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CO-CHAIRS' FINAL REPORT
OF THE
NATIONAL ACADEMY OF SCIENCES-
ACADEMY OF SCIENCES OF THE USSR
WORKSHOP ON SOLAR ACTIVITY, SOLAR WIND,
TERRESTRIAL EFFECTS, AND SOLAR ACCELERATION
OCTOBER 15-20, 1990

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EXECUTIVE SUMMARY

From October 15-20, 1990, in accordance with the Agreement on Scientific Cooperation Between the National Academy of Sciences (NAS) and the Academy of Sciences of the USSR (ASUSSR), a scientific workshop was held in Dagomys, USSR entitled "Solar Activity, Solar Wind, Terrestrial Effects, and Solar Acceleration" This document contains a summary of the proceedings of the workshop, attendance lists for both delegations, a scientific agenda, and a list of the scientific site visits which the NAS delegation made immediately following the workshop.

The workshop was cochaired by Professor Norman F. Ness, President of the Bartol Research Institute at the University of Delaware and an NAS member; Professor Charles F. Kennel of the University of California at Los Angeles; and Professor Viktor N. Orayevskiy, a corresponding member of the ASUSSR and Director of the Institute of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation (IZMIRAN) in Troitsk.

The chairmen organized the workshop presentations around four main themes:

1. Solar Activity: Solar cycle manifestations, both large scale and small scale, as well as long-term and short-term changes, including transients such as flares.

2. Solar Wind: Sources of solar wind, as identified by interplanetary observations including coronal mass ejections (CMEs) or X-ray bright points, and the theory for and evolution of large-scale and small-scale structures.

3. Terrestrial Effects: Magnetosphere responses, as observed by spacecraft, to variable solar wind and transient energetic particle emissions. Also, ground-based studies of ionospheric and magnetospheric disturbances including ring currents and Sq enhancements.

4. Solar Acceleration: Origin and propagation of solar cosmic rays as related to solar activity and terrestrial effects, and solar wind coronal-hole relationships and dynamics.

A Soviet-American workshop on solar terrestrial physics is significant for several reasons:

First, the Division of Space Physics of NASA is considering the development of the "Solar Probe" mission, which would be sent near the sun in the second half of the 1990s. This particular workshop allowed the American and Soviet participants to explore possible collaborations related to the objectives of the solar probe project in a noncommittal but open manner.

Second, the sun is just now at the peak of cycle 22. Specialists have completed over 25 years (one 22-year magnetic solar cycle) of in situ measurements by American and Soviet spacecraft of the interplanetary medium and heliospheric cosmic ray variations. The workshop provided an excellent opportunity for an exchange of data and interpretations.

Third, present and future spacecraft to be launched by the United States and the Soviet Union will provide data bases to extend archival recording of solar-terrestrial coupling. It was therefore timely for both countries to share recent results and plans for future research of scientific problems.

Finally, the workshop examined the current state of knowledge about sequences of events linking activity at the surface of the sun to its terrestrial response. One example is the sequence that starts with the heating of the solar corona: the expansion of part of the corona out into a "coronal mass ejection" (CME); the solar flare activity associated with these events; the further expansion of the CME into the solar wind; the formation of shocks leading the CME; the acceleration of energetic particles by those shocks; and the interaction of the energetic particles, shocks, and coronal plasma with the earth's magnetosphere, ionosphere, and atmosphere to create a "magnetic storm."

The study of all these events, and particularly the quantitative reconstruction of the chain of events, requires the integration of knowledge from several disciplines. Crucial understanding is acquired from both space-and ground-based data, which are the province of the National Aeronautics and Space Administration and the National Science Foundation in the United States. There are few workshops that review the whole solar-terrestrial chain in the United States. This particular workshop therefore had the added benefit of helping to set objectives for the coordination of the U.S. program of space- and ground-based research.

The NAS expresses appreciation to the National Science Foundation and the National Aeronautics and Space Administration which provided necessary funding for the workshop.

II. WORKSHOP PROCEEDINGS

Co-Chairmen:	V.N. Oraevsky N.F. Ness C.F. Kennel
Organizing Committee Chair:	V.N. Oraevsky
Deputy Chairman:	Vu D. Zhugzhda V.V. Fomichev
Secretaries:	V.N. Ishkov V.V. Zhurin A.I. Osin Yu. K. Shiyan V. Lebedev R.T. Tretyakawa L.A. Utrobina

Tuesday, October 16, 1990

Morning Session 9:00 - 13:00

Session 1. Geoffective Solar Events (Solar Activity)
Chairman: Oraevsky, V.N.

1.1 Ruzmaikin, A.A. (IZMIRAN, Troitsk)
The Origin of Solar Magnetism

ABSTRACT

An initial solar magnetic field is formed in the collapse of the protosolar nebula. This cosmogonic field is still present in the radiative core and is hardly consistent with any persistent differential rotation in it. The violent convection in the solar convective shell removes a memory about the initial magnetic field so that a dynamo reproducing the observed magnetic field is needed.

The solar dynamo creating the large scale magnetic field acts due to a differential convection and mean helicity in the convective zone. The field has a form of magnetic wave on which period and direction of propagation depend for the distribution of the differential rotation and mean helicity. Qualitatively this solution explains the mechanism of the solar cycle. However for a quantitative justification more helioseismological information on the distribution of the source of magnetic field generation is needed.

A back action of the mean helicity and differential rotation on the magnetic field results in non-linear oscillations on a phase portrait of which there is a low dimension strange attractor. It can explain the origin of the Grand Minima like the Maunder Minimum. There are attempts to determine the dimension of the solar attractor directly from the observations.

The small-scale solar magnetic fields have a highly intermittent character. The intermittent distribution can be explained by the dynamo theory. A natural dynamo model predicts a fractal structure of the small-scale magnetic field. The confrontation of the model with the fractal characteristics observed at Mt. Wilson and La Palma results in an important conclusion on the structure of the convective velocity field.

REVIEW

Dr. Ruzmaikin discussed the origin of solar magnetism from the collapse of the protostar nebula. This primordial magnetic field still lies within the solar core in his model. Within the solar convection zone, he discussed general dynamo mechanisms. The solar dynamo may work, in his view, using differential rotation and a mean helicity of turbulent motions.

1.2 Schatten, K.H. (NASA, GSFC, Greenbelt)
The Dynamo Method for Solar Activity Predictions

ABSTRACT

Based upon physical principles, the "dynamo" activity prediction method utilizes the Babcock model of the solar cycle. In this model, the Sun's polar field at the start of a cycle is regenerated by dynamo processes into a toroidal field within the Sun, peaking years afterwards during the maximum phase. Thus the Sun's polar field serves as a "seed" for future solar activity and thus can be used to forecast future activity. We have been able to correctly predict, several years in advance, the magnitude of solar cycles 21 and 22 after having previously tested the dynamo method with 8 solar cycles. The dynamo method was an outgrowth of the "precursor" methods of Ohl and Ohl and Brown and Williams, wherein it was noticed that fluctuations in the Earth's field (geomagnetic activity) could be used to predict solar activity. Although their correlations were statistically significant, there was no clear physical mechanism involved which could explain how variations in terrestrial magnetism could influence future solar behavior. We will discuss the physical mechanisms (between the Sun's dynamo, the solar wind, and the terrestrial field) that enables the geomagnetic field to serve, as a "precursor" for future solar activity. In early 1987, near solar minimum, the dynamo method went against folklore (wherein even numbered cycles are small), by predicting that cycle would be exceptionally large - the 2nd largest in recorded history! Conversely, statistical methods predicted that cycles 21 and 22 would be low, and were proved dramatically wrong for cycle 21 when Skylab returned to Earth prematurely due to the enhanced drag caused by activity related to exospheric heating. In 1988, solar activity levels increased faster than for any previous cycle causing great concern. We will compare the present state of solar cycle 22 with the predictions.

1.3 Makarov, V.I., (Main Astronomical Observatory, Leningrad)
Global Solar Activity: Evolution of Large Scale Magnetic Fields

ABSTRACT

The global solar activity is considered as an interaction of 3 types of activity: B component that is the low-latitude (sunspots) and high-latitude (polar faculae) activities and Br component that is observed in an evolution of latitude zones of a weak magnetic field. It is shown that the 22-year solar cycle begins with a cycle in which a 3-fold reversal of the polar magnetic field is observed in one of the hemispheres, but a single reversal takes place in the succeeding II-year cycle. The variation spectrum of the large-scale magnetic field of the Sun is analyzed in the range of 1-30 nHz in the period 1910-1985. A high correlation between activity fluctuations at high and low latitudes is analyzed within the model of global activity. The observational data of the present solar cycle No. 22 are discussed: the onstart of 3 types of activity, velocity of the poleward migration of magnetic fields, peculiarities of the next magnetic field reversal.

REVIEW

The author described the evolution of large-scale magnetic structures on the surface of the sun over the course of 6-7 cycles of activity. The data on which his work is based are synoptic Hα charts on which quiescent filaments serve as proxies for magnetic neutral lines. An older view of magnetic evolution would have concentrated solely on regions of strong field (spots and active regions): these features follow the usual "butterfly" pattern with spots approaching the equator as the cycle progresses. Makarov showed that the weak field regions (specifically the neutral line between large unipolar regions) have quite different behavior: they migrate poleward as the cycle progresses, with a phase which leads the sunspot "butterfly" by ~6 years. (This result may help to save the dynamo models from a hitherto embarrassing error in sign.)

The weak field regions at high latitude have been averaged by Makarov to determine a dominant polarity. The switch of this dominant polarity marks the onset of a new cycle at high latitudes. This switch occurs sharply in certain cycles, with a clear cut reversal occurring over a short interval. But in other cycles, short-lived (~1 year) reversal occurs following the onset of an apparently new cycle. In such cases, an extra 1-2 years elapse before the reversal of dominant polarity is complete at high latitudes; Makarov suggests that, as well as the familiar 22-year cycle, solar activity also includes a 2-year component.

1.4 Feynman, J. (Jet Propulsion Laboratory, California Institute of Technology, Pasadena)
Coronal Mass Ejections Associated with Major Solar Flares

ABSTRACT

Between March and December of 1989, a series of great active regions crossed the face of the sun. These regions produced some of the most intense solar flares, geomagnetic storms, and interplanetary energetic proton events that have been seen in the past thirty years. Coronal mass ejections (CMEs) associated with these active regions were observed by the coronameter on board the Solar Maximum Mission until its re-entry into the Earth's atmosphere in November. Several aspects of these events will be discussed. I will compare and contrast the events associated with the flares of March 6th and March 9th. Both flares were classified as 3B or larger and X4 or larger. However, the March 6th flare was associated with a major CME and intense interplanetary proton events. No CME was observed for the March 9th event and the data indicates that none took place. This implies that major flares do not cause CMEs. The probable failure of the March 9th event to produce an enhancement of the interplanetary proton fluxes is in agreement with the concept that CME are involved in the production of energetic proton events. In addition, I will discuss the changes required in the predictive models of the interplanetary proton environment due to the occurrence of the 1989 proton events.

1.5 Chertok, I.M., Fomichev V.V. (IZMIRAN, Troitsk)
Solar Radio Bursts, Coronal Mass Ejection, and Proton Events

ABSTRACT

This report is a short review of some investigations, performed in IZMIRAN's Solar Radio Laboratory, on flare radio bursts and their use for diagnostics of two principal sporadic disturbances: interplanetary proton fluxes and Coronal Mass Ejections (CMEs).

The main regularities of relationship between radio bursts and proton fluxes have been studied and the corresponding technique of the proton flare diagnostics has been developed (Akinyan et al., 1980; Chertok and Fomichev, 1990). This technique is based on the close physical relation between the flare acceleration of electrons and protons. It allows estimation of the expected parameters of the >10, 30, and 60 MeV proton fluxes near the Earth, as well as the power-law index of their energy spectrum and the polar cap absorption (PCA) amplitude, in advance of the particle event onset. The intensity and frequency spectrum of microwave bursts contain information on the intensity and energy spectrum of protons, and the meter component of radio emission is an indicator of coronal disturbances defining the escape condition of particles from the flare region. The flare heliolongitude is taken into account.

The proton flare diagnostics technique can be used also as an effective investigative instrument. In particular, it revealed that there is a special class of events in which the >10 MeV proton flux near the Earth is considerably enhanced in comparison with the average particle flux for the given intensity of microwave and metric radio bursts. It is discovered that the relative surplus factor reaches the value k - 10 - 100 for flares with the soft frequency radio emission spectrum (the spectral maximum frequency fm - 3-5 GHz) and with the corresponding soft energy spectrum of protons (the integral spectrum index ~ - 2.0 - 3.50. The surplus factor decreases sharply with increasing proton energy. A prolonged acceleration during the magnetic reconnection, at the time of formation of post-flare loops, may be an additional source of the surplus and delayed proton fluxes in interplanetary space (Bazilevskaya et al., 1990).

The characteristics of microwave bursts from flares associated with CM-As were analyzed (Chertok, Ghezdilov, and Zaborova, 1990). A combination of the peak intensity and effective duration is taken as a main characteristic of the bursts. The analysis of the SOLWIND CMEs reveals that the distribution of the events on the intensity-duration plot allows not only separation of the separate flares with CMEs and the ones without CMEs, but also determination of the relation between the bursts' characteristics and main parameters of CMEs (angular sizes, speed, mass, shapes). The large and fast CMEs of complex shapes are observed as a rule in combination with the most intensive and long-duration bursts. The CMEs having average parameters and simple shapes are mainly identified with moderate non-impulsive microwave bursts as well as with "gradual rise and fall" radio bursts. The majority of impulsive bursts are not accompanied by CMEs in general, but the most intensive of them may be sometimes associated with small and simple CMES. That means that there is a wide spectrum of events with the different correlation between the eruption of CMEs and flare or flare-like energy release.

REVIEW

> The authors studied flare production of protons and Coronal Mass Ejection (CME). They found the proton flux is enhanced for events with relatively low frequency microwave burst peaks, that largest and fastest, CME's are connected with the biggest and fastest flares, and that average CME's correlate with average flares.

1.6 Zirin, H., Marquette, W. (Big Bear Solar Observatory, California Institute of Technology)
· *BEAR Alerts: A Successful Flare Prediction System*

ABSTRACT

To test our understanding of solar flares, we have begun the BEARALERT flare prediction program. When we see a likelihood of high activity, we issue a BEARALERT message via electronic mail to a list of colleagues and observatories around the world. Neither the exact timing of the flare nor the possibility of emergence of new active regions can be predicted. But high-resolution observations of the magnetic configuration, Hα brightness and structure, and other properties of a region enable one successfully to determine the probability of flares over a period of some days. the criteria for prediction are given and discussed, along with those for filament eruption.

In this discussion we analyze 45 BEARALERTS issued between December 1987 and November 1989. We evaluated their success by counting the M and X-class flares in six days following the alert and comparing these results with those of a number of other predictive schemes. We find the single regions chosen had about 40% more flares than the whole disk on random days, or several times more than individual regions chosen at random. There was a gain of 1.5 to 2.0 times in flare frequency compared to regions selected by spot size or complexity. We also find an improvement of 20-40% over large or complex regions that have had some flares already. The ratio of improvement has increased, with time as we gained experience. In the 24-hour period following each alert, one or more M-class or greater flares occurred 72% of the time, about twice the success rate obtained by NOAA.

The criteria for BEARALERTS includes elongated umbras, island delta spots, high magnetic shear, and rapid spot motion. We are currently examining, the role of anomalous Doppler shifts and high radio flux.

DISCUSSION

Afternoon Session 15:00-18:30

Session 2. Solar Neutrinos, Helioseismology

Chairman: Ness N.F.

2.1 Oraevsky, V.N., Semikoz, V.B. (IZMIRAN, Troitsk), Smorodinsky, Ya.A. (I.V. Kurchatov Institute of Atomic Energy, Moscow)
Electrodynamic Neutrinos in the Sun and Stars

It is shown that the electromagnetic properties of the neutrino in dispersive media (DM) such as the Sun and star differ greatly from the vacuum ones.

The polarization of DM by weak forces is much stronger than the vacuum one (vac - 1) which is close to zero and has the character of small RC at reasonable values of momentum transfer $|q^2| << Mw^2$, where Mw is the mass of W-boson. In a medium the polarization |^W, med - 1| is comparable with and greater than unity and this determines a relatively large value of the additional interaction of electromagnetic nature comparable with the familiar Born contribution[1,2].

The polarization of DM leads to a screening of the neutrino elastic scattering from nuclei in plasma. The multi-pole electromagnetic moments of Dirac and Majorana neutrinos in a medium were calculated in the standard model[4].

The addition of a small admixture of right currents to the weak interaction leads in DM to appearance of an effective magnetic moment of the neutrino, which is proportional to the density of the medium but which leads to the helicity flip even with neglect of the vacuum magnetic moment. The inclusion of right currents immediately causes the appearance in a homogeneous medium of a finite effective neutrino mass which is proportional to the density of matter[5].

References

1. V.N. Oraevsky and V.B. Semikoz. ZhETF, 1984, 86, 796.
2. V.N. Oraevsky, V.B. Semikoz and Ya.A. Smorodinsky. ZhETF Pis'ma, 1986, 43, 549.
3. L.B. Leinson, V.N. Oraevsky and V.B. Semikoz. Phys.Lett., 1988, 209B, 80.
4. V.B. Semikoz and Ya.A. Smorodinsky, ZHETF, 19B9, 95, 35.
5. V.N. Oraevsk-v, V.B. Semikoz and Ya.A. Smorodinsky. Phys.Lett., 1989, 227B, 25-0.

2.2 Semikoz, V.B. (IZMIRAN, Troitsk)
A Change of the Neutrino Helicity in a Dense Plasma

ABSTRACT

It is possible to explain the Davis puzzle of solar neutrinos due to the presence of a large vacuum neutrino magnetic moment and its interaction with solar magnetic field. The main difficulty of this idea is the necessary compatibility of some astrophysical and cosmological constraints on the vacuum magnetic moment with the admissible values of solar magnetic field inside the Sun.

It is shown that in the same models (with right currents) in a dense medium there is a more effective mechanism of neutrino helicity flip than the usual channel via vacuum magnetic moment of neutrino. The polarization of isotropic dispersive medium by moving neutrino (due to weak forces) leads to the appearance of an effective magnetic

moment of neutrino which is proportional to the density of the medium and greater by approximately two orders of magnitude than vacuum one in the same model[1].

Apparently, a further development of the suggested approach for the case of the magnetoactive (anisotropic) solar plasma is called for.

References

1. V.B. Semikoz, JETP Lett.; 1989, 49, N5, 288.

REVIEW

The polarization of a dispersive medium by a neutrino via weak interactions leads to an induced electric charge for the electron neutrino. It has been found that this electro-magnetic channel of scattering leads to a screening of the total cross-section. The net total cross-section is ten times less than the well-known standard one and as a result, the neutrino transport by neutrino diffusion inside the neutrino sphere of a collapsar would be changed. It has also been found that in degenerate neutron matter with density ~ 10^{14}, there are collective interactions of neutrinos with zero sound and spin waves which are more important for neutrino energy losses than by the usual channel of e scattering. The effects of different extended models of neutrino interactions in a dispersive medium have been studied, leading to several new interesting results: there is a more effective mechanism for neutrino helicity flip than the usual one via the vacuum neutrino magnetic moment; there are some new channels of neutrino helicity flip without taking into account a polarization of medium; there is an effective neutrino mass arising in homogeneous media; there is a screening of a large vacuum neutrino magnetic moment in the hot plasma of the Early Universe.

2.3 Gavrin, V.N. (Nuclear Research Institute, Troitsk)
Gallium Experiment on *Solar Neutrinos*

(This paper was not presented at the workshop)

2.4 Zaitsev, V.V. (Institute of Applied Physics, Gorkiy)
Solar Plasma Diagnostics by Radio Emission

(No abstract submitted)

REVIEW

V.V. Zaitsev reported on oscillatory emissions (period ~ 1 sec.) observed in a solar burst at = 8 mm. Zaitsev calculated the oscillation induced in the chromosphere by

the flare process. He calculates appropriate flares and chromospheric models. He also confirmed the millisec pulsations found by Kaufman at 37 GH-z.

2.5 Krimigis, S.M. (Applied Physics Laboratory, Johns Hopkins University, Laurel, MD)
Solar Energetic Particle Activity in 1989

The year 1989 was, in the aggregate, the most active in terms, of energetic particle production since 1960. The energetic particles, together with associated X-ray and y-ray events, were recorded by several spacecraft including IMP-8, GOES, SMM, etc. at 1 AU, and by Voyagers 1 and 2 in the outer (≥ 28 AU) heliosphere. In particular, the events of March 1989, produced by a single flaring region (5395), resulted in large fluxes of *low energy protons* produced the biggest Forbush decrease since August 1972, and caused auroral activity that was visible as far south as Los Angeles, California. These flares represent a classic case of varying degrees of interplanetary propagation since they occurred regularly as the region rotated from the east to the west limb, and gave rise to slow intensity increases and strong interplanetary shocks (eastern flares), to prompt particle onsets and absence of strong shocks (western flares). These results are in accord with East-West asymmetry models in the development of interplanetary shocks, as suggested by global observations of interplanetary scintillations. The shocked plasma arrived at Voyagers 1 and 2 in early June, implying average propagation velocities of 600-620 Km/s. Details of the March events, including onsets, shock acceleration, compositional and spectral signatures will be presented and discussed in the context of current models.

Wednesday, October 17, 1990

Morning Session 9:00-13:00

2.6 Zhugzhda, Yu.D. (IZMIRAN, Troitsk)
Solar Helioseismology

(No abstract submitted)

REVIEW

Helioseismology is a new branch of solar physics which makes it possible to study the internal layers of the sun. For example, it is possible to measure the sound speed dependence on depth and differential rotation and potentially the internal magnetic field. Information about the internal structure of the sun may be important to resolving the solar neutrino paradox and is important to work on dynamo theory. There are two well-known projects under development for work on helioseismology. They are the ground based networks GONG and the space project SOHO. In the Soviet Union space program, a three-channel photometer for helioseismology should be launched on CORONAS-1 satellite. Associated with this project, ground based telescopes are under development for observations of low degree, I = 3-10, modes. These telescopes are portable and can be installed in different places of a network. The telescopes are designed to detect solar oscillations as changes in intensity. There are arguments that intensity observations should be more sensitive to gravity modes than velocity observations. The arguments are connected with the excitation of temperature waves in the solar photosphere. One branch of helioseismology is the seismology of features in the solar atmosphere: sunspots, flux tubes, convective cells, and loops. In this case, helioseismology is based on detection of resonance frequencies of magnetohydrodynamic oscillations. The most important part of these features are connected with a magnetic field which considerably complicates the seismology of these features. Before the appearance of solar seismology, it was possible to observe only the thin outer layer of the sun. Essentially all layers of the sun can now be investigated by seismological methods. This widens our possibility to understand basic processes on the sun.

2.7 Hill, H. (Arizona State University, Tempe)
Helioseismology (Program SCLERA)

ABSTRACT

It is generally recognized that ground-based solar observations can achieve considerable improvement in signal-to-noise ratio when the observations from two observatories widely separated in longitude (120') are combined in data reduction. In order to take advantage of this, the SCLERA International Network is being established to observe the sun with sets of identical photometric and astrometric solar seismographs for a good fraction of 24 hours per day. In the design of the instruments, great care is being taken to produce those that are well suited for both the shorter period 5 minute solar oscillations as well as the longer period pressure and gravity modes. The network will be used to study the solar interior and long term solar variability relevant to solar-terrestrial physics. In September, 1987, a Memorandum of Agreement was signed between Yunnan Observatory, Kunming, the Peoples' Republic of China, and the University of Arizona as the first step in setting up the Network. This step was followed with the signing of protocols by IZMIRAN and Pulkovo Observatory of the USSR with the University of Arizona in November 1989 March 1990, respectively. The agreement and protocols call for the exchange of instruments, observations, staff and students. The first instrument to be located at Yunnan Observatory is the photometric type and scheduled to go on-line October 1990. The construction of the photometric solar seismograph to be located at Kislovodsk Station of Pulkovo Observatory is underway and scheduled to be shipped to the Soviet Union in March 1991. The first of the astrometric solar seismographs is projected to be on-line in the spring of 1992.

Session 3. Solar Wind

Chairman: Zastenker, G.N.

3.1 Coles, W.A. (University of California, San Diego)
Observations of the Solar Wind Using Interplanetary Scintillations

ABSTRACT

I will summarize the results of 16 years of observations using the three-antenna IPS observatories at UCSD and Toyokawa. The solar wind velocities estimated from the IPS observations have been "calibrated" against spacecraft data where they overlap. The velocity measurements have been mapped back to the point of solar origin, for comparison with coronal observations, using a simple spiral geometry. To facilitate comparison of the large-scale quasi-static structures, the IPS measurements have been averaged for

6 solar rotations to form "Carrington maps" over heliographic latitude and longitude. This averaging period is large enough to provide good coverage of the map, yet not to smooth out the large scale structures of interest. I will compare the velocity maps with similar maps of white light brightness (from HAO, Mauna Loa) and magnetic field (from the Wilcox Solar Observatory, Stanford). The spatial spectrum of electron density in the scale range from 10 to 1000 km can also be estimated from the LPS observations. I will summarize these results and discuss the effect of "corotating interaction regions" on this spectrum.

The UCSD and Toyokawa observatories are restricted (by their operating frequencies) to observations outside of 40 solar radii. I will discuss recent observations, by a variety of radio propagation techniques, inside of 20 solar radii. A model showing the variation of the electron density spectrum with distance outside of 10 solar radii has been derived from these data. However, inside of 10 solar radii the spectrum becomes increasingly anisotropic and the two dimensional form of the spectrum has yet to be determined. Velocity observations near the sun are much less complete because the few observatories capable of such measurements are heavily scheduled. However, a major observing program at the Very Large Array in New Mexico has just been completed and a long-term campaign of observations at the EISCAT array in northern Scandinavia is under way. I will discuss the recent results of both these programs.

3.2 Lotova, N.A. (IZMIRAN, Troitsk)
The Investigations of the Solar Wind Transonic Region

ABSTRACT

The results of occultation studies of the interplanetary medium near the Sun are presented. Both the subsonic and supersonic regions of the solar wind were involved. Water vapor masers and quasars were used as sources. The existence of an enhanced scattering region stretching from about 10 to 30 solar radii is reported. This region was identified as that of sub- to supersonic transition in the solar wind flow. It may be treated as a region of mixed flow where subsonic and supersonic streams coexist and interact. A peculiarity in the structure of the transonic region was found: the wide region of enhanced scattering is preceded by a comparatively narrow zone of diminished scattering, "a predec ss zone". This zone coincided with the local minimum of plasma density and maximum of positive velocity gradients. It is shown that the stream structure of the solar wind is one of the principal factors in the formation of the extended transonic region.

REVIEW

The author claims to have identified a "transonic zone" stretching from about 10 to 30 R_o in which turbulence is enhanced and the velocity acceleration is large.

This work is based on a few questionable velocity measurements and a large number of very questionable scattering measurements. The velocity estimates are made from model fits to single antenna scattering measurements and are thus sensitive to model errors such as a failure to account for anisotropic structure. The scattering measurements have not been corrected for latitude, longitude, or time variations. The effect of latitude is partially important.

3.3 Mullan, D. (University of Delaware, Newark)
Sources of the Solar Wind: Smallest Structures

ABSTRACT

The solar wind departs significantly from spherical symmetry, with structures on a wide variety of length scales. On the largest scales, highspeed streams and coronal transients have dimensions of order one solar radius, R_s. On progressively smaller scales, observations of radio occultations of natural sources and spacecraft transmitters indicate that structures as small as 10^{-6} R_s exist in the solar wind near the Sun, with maximum "turbulence" in the region of maximum wind acceleration. Conventional hydrodynamics suggest that small structures may simply evolve via turbulent cascade from injection of large features.

Although a cascade of this sort may operate, spatial spectra suggest that a separate source of small-scale structure may also be present. The observational evidence is consistent with multiple small sources in the solar corona. The nature of the smallest sources is not yet clear, however, recent discussions of coronal heating suggest that many small magnetic reconnection events may be responsible for the heating. Such events are believed to be occurring continually in the solar atmosphere. If such reconnection events are present in the corona, then they should also give rise to the formation of discrete magnetic plasmoids with dimensions of order 10_{-4} R_s in the corona. Such plasmoids, subject to outward Lorentz forces in the large-scale diverging solar magnetic field, will contribute to acceleration of the solar wind. Moving outwards, they will expand and may eventually merge with neighbors. Wind acceleration will be most rapid at radial distances where the plasmoids occupy maximal volume: in such conditions, the "turbulence" in the solar corona will also be maximized.

3.4 Veselovsky, I.S. (Research Institute of Nuclear Physics, Moscow State University)
IMF Structure and Models

ABSTRACT

Quasistationary IMF structures are determined by electric currents distributions on the sun, in the solar corona and in the interplanetary space. Corresponding equivalent current systems (distributed currents and current sheets) are considered and their relative contributions are discussed. Some recent results and involved problems are critically reviewed concerning appropriate 3-D time-dependent and averaged IMF models.

Kinematic models are used with infinite as well as finite conductivity. Examples are considered of loop-like IMF formation due to non-stationary boundary conditions near the Sun. The IMF topology in the inner heliosphere is determined by the zero points appearing on the Sun and moving in the interplanetary space with the Solar wind. Dynamical processes in the Solar wind are responsible for the CIRs and MIRs formation.

Two important phenomena in the outer heliosphere are investigated: the interstellar magnetic field screening and IMF reconnection. As a result open and closed field structures are obtained near "sector boundaries".

It is anticipated that deeper insight into these problems will be achieved during the next IAGA Symposium 4.10 in 1991.

REVIEW

Veselovsky summarized theoretical ideas regarding the structure of the interplanetary magnetic field, with some emphasis upon time variations induced or produced by solar wind sources of variable characteristics. This presentation was heavily focused upon models using different assumptions for the nature of the interplanetary current sheet with respect to its origin and evolution.

3.5 Lyubimov, G.P. (Research Institute of Nuclear Physics, Moscow State University)
Coronal and Heliospheric Loops

(This paper was not presented at the workshop)

Afternoon Session 15.00 - 18.30

3.6 Feldman, W. (Los Alamos National Laboratory)
Signatures of Small Solar Transients in the Solar Wind

The interplanetary effects of large solar transients that result in coronal mass ejections have been catalogued for nearly three decades. They span a considerable range of intensities from the very bright, large-area solar flares, to microtransients that fall below detection thresholds at 1AU. Although the large solar flares often drive interplanetary shock-wave disturbances that cause severe disruptions of planetary magnetospheres, they occur relatively rarely. In contrast, coronal microtransients occur very often but have an unknown effect on the solar wind. However, evidence has been building lately to suggest that microtransients drive a sufficient number of jets of relatively cold, dense plasma into the corona, that they may contribute significantly to the general heating of the corona and the acceleration of the solar wind.

A likely origin of these jets is the emergence of magnetic flux through the photosphere into the high chromosphere, where it reconnects with overlying coronal magnetic fields. If true, then acceleration of these jets occurs all along, but within, twin slow mode shocks that emanate from a small reconnection zone. The densities and speeds of observed jets can be used to set an upper limit of about 5 Gauss for the magnetic field upstream of these shocks. This estimate constrains such reconnection to occur outside of the chromospheric network, as observed. A model of coronal heating involving an ensemble of such processes will be described. It leads to quantitative predictions about the structure of the turbulent coronal envelope that can be tested only with a solar probe.

3.7 Zastenker, G.N., Bordkova, N.L., Avanov, L.A., Yermolaev, Yu. (Institute of Space Research, Moscow)
The Solar Wind Parameters, Energy and Momentum Flux Fluctuations at 1 AU in the Wide Time-Scale

ABSTRACT

The comparative variabilities of solar wind parameters for proton and α-particles and variations of solar wind kinetic energy, ion thermal energy, ion flux and momentum are studied according to data of direct spacecraft measurements in a wide time-scale: from fractions of a second to several days.

The "persistent time," about 60 hours, was obtained for large scale variability of α-particles. Power density spectra of velocity, density and magnetic field were computed in frequency range from 10^{-5} to 10^{-3}. Middle scale fluctuations of both protons and

α-particles are close to each other and α-particles spectrum has a somewhat greater slope than the one for protons. To estimate the small scale variations, the power density of ion flux are given in frequency range from 10^{-3} to 10 Hz.

Kinetic energy, ion thermal energy, ion flux and momentum fluctuations are discussed in this paper too. The average variations of kinetic energy flux and momentum in an hour interval are about 10% from the values themselves. Consideration is given to the differences in the energy flux and momentum values for low-speed and high-speed solar wind streams. Particular emphasis was placed on analysis of the most intensive disturbances of energy and momentum due to the arrival to Earth of interplanetary shock waves.

REVIEW

Dr. Zastenker summarized for us analyses of Prognoz solar wind data regarding temporal fluctuation in a variety of solar wind proton and α-particle parameters, including the convective kinetic energy and momentum fluxes. His results showed that power spectra of the velocity, density, and magnetic field yielded a correlation length equivalent to 20° to 30° rotation in solar longitude. Variation magnitudes for proton and α-particles over the observed frequency range spanning 10^{-5} to 10^{-3} hz were also found to be similar.

His study of kinetic energy and momentum fluctuations during hour-long periods revealed variations typically of order 10% of the average value. The magnitude of these variations did not differ significantly between high-speed and low-speed solar wind streams. The resultant total integrated power into the terrestrial magnetosphere amounted to about 2×10^{13} joules/s.

3.8 Gringauz, K.I. (Institute of Space Research, Moscow)
The Dependence of Solar Wind Velocity on the Distance From Heliospheric Current Sheet

(No Abstract Submitted)

REVIEW

Gringauz presented a review of an earlier published study of the relationship of solar wind velocity to the aa index of magnetic activity and extrapolated it back to the 19th century (see SOLAR WIND FOUR, pp 8495, ed. by H. Rosenbauer, 1981). He also used solar wind velocity measurements from Prognoz s/c to estimate the velocity as a function of distance from the heliospheric current sheet. This required extrapolating the measurements inward 1 AU to the solar surface so as to derive the equivalent latitude of the observations. Only a limited period of observations were treated, less than 6 months, and a large gradient was detected. This was not with other contemporary results from scintillation studies, for example.

3.9 Ness, N.F. (University of Delaware, Newark)
Evolution of Solar Wind Structures 0.3 - 20 AU

Spacecraft studies by the IMPS, Mariner 10, Helios A & B, Pioneers 10 & 11, and Voyagers 1 & 2 in-situ during the last two decades have provided detailed observations of the characteristics of the interplanetary medium between 0.3 and 20 AU. These data provide evidence for an 11 year solar cycle variation of certain solar wind plasma and interplanetary magnetic field (IMF) parameters. In addition, shorter time scale fluctuations, associated with the solar rotation period of 27-30 days and transient flare and coronal mass ejections have been investigated as these solar originating disturbances propagate outward into the heliosphere. Within 1-2 AU from the Sun, correlations of specific variations with these transients are usually clearly established. Beyond this radial range, a merging of disturbances occurs in regimes termed interaction regions. These themselves also merge so that beyond 5-10 AU, the structure of the heliosphere is dominated by expanding convective shells of enhanced magnetic fields referred to as compressions while in between there are rarefaction regions. The polarity structure of the IMF displays the now well-known sector structure associated with the coronal holes and solar wind convected magnetic fields of solar origin. This paper will present an overview of the morphology, dynamics and statistical properties of the heliospheric plasma as currently understood.

REVIEW

3.10 Zwickl, R.D. (NOAA Space Environment Laboratory, Boulder, Colorado)
Relationship Between Solar Wind Density Fluctuations and Density at High Frequency

ABSTRACT

During the Coronal Mass Ejection Workshop (March 1988, Colorado Springs, Colorado), a question was raised concerning the relationship between interplanetary scintillation (IPS) measurements, solar wind density (n), and density fluctuations (n). To address this question, we examined the highest-time-resolution solar wind plasma data obtained by the ion instrument on ISEE-3, from launch in August 1978 through February 1980. As a measure of the level of high-frequency density fluctuation, we calculated the

difference, n, between successive 24-s determinations of density, this resulted in a total data set of 670,000 points. When the standard deviation σn of n, measured for a given n, is plotted against n, the amplitude of the fluctuations (σn) increases as n increases-at all spatial scales. The fluctuation level has only a weak dependence on temperature and velocity.

3.11 Krasnoselskikh, V.V. (IZMIRAN, Troitsk)
High Mach Number Collisionless Shocks

(No abstract submitted)

REVIEW

Dr. Krasnoselskikh argued that electrons are heated in super-critical quasi-perpendicular shocks by interactions with large amplitude standing whistler waves. This idea is not pursued very much in the American literature, primarily because the principal supporting observations are Soviet.

DISCUSSION

Thursday, October 18, 1990

Morning Session 9.00 - 13.00

3.12 Yermolaev Yu.I. (Institute of Space Research, Moscow)
Large-Scale Structure of Solar Wind and Solar Corona: Prognoz 7 Observations

ABSTRACT

On the basis of selective measurements of proton and α-particle bulk parameters and magnetic field--on board the Prognoz 7 satellite, the structure of the solar wind is studied and is compared with a possible structure of the solar corona. For that purpose the magnetic field value B, proton temperature T_p, ratio of thermal and magnetic pressures $\beta = nkT_p/(B^2/8\pi)$ and relative helium abundance n_a/n_p are represented as a distribution on the n - V_p (density - proton velocity of the solar wind) plane. Values and different behavior of these parameters on the n - V_p plane make it possible to identify 5 regions (types of solar wind streams) which may be connected with the solar corona structure: (1) the heliospheric current sheets, (2) streams from closed coronal magnetic field regions (streamers), (3) streams from open magnetic field regions (coronal holes), (4) disturbed solar wind streams at large angles relative to the solar meridians of non-stationary events in the corona, and (5) disturbed streams at small angles relative to meridians of non-stationary events including coronal mass ejections. On the basis of this structure the behavior of the (α-particle and proton velocity difference $V_\alpha - V_p$ and temperature ratio T_α/T_p is investigated.

REVIEW

Yermolaev used solar wind observations from November 1978 to July 1979 to investigate the patterns of solar wind evident in 2-D plots of density versus velocity, proton temp versus velocity and attempted to identify different regimes from the ensemble plots. It was concluded that the ratio of alpha to proton ratio increased across a solar wind stream interface while the density of the protons decreased. The 5 separate classes so identified were not grouped in an especially distinct set of categories.

3.13 Mishin, E.V. (IZMIRAN)
Macroscopic Effects of Plasma Turbulence Following Electron Beams Intrusion in the Solar Plasma

ABSTRACT

Acceleration of energetic (Suprathermal) electrons is a fundamental

feature of many astro- and geophysical dynamical phenomena such as the solar flares and auroras. Interaction of intensive electron fluxes with the surrounding plasma leads to perceptible perturbations of plasma density and temperature. Thus, the local phenomena are accompanied by radio emissions, optical and x-ray radiation, etc. The aim of the report is to discuss the peculiarities of these "macroscopic" manifestations of collisionless interaction characteristic of intrusion of energetic electrons in the inhomogeneous plasma.

REVIEW

Dr. Mishin presented an excellent summary of ten years' research on the role of the beam plasma discharge in auroral physics. Of particular interest is the creation of a second temperature maximum near 110 km altitude due to turbulent heating.

DISCUSSION

Session 4. Near Earth Processes
Chairman: S.M. Krimigis

4.1 Kennel, C.F., Coroniti, F.V., Pellat, R. (University of California, Los Angeles), Akasofu, S.I., Kan, J.R. (University of Alaska, Fairbanks)
Plasma Sheet Transport and Auroral Activity

ABSTRACT

We present a critical review of the reconnection model of magnetospheric convection and its application to magnetospheric and auroral substorms. The mapping of auroral boundaries into the plasma sheet once again appears to be consistent with the convection model, now that ions associated with the plasma sheet boundary layer have been detected poleward of the most poleward arc. The venerable "conceptual substorm model", which describes a growth phase after the IMF turns southward and an expansion phase after enhanced tail reconnection, is generally supported by observations of large scale structural reconfigurations associated with substorms. Plasmoids in the deep tail clearly indicate that substorm expansion is associated with formation of a near-earth reconnection region. Numerical MHD substorm models confirm and clarify the conceptual model. However, neither the conceptual nor numerical models have enough resolution to pinpoint the magnetospheric counterparts to the auroral phenomena which first defined the term substorm. Moreover, both the conceptual and numerical substorm models are based on MHD, and the plasma sheet is not an MHD system. We close by reviewing evidence suggesting that phenomena on small space and time scales may be critical to the physics of breakup. The auroral expansion takes place on the Alfven Bounce time scale of Pi 2 oscillations, several minutes, and recent AMPTE measurements indicate that the flow in the central plasma sheet is highly

structured. Such observations suggest that substorm expansion cannot be understood using quasi-steady convection theory.

REVIEW

4.2 Ivanov-Kholodny, G.S. (IZMIRAN, Troitsk)
The Solar Activity as a Source of Direct and Indirect Influence on the Ionosphere

ABSTRACT

The condition of the ionosphere is controlled directly by solar EUV radiation. Besides through the variations of the aeronomic processes and the upper atmosphere (namely its temperature and composition), the solar activity influences indirectly the ionosphere. Both types of influences can be seen when dependencies of ionospheric layers E, F1, and F2 on EUV-radiation are considered for different levels of the solar activity. Theoretical explanation of the dependencies is complicated by the nonlinearity of the aeronomic processes. New mechanisms of the formation of the E and F1 layers on the basis of geophysical invariant are proposed. The direct and indirect influence of the solar activity on the ionosphere for the ionization recombination equilibrium is considered.

REVIEW

The formation of the E, F1, F2 and D layers of the ionosphere by ionizing EUV solar radiation was discussed by Dr. Ivanov-Kholodny. Detailed variations of these layers (their altitude, magnitude, variation, etc.) were compared with 5 parameters: 1) the degree of solar activity; 2) the day of the year; 3) time of day; 4) altitude; and 5) geographic latitude.

The most important dependence was upon solar activity.

4.3 Antonova, E.E., Tverskoy, B.A. (Research Institute of Nuclear Physics, Moscow State University)
The Excitation of the Large-Scale Magnetospheric Turbulence Spectrum at the Solar Wind-Magnetosphere Interaction, Magnetospheric Substorms and Multi-Satellite Projects

ABSTRACT

The analysis of the forms of the solar wind energy penetration into the magnetosphere of the Earth shows that the main effect of such penetration is hot plasma pressure redistribution beginning in the polar cusps. The pressure in cusps can be changed due to flux transfer events, plasma diffusion, penetration of protons resulting from gradient drift or injection of plasmoids.

According to the magnetosphere-ionosphere interactions theory, in

a few minutes after the change of conditions in subpolar point, the main large-scale two-vortex harmonic of magnetospheric turbulence spectrum is developed corresponding to the intensification of the dawn-dusk electric field. Approximately after 40 minutes, the second harmonic is developed corresponding to increases of current system II followed by Alfvenic screening in the inner magnetosphere. The consideration of the role of field line nonequipotentiality in the formation of large and middle scale harmonics give the possibility to explain the form of experimentally observed spectrum.

Combining various approaches to the description of magnetospheric substorms, it is possible to develop the substorm scheme which can explain the main features of growth, expansive and recovery phases of substorm. The verification of the correctness of this scheme requires the comparison of simultaneous multi-satellite measurements using the physically selected coordinate system obtained through projection of equal magnetic flux tube levels on the ionosphere. The suggested substorm scheme is used in planning programs of multi-satellite projects INTERBOL and REGATA.

REVIEW

> This excellent paper reviewed the past 15 years of research by the Moscow State University group headed by Professor Tverskoy. Not all of this excellent research is well known in the U.S. Topics discussed included a new scheme for mapping the auroral oval into the plasma sheet, illustrations of the importance of the polar cusp in magnetospheric dynamics, a new picture of turbulent transport in the plasma sheet, and the role of small-scale structures in substorms.

4.4 Kuklin, V. Panchenko, I. (Kharkov State University)
Induced Alfven and MHD Spatial Dissipative Structures

ABSTRACT

Quasistationary spatial structures may be formed in nonequilibrium medium. If they are formed under the above threshold condition (high dissipation level) and supported by the constant energy supply, for example, by mean pump wave, then these structures can be called induced and dissipative.

Its appearance is defined by phase synchronization of excitation modes, which takes place on linear stage of process. Nonlinear influence registration leads to instability restricting via "resonant" mechanisms, which are connected with inverse influence unstable satellites on pump. Phase correlation between them saves the same sort as on the initial stage of parametric instability.

"Nonresonant" (i.e., unsynchronized with pump) interaction upon

nonlinear evolution of induced dissipative structures prevail after instability saturation (spatial structure formation) and define further behavior of the latest.

REVIEW

The nonlinear Schrodinger-equation (NSE) and the derivative nonlinear Schrodinger equations model turbulent Alfven wave fields. The authors presented a comprehensive view of dissipative Alfven wave structures-vortices, solitary waves, and shocks.

DISCUSSION

Friday, October 19, 1990

Morning Session 9.00 - 13.00

General Discussion

The Solar Maximum: Workshop Suggestion

At present, indices of solar activity are primarily observation-oriented, do not have a basis in physical theory, and do not necessarily reflect important solar-terrestrial indices. We believe it should be our long-term goal to determine indices that have a physical basis in the theory of the solar cycle, and a short term goal to concentrate on indices with closer and more constant phase relation to solar terrestrial phenomena.

We point out that in recent years two important new global solar indices, the frequency of the p-modes and the value of the solar constant, have been identified. The intensity of the K line in the integrated spectrum is another. The use of such integrated global indices should be pursued.

Closing of the Workshop

APPENDIX 1
LIST OF PARTICIPANTS

NAS Delegation:*

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*Henry Hill, an American scientist affiliated with Arizona State University, was not a member of the NAS delegation but participated in the workshop as a guest of the ASUSSR.

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APPENDIX 2: SCIENTIFIC AGENDA

NAS-ASUSSR WORKSHOP ON THE SUN, SOLAR WIND, AND NEAR EARTH PROCESSES
OCTOBER 15-20, 1990

October 15 - Arrival

October 16-19 - Working days

October 19 - Excursion

October 20 - Flight back to Moscow or elsewhere

TUESDAY OCTOBER 16, 1990

Morning Session 9:00-13:00

Opening addresses of the Workshop co-chairman
Introduction by the Organizing Committee Representative

Session 1. Geoeffective Solar Events (Solar Activity)
Chairman : Oraevsky, V.N.

1.1 Ruzmaikin, A.A. (IZMIRAN, Troitsk)
"The Origin of Solar Magnetism"

1.2 Schatten, K.H. (NASA, GSFC, Greenbelt)
"The Dynamo Method for Solar Activity Predictions"

1.3 Makarov, V.I. (Main Astronomical Observatory, Pulkovo, Leningrad)
"Global Solar Activity: Evolution of Large Scale Magnetic Fields."

11:10-11:30 Coffee Break

1.4 Feynman, J. (Jet Propulsion Laboratory, Caltech, Pasadena)
"Coronal Mass Ejections Associated with Major Solar Flares"

1.5 Chertok, I.M. Fomichev, V.V. (IZMIRAN, Troitsk)
"Solar Radio Bursts, Coronal Mass Ejections and Proton Events"

1.6 Zirin H., Marquette W. (Caltech, Big Bear)
"BEARALERTS: A Successful Flare Prediction System"

DISCUSSION

13:50-15:00 Lunch

Afternoon Session 15:00-18:30

Session 2. Solar Neutrinos. Helioseismology
Chairman: Ness, N.F.

2.1 Oraevsky, V.N., Semikoz, V.B. (IZMIRAN)
Smorodinsky, Ya.A. (I.V. Kurchatov Institute of Atomic Energy, Moscow)
"Electrodynamic Neutrinos in the Sun and Stars"

2.2 Semikoz, V.B. (IZMIRAN)
"A Change of the Neutrino Helicity in a Dense Plasma"

2.3 Gavrin, V.N. (Nuclear Research Institute, Troitsk)
"Gallium Experiment on Solar Neutrinos"
(Paper Was Not Presented)

16:45-17:00 Coffee Break

2.4 Zaitsev, V.V. (IPFAN)
"Solar Plasma Diagnostics by Radio Emission"

2.5 Krimigis, S.M. (Johns Hopkins University, Laurel)
"Solar Energetic Particle Activity in 1989"

DISCUSSION

WEDNESDAY, OCTOBER 17, 1990

Morning Session 9:00-13:00

2.6 Zhugzhda, Yu.D. (IZMIRAN)
"Solar Helioseismology"

2.7 Hill, H. (Arizona State University, Tempe)
"Helioseismology (Program SCLERA)"

DISCUSSION

Session 3. Solar Wind
Chairman: Zastenker, G.N.

3.1 Coles, W.A. (University of California at San Diego)
"Observations of the Solar Wind Using Interplanetary Scintillation"

11:15-11:30 Coffee Break

3.2 Lotova, N.A. (IZMIRAN)
"The Investigations of the Solar Wind Transonic Region"

3.3. Mullan, D. (University of Delaware, Newark)
"Sources of the Solar Wind: Smallest Structures"

3.4 Veselovsky, I.S. (Research Institute of Nuclear Physics, Moscow State University)
"IMF Structure and Models"

3.5 Lyubimov, G.P. (Research Institute of Nuclear Physics, Moscow State University)
"Coronal and Heliospheric Loops"
(Paper not presented)

DISCUSSION

13:45-15:00 Lunch

Afternoon Session 15:00-18:30

3.6 Feldman, W. (Los Alamos National Laboratory)
"Signatures of Small Solar Transients in the Solar Wind"

3.7 Zastenker, G.N., Bordkova, N.L., Avanov, L.A., Yermolaev, Yu. I., (Institute of Space Research, Moscow)
"The Solar Wind Parameters, Energy and Momentum Flux Fluctuations at 1 AU in the Wide Time-Scale"

3.8 Gringauz, K.I. (Institute of Space Research, Moscow)
"The Dependence of Solar Wind Velocity On the Distance from Heliospheric Current Sheet."

16:45-17:00 Coffee Break

3.9 Ness, N.F. (University of Delaware)
"Evolution of Solar Wind Structures 0.3 - 20 AU"

3.10 Zwickl, R.D. (NOAA Space Environment Laboratory, Boulder, Colorado)
"Relationship Between Solar Wind Density Fluctuations and Density at High Frequency"

3.11 Krasnoselskikh, V.V. (IZMIRAN)
"High Mach Number Collisionless Shocks"

DISCUSSION

THURSDAY, OCTOBER 18, 1990

Morning Session 9:00-13:00

3.12 Yermolaev, Yu.I. (Institute of Space Research, Moscow)
"Large- Scale Structure of Solar Wind and Solar Corona: Prognoz 7 Observations"