-step analysis "Storm ⇒ CME". The obtained estimations of CME geoeffectiveness 40-50% are close to estimations of geoeffectiveness of solar flares 30-40% and exceed them only a little. As we have shown in paper by Yermolaev and Yermolaev [Cosmic Research, N 1, 2002], for random distribution of solar processes and the magnetic storms the formally counted coefficient of correlation can be 30-40%. It means that the obtained estimations of CME and solar flare geoeffectiveness can be result of random processes and therefore the forecast of geomagnetic conditions on basis of observations of the solar phenomena can contain high level of false alarm.

# Author Index

# Dependence of Cold Proton Temperatures in the Night, Day, and Dusk Sides of the Earth's Plasmasphere on Geomagnetic Disturbances as Observed by the Auroral Probe/Alpha-3 Experiment

*Bezrukikh, V. V.*[1] , Kotova, G. A.[1] , Lezhen, L. A.[1] , Verigin, M. I.[1] , Lemaire, J.[2] , Pierrard, V.[2]
[1]Space Research Institute of RAS,Prfsoyuznaya 84/32, Moscow, Russia,
[2]Institut D'Aeronomie Spatiale De Belgique, avenue Circulaire 3, 1180 Bruxelles, Belgium

Proton temperatures have been determined from energy spectra of cold protons measured by the Interball 2/Alpha-3 instrument. The L-distributions of proton temperatures obtained from September 1996 to May 1997 in the nighttime (23–02 MLT), daytime (08–14 MLT), and dusk (18–22 MLT) local time sectors of the plasmasphere are considered for magnetically quiet periods, as well as for magnetically disturbed conditions. The data show how the different characteristic temperature profiles depend on the level of geomagnetic activity. In the local time sector 08–14 MLT typical temperature values are $T \sim 4000$–$5000$ K; they are almost independent of $L$ for $2 < L < 3$, for $0 < K_p < 6$. In the nighttime sector 23–02 MLT, the dependence of temperature on the $L$ can be approximated by $T \sim L^{0.7} \sim 1.6$ for $2 < L < 3$, when the level geomagnetic activity is low. However when geomagnetic activity increases up to $K_p = 5$ or above, the proton temperature in the plasmasphere decreases, and its gradient versus $L$ is significantly reduced. In particular, the proton temperature profile is well approximated by $T \sim L^{0.7}$ during quiet conditions from 13 UT September 25 until 19 UT September 26, 1996 . At 23 UT on September 26, after $K_p$ increased up to 6+, the temperature became lower than 1500 K at $1.5 < L < 2.7$, and its cross-L distribution could be approximated by $T \sim L^{0.2}$. In the dusk sector 17–21 MLT, the temperatures varied in the range 4000–7000 K; it was nearly independent of $L$ for $2 < L < 4$. The same behavior was observed in the daytime sector. It was found that for $K_p < 5$, $T(L)$ was independent of the level of geomagnetic activity in the dusk sector. However, for more disturbed conditions ($K_p > 5$) the dusk side temperature distribution changes with $K_p$ as drastically in the night side sector. Sometimes at the boundary between the evening sector and the night side MLT sectors, the $T(L)$ distributions were similar to those generally found in the night time sector. We suggest that this behavior is due to the change of LT of the boundary between day and night MLT sectors. In an earlier study we suggested that the mechanism responsible for the marked temperature decrease in the night time plasmasphere, is the upward motion of cold ionospheric plasma refilling the flux tubes that had been emptied during the preceding substorm(s). Local convection of the uplifted cold ionospheric plasma in the bulge region could also be responsible for the decrease of $T_p$ in the dusk MLT sector.

## Evaluation of Interplanetary Shock Analysis Techniques

*Kasper, J. C.*, Lazarus, A. J., Ashmall, J., Mitchel, B. S.
MIT Center for Space Research, USA

In order to evaluate the success of interplanetary shock analysis techniques, we have identified 181 shocks which were observed by the plasma and magnetic field instruments on the Wind and ACE spacecraft between 1998–2002. For each event, the shock normal and speed are calculated using the magnetic coplanarity, velocity coplanarity, and the Rankine-Hugoniot jump relations, as well as three mixed methods which combine velocity and field data. The "success" of each method is evaluated by comparing the time delay between observations of the same event by the two spacecraft and a predicted delay using the derived shock speed and direction. Once we have established the accuracy of the shock analysis, we may examine the variation of shock properties as a function of spacecraft separation along the surface of the interplanetary shock.