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FINAL REPORT

ONGOING DATA REDUCTION, THEORETICAL STUDIES AND SUPPORTING RESEARCH IN MAGNETOSPHERIC PHYSICS

Principal Investigator: F. L. Scarf
Co-Investigator: E. W. Greenstadt

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Space Sciences Staff

TRW Defense & Space Systems Group
One Space Park
Redondo Beach, California 90278

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1. INTRODUCTION

F. L. Scarf and E. W. Greenstadt have been conducting theoretical studies, ongoing data analysis programs, and supporting research and technology tasks under NASA Headquarters Contract NASW-3087. This contract expires on April 30, 1978, and the present report summarizes significant tasks completed and lists important studies initiated.

The present contract, and earlier ones in this series, provided support for theory, correlative data analysis and supporting research and technology. The data analysis tasks generally involve older spacecraft or multi-spacecraft and multi-instrument correlation studies which are not associated with any single, project-associated analysis program. F. L. Scarf is Principal Investigator or Co-Investigator for plasma wave investigations presently operating on ISEE-1, ISEE-2, Voyager-1, Voyager-2, IMP-7 (and Pioneer 8, Pioneer 9). E. W. Greenstadt has recently been appointed as Co-Investigator (without Project funds) for the magnetometer investigation on ISEE-1, ISEE-2. Many of the required analysis programs involve IMP-7, ISEE, and Voyager correlations, or studies based on IMP-7 and -8 and/or Voyager-Helios data comparisons. Thus, the generalized data analysis and reduction program has been used to support the coordination of various projects.

F. L. Scarf and E. W. Greenstadt have also been involved with NAS and NASA mission planning activities. Mr. Greenstadt was a member of the Panel on Plasma Processes of the National Academy of Sciences, and Dr. Scarf is a member of the Space Science Board, the Committee on Solar Terrestrial Research, and the Committee on Space Physics, in addition to his duties as Chairman of the CSTR Panel on the IMS. These NAS planning activities are related to many of the SR/T activities summarized below, and Dr. Scarf also serves as a member of the NASA Headquarters Atmospheric and Space Physics Management and Operations Working Group under Dr. E. R. Schmerling and Dr. D. P. Cauffman.

2. SUMMARY OF COMPLETED RESEARCH, OCTOBER 1977 TO PRESENT

We indicate our completed research activity, and the degree to which this research involves other groups, by the ensuing copies of the title pages from all relevant reports dated after October 1977. We divide reports into five categories:

1) Papers published
2) Papers completed and awaiting publication
3) Abstracts of results presented orally at scientific meetings
4) Workshop presentations
5) Related papers.

Title pages or suitable reproductions follow in the above order. Item 5 refers to a related subject of investigation supported by another agency (AFOSR), but demanding comprehensive integration of surface and satellite measurements and expected to involve ISEE as well as other spacecraft in the immediate future.

GROUP 1: PUBLISHED PAPERS

Magnetosphere Boundary Observations Along the Imp 7 Orbit
1. Boundary Locations and Wave Level Variations

F. L. SCARF

Space Sciences Department, TRW Defense and Space Systems Group, Redondo Beach, California 90278

L. A. FRANK

Department of Physics and Astronomy, University of Iowa, Iowa City, Iowa 52242

R. P. LEPPING

Laboratory for Extraterrestrial Physics, NASA Goddard Space Flight Center, Greenbelt, Maryland 20771

We discuss and analyze magnetosphere boundary phenomena observed by the Imp 7 magnetic field, plasma, and plasma wave instruments in 1972 and 1973. The spacecraft crosses the dawn and dusk boundaries near 25 R_E downstream, and the physical processes at the Imp 7 magnetopause appear to be intermediate between those observed over the poles and those observed at the lunar orbit. The Imp 7 orbit also traverses a downstream region near where 'fireball' phenomena occur, and this indicates that it is especially important to investigate the range of magnetopause phenomena detected with the plasma and fields payload complement. This report contains a brief description of the relevant Imp 7 instrumentation, a survey of the boundary locations for a 15-month period, a discussion of the different types of crossings (essentially, sharp and diffuse), and an analysis of the electromagnetic wave modes being detected in the broad low-frequency channel of the wave instrument. The wave mode discussion, based on comparison of Imp 7 data with low-frequency plasma sheet and magnetosheath observations from other spacecraft, leads to the conclusion that the broad low-frequency channel is sensitive to oscillations in the lower hybrid resonance region of the spectrum. Details of the broad diffuse boundary crossings will be discussed in a separate report.

INTRODUCTION

Although theoretical fluid dynamic predictions of the average shape and the mean location of the magnetopause are generally in very good agreement with observations, there remain large gaps in our understanding of the important microscopic physical processes that develop at the magnetosphere boundary. Several years ago, *Willis* [1972] emphasized the fact that many theories of the small-scale internal structure of the magnetopause are controversial, and he tabulated 10 outstanding questions to be resolved in future studies of the magnetopause. This 1972 listing included a number of problem areas involving the local physics of the magnetosphere boundary on the flanks of the geomagnetic tail. Specifically, Willis noted that we had, at that time, little definitive information on (1) the nature of the tangential drag on the magnetopause and its importance with respect to tail formation, (2) the consequences of periodic wave motions of the magnetopause, (3) the extent to which the magnetopause remains well defined as a function of downstream distance, and (4) the degree to which the interplanetary and geomagnetic fields are interconnected across the boundary.

In the years since this article appeared considerable progress has been achieved in providing partial answers to these and related questions, especially for the dayside and polar sections of the magnetosphere boundary. For instance, the observations of the plasma mantle [*Rosenbauer et al.*, 1975; *Paschmann et al.*, 1976] are of considerable importance in terms of the dynamics of the entire magnetosphere (see, for instance, *Haerendel and Paschmann* [1975]), but to date the majority of reports on the physics of the magnetosphere boundary come from local measurements made on the dayside [*Russell et al.*, 1974; *Eastman et al.*, 1976] or at high latitudes just over the poles or from the region of the dayside cusp [see *Reiff et al.*, 1977].

In this series of papers we describe different types of magnetosphere boundary phenomena observed by the Imp 7 plasma wave, plasma, and magnetic field instruments in 1972 and 1973. This first report contains a brief description of the relevant Imp 7 instrumentation, a survey of the boundary locations for a 15-month period, a discussion of the different types of crossings (essentially, sharp and diffuse), and an analysis of the electromagnetic wave modes being detected in the broad low-frequency channel of the wave instrument. The second paper in this series will be concerned with the physics of the diffuse magnetosphere boundary layers. In this second paper we will assess the role of the plasma mantle in terms of the propagation of magnetosheath turbulence into the magnetosphere, and we will evaluate the possible roles of the local wave-particle interactions in terms of tangential drag and viscosity effects.

Imp 7 Orbit and Instrumentation

The spacecraft Imp 7 (also known as Imp H and Explorer 47) was launched on September 23, 1972, into a nearly circular low-inclination orbit with a mean geocentric radial distance of 35 R_E and an orbital period of 12.5 days. Detailed Imp 7 trajectory plots for the period September 1972 through December 1975 are contained in a recent report by *King and Teague* [1976], and these plots show that in late 1972 the spacecraft generally crossed the magnetosphere boundary (as defined by *Fairfield*'s [1971] average magnetopause location) at downstream distances near 25 R_E, with the successive inbound and outbound crossings separated by about 2½ days.

On Imp 7, simultaneous measurements of the ambient mag-

Paper number 7A0728.

9. THE VENUS IONOSPHERE AND SOLAR WIND INTERACTION

S. J. BAUER
NASA/Goddard Space Flight Center, Greenbelt, Mary. 20771, U.S.A.

L. H. BRACE
NASA/Goddard Space Flight Center, Greenbelt, Mary. 20771, U.S.A.

D. M. HUNTEN
Kitt Peak National Observatory, Tuscon, Ariz. 85726, U.S.A.

D. S. INTRILIGATOR
University of Southern California, Los Angeles, Calif. 90007, U.S.A.

W. C. KNUDSEN
Lockheed Missiles and Space Corporation, Palo Alto, Calif. 94304, U.S.A.

A. F. NAGY
University of Michigan, Ann Arbor, Mich. 48105, U.S.A.

C. T. RUSSELL
Institute of Geophysics and Planetary Physics, University of California, Los Angeles, Calif. 90024, U.S.A.

F. L. SCARF
TRW Systems Group, Redondo Beach, Calif. 90278, U.S.A.

and

J. H. WOLFE
NASA/Ames Research Center, Moffett Field, Calif. 94035, U.S.A.

Abstract. The current state of knowledge of the chemistry, dynamics and energetics of the upper atmosphere and ionosphere of Venus is reviewed together with the nature of the solar wind-Venus interaction. Because of the weak, though perhaps not negligible, intrinsic magnetic field of Venus, the mutual effects between these regions are probably strong and unique in the solar system. The ability of the Pioneer Venus Bus and Orbiter experiments to provide the required data to answer the questions outstanding is discussed in detail.

1. Introduction

The interaction of the solar wind with each of the presently explored planets appears, in many respects unique, but at the same time forms part of a continuum of possible interactions. In the terrestrial interaction, the solar wind is deflected by the magnetic field far above the ionosphere, and the flow associated with the drag

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The ISEE-C Plasma Wave Investigation

F. L. SCARF, R. W. FREDRICKS, D. A. GURNETT, AND E. J. SMITH

Abstract—The ISEE-C plasma wave investigation is designed to provide comprehensive information on interplanetary wave-particle interactions. Three spectrum analyzers with a total of nineteen bandpass channels cover the frequency range 0.3 Hz to 100 kHz. The main analyzer, which uses 16 continuously active amplifiers, gives two complete spectral scans per second in each of 16 filter channels. The instrument sensors include a high-sensitivity magnetic search coil, and electric antennas with effective lengths of 0.6 and 45 m.

Introduction

THE ISEE-C plasma wave instrument will provide high-sensitivity measurements of interplanetary wave phenomena over the spectral range extending from below 1 Hz to 100 kHz. The wave electric-field and magnetic-field components are detected using a long body-mounted electric dipole (90 m, tip-to-tip), a short boom-mounted electric dipole (0.6-m, effective length), and a high-sensitivity magnetic search coil. The signal processing units in the plasma wave electronics box and in the dc magnetometer utilize three distinct spectrum analyzers that cover a total of 19 different frequency channels with varying time resolution. The main analyzer, with 16 continuously active channels, provides two complete spectral scans per second.

The primary scientific objectives of the ISEE-C plasma wave investigation can be summarized as follows:

1) To determine the roles that plasma waves play at interplanetary discontinuities and at stream-stream interaction fronts. Some wave energy must propagate away from the discontinuity, and this provides a nonlocal wave-particle interaction mechanism.

2) To analyze the basic interplanetary instabilities associated with thermal anisotropy and heat conduction that cause the solar wind to behave as an effective fluid even when the mean free path becomes large near 1 AU.

3) To study the energy loss and wave-wave conversion mechanisms for suprathermal electrons and protons by correlating particle distribution data with wave measurements. This study will involve effects associated with solar radio bursts.

4) To determine the effective transport coefficients (heat conductivity, electrical conductivity, viscosity) associated with wave-particle scattering in the solar wind.

5) To search for local wave-particle acceleration processes in the solar wind.

We will also try to evaluate local plasma parameters by analyzing plasma wave data, search for interplanetary whistler-mode signals that should develop whenever $(T_\perp/T_\parallel)_e$ exceeds unity, and study the dynamical energy dissipation processes that can cause large amplitude MHD waves in the solar wind to steepen into collisionless shocks.

Manuscript received April 3, 1978.

F. L. Scarf and R. W. Fredricks are with TRW Defense and Space Systems Group, Redondo Beach, CA 90278.

D. A. Gurnett is with the Department of Physics and Astronomy, University of Iowa, Iowa City, IA 52242.

Pasadena, CA 91103.

Space Plasma Physics:

The Study of Solar-System Plasmas

Volume 1
Reports of the Study Committee and Advocacy Panels

Space Science Board

Assembly of Mathematical and Physical Sciences

Participants and Contributors

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Eugene Greenstadt, TRW Systems Group
Gehard Haerendel, Institute for Estraterrestrischphysik
Lawrence R. Lyons, NOAA, Space Environment Laboratory

8.3.6 Collisionless Shock Waves

The sudden air-pressure changes, or sonic booms, associated with the flights of supersonic jet aircraft are familiar examples of shock waves. These shocks in the earth's relatively dense, collisional atmosphere have their counterparts in the tenuous plasmas of space, where they are in fact common and have an appreciable effect on the space environment. The shock that forms in a collisionless plasma directs fluxes of gas into new directions of flow; transforms coherent, di- rected motion into heat; raises individual ion energies to cosmic-ray energies; and emits particle and wave energy into space far from the shock location.

The fundamental problems of the collisionless shock derive from its inherent nonlinearity, which makes closed mathematical represen- tation difficult, and from the complexity of the plasma—a multi- component gas of electrons and one or more ion species, pervaded by a magnetic field of sufficient energy density so that individual parti- cle motion and wave-mode propagation and dispersion are governed by the field. In essence, the objectives of collisionless shock research are to determine (a) how nature selects the particular combinations of field and plasma parameters that fashion them; (b) how the shocks, once formed, behave; and (c) how they influence the param- eters of the space environment.

Collisionless shock waves have been found on the sunward side of all five of the planets of the solar system visited thus far. In addition to the shocks at the planets, spacecraft instrumentation has measured collisionless plasma shocks traveling through the solar wind away from solar flares and ahead of plasma streams originating on the sun; the existence of such shocks has been inferred in the solar atmo- sphere as well as in distant parts of the universe. Particles are re- flected from, and energized by, shocks. Waves are generated in the solar wind both upstream and behind them. In the case of the earth's bow shock, a portion of the energy of the downstream waves is trans- ferred to the surface of the earth. Such an energy transference may well occur at other planets as well.

The study of natural plasma shocks in space has benefited from traditional methodology. Laboratory experiments, for example, have played an important role in defining collisionless shock phenom- enology. Such laboratory shocks have been observed in oscillatory motion; upstream standing whistler waves have been observed that destabilize and are damped; some laboratory shock thickness scales have been measured.

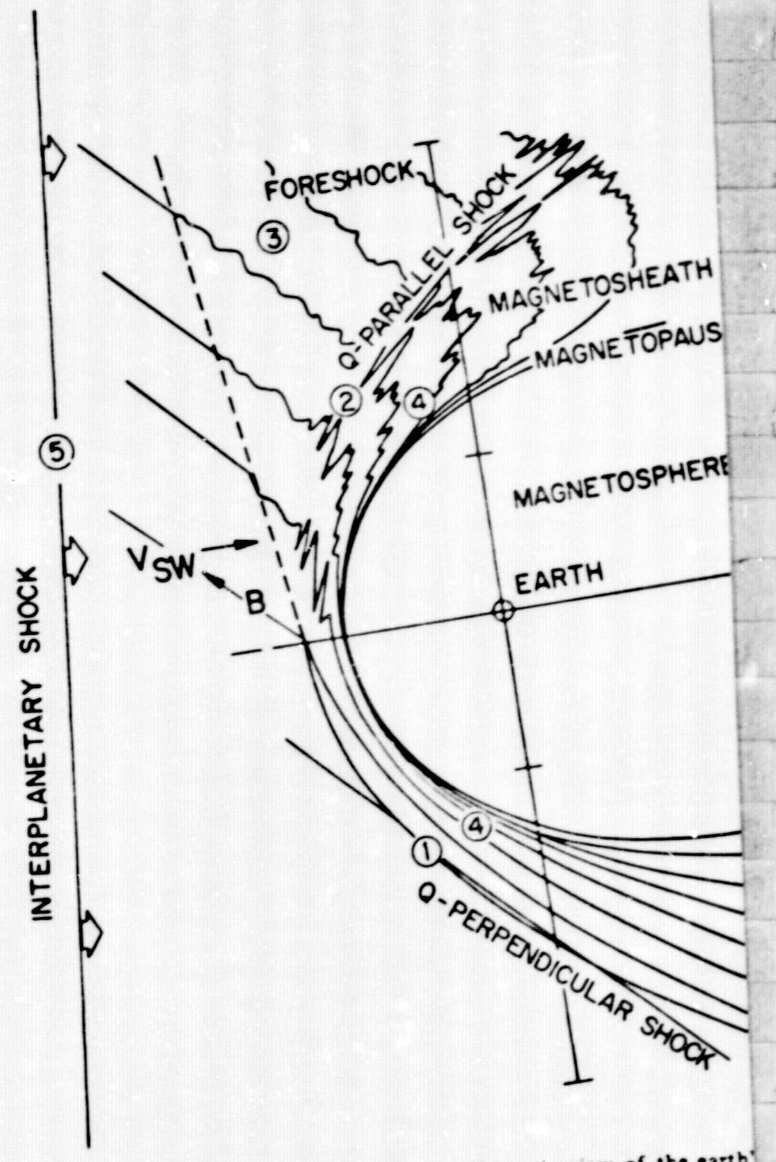

FIGURE 8.6 Ecliptic-plane, cross-section schematic view of the earth' shock system with an approaching solar-wind shock. The interp' ar netic field lies in the plane of the paper. The numbers refer to ph al r discussed in Section 8.3.6.

GROUP 2: COMPLETED REPORTS, PENDING PUBLICATION

31219-6001-RU-00

ION ACOUSTIC STABILITY ANALYSIS OF THE EARTH'S BOW SHOCK

by

E. W. Greenstadt(1), V. Formisano(2)
C. T. Russell(3), M. Neugebauer(4), and F. L. Scarf(1)

(1)Space Sciences Department
TRW Defense and Space Systems Group
Redondo Beach, California 90278

(2)Temporary Address: ESTEC
European Space Agency
Domeinweg - Noordwijk
The Netherlands

(3)Institute of Geophysics & Planetary Physics
University of California, Los Angeles
Los Angeles, California, California 90024

(4)Jet Propulsion Laboratory
4800 Oak Grove Drive
Pasadena, California 91103

October 1977

Space Sciences Department
TRW Defense and Space Sciences Group
One Space Park
Redondo Beach, California 90278 USA

PLASMA FLOW PULSATIONS IN EARTH'S MAGNETIC TAIL

by

F. V. Coroniti[1,*], L. A. Frank[2], R. P. Lepping[3], F. L. Scarf[1], and K. L. Ackerson[2]

[1]Space Sciences Department
TRW Defense & Space Systems Group
Redondo Beach, California 90278

[2]Department of Physics & Astronomy
University of Iowa
Iowa City, Iowa 52242

[3]Laboratory for Extraterrestrial Physics
NASA Goddard Space Flight Center
Greenbelt, Maryland 20771

[*]also at Departments of Physics & Astronomy
University of California, Los Angeles
Los Angeles, California 90024

October 1977

Space Sciences Department
TRW Defense & Space Systems Group
One Space Park
Redondo Beach, California 90278

TRW No. 23499-6011-RU-00

THE ISEE-C PLASMA WAVE INVESTIGATION*

by

F. L. Scarf[1], R. W. Fredricks[1], D. A. Gurnett[2],
and E. J. Smith[3]

[1]TRW Defense and Space Systems Group, One Space Park, Redondo Beach, California 90278

[2]Department of Physics & Astronomy, University of Iowa, Iowa City, Iowa 52242

[3]Jet Propulsion Laboratory, 4800 Oak Grove Drive, Pasadena, California 91103

*Prepared for the special ISEE issue of Geoscience Electronics

November 1977

Space Sciences Department
TRW Defense and Space Systems Group
One Space Park
Redondo Beach, California 90278

TRW No. 31219-6003-RU-00

CONNECTIONS BETWEEN COMETS AND PLASMAS IN SPACE*

by

Frederick L. Scarf

December 1977

*Prepared for Proceedings of the Symposium on Space Missions to Comets, NASA Goddard Space Flight Center, October 17, 1977.

Space Sciences Department

TRW Defense & Space Systems Group
One Space Park
Redondo Beach, California 90278

U. of Iowa 78-12

The ISEE-1 and -2
Plasma Wave Investigation*

by

D. A. Gurnett[1], F. L. Scarf[2]
R. W. Fredricks[2] and E. J. Smith[3]

March, 1978

[1]Department of Physics and Astronomy, The University of Iowa, Iowa City, Iowa 52242

[2]TRW Defense and Space Systems Group, One Space Park, Redondo Beach, California 90278

[3]Jet Propulsion Laboratory, 4800 Oak Grove Drive, Pasadena, California 91103

*To be published in the special ISEE issue of Geoscience Electronics.

U. of Iowa 78-3

The Heliocentric Radial Variation of Plasma Oscillations Associated with Type III Radio Bursts+

by

D. A. Gurnett, R. R. Anderson
F. L. Scarf*, and W. S. Kurth

January, 1978

Department of Physics and Astronomy
The University of Iowa
Iowa City, Iowa 52242

*TRW Defense and Space Systems Group, One Space Park,
Redondo Beach, California 90278

Submitted to J. Geophys. Res.

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GROUP 3: PRESENTATIONS

SS 14

SOLAR FLARE MODIFICATION OF THUNDERSTORM RELATED ELECTRIC FIELDS

R. H. Holzworth
F. S. Mozer (both at: Space Sciences Lab, University of Calif., Berkeley, CA 94720)

A direct observation of solar flare modification of thunderstorm driven electric fields is presented. During the August 1972 solar flares the vertical atmospheric electric field in the stratosphere decreased by at least an order of magnitude. The electric field decrease can be explained by a model in which the electrical conductivity is enhanced by ionization due to the solar protons. A global index of VLF whistlers shows a large increase at the time of the solar proton maximum, thereby indicating a possible world-wide high latitude enhancement in thunderstorm activity. Models of thunderstorm triggering mechanisms which are supported by these data will be discussed.

SS 15

DUST FROM CATASTROPHIC METEORITE COLLISIONS; AGENT OF CLIMATIC CHANGE?

Frank Dachille (Department of Geosciences, The Pennsylvania State University, University Park, Pennsylvania 16802)
B. J. Moyer (536 W. College Ave., State College, Pennsylvania 16801)

An impressive frequency of meteorite impacts of great magnitude is supported by the meteorite flux and the growing list of terrestrial craters. The 720 km diameter ISHIM impact structure, about 350 MY old, presents the possibility that masses as great as the largest asteroids (10^{22}gm) have collided with the Earth throughout its history. Dust from collisions, suspended about the Earth, will reduce insolation. Substantial reductions would result from collisions with masses greater than 10^{12}gms and kinetic energies greater than 10^{24} ergs; volcanic explosions are of the order of 10^{23} ergs whereas a Ries crater represents a 10^{28} ergs collision, and ISHIM, 10^{31}. Analytical approaches of W. J. Humphreys (1940) and E. W. Barrett (1971) are used to evaluate temperature changes to be expected from dust produced by collisions. Assumptions made are 1) the dust amounts to only 0.0001 to 1.0% of the impacting mass 2) the aerosol is uniformly dispersed through the upper atmosphere and persists for an appreciable time. Thus, a colliding mass of 10^{16}gms, capable of forming a 37 km diameter crater, might generate 10^{10}-10^{14}gms of dust; 10^{14} gms of aerosol are equivalent to 2000 gms/hectare. This much aerosol, made up of particle sizes between 0.04 and 10.0 μm diameter, would lead to a 23% decrease of irradiance and a lowering by 18°C of the global annual mean temperature. While the dust mechanism appears to be effective for lowering temperature for short periods it cannot account for cold or warm climatic episodes of millions of years. These limitations will be discussed along with the possibilities residing in other effects of collision - change of axis of rotation and change of the geographical relationships of continental and oceanic masses.

Waves, Abundances, and Other Topics

Cathedral Hill B (JT), Thursday 1330h
Louis Frank (University of Iowa), Presiding

SS 16

INITIAL ISEE MAGNETIC FIELD OBSERVATIONS: THE SUBSOLAR REGION OF THE BOW SHOCK

E. W. Greenstadt (Space Sciences Dept., TRW Defense & Space Systems Group, Redondo Beach, Cal 90278)
P. C. Hedgecock (Dept. of Physics, Imperial College of Science & Technology, London S.W. 7, England)
M. Kivelson
R. L. McPherron
C. T. Russell (all at: Inst. of Geophysics & Planetary Physics, Univ. of California at Los Angeles, Los Angeles, Calif 90024)

The early orbits following launch of the ISEE A, B satellite pair carry the two spacecraft through the subsolar region of the earth's bow shock where the nominal range of orientations of the interplanetary field is expected to provide numerous crossings and recrossings of quasi-perpendicular profiles. Such crossings are ideal for detecting shock motion and measuring shock velocities. Previous observations by single spacecraft or fortuitous locations of pairs of independent satellites have given estimates of equivalent, constant bow shock velocities in the range 10 to 200 km/sec. However, all estimates have required assumptions about the way in which the shock moved or the symmetry and shape of the nominal shock "surface," since even when two spacecraft were available, they were at least several earth radii (R_E) apart, never along the same shock normal, and had to be "connected" by a hypothetical shock contour. Now, for the first time, simultaneous measurements separated by .01 R_E afford an opportunity to estimate local, instantaneous velocities of shock motion and apply them to the study of shock structure.

SS 17

MAGNETOHYDRODYNAMIC WAVES IN THE SOLAR WIND

M. J. Wiskerchen (Lunar and Planetary Laboratory, Univ. of Arizona, Tucson, Arizona 85721)
C. P. Sonett (Dept. of Planetary Sciences, Lunar and Planetary Laboratory, Univ. of Arizona, Tucson, Arizona 85721)

We have investigated the behavior of magnetohydrodynamic waves in the interplanetary medium. Using Explorer 35 magnetometer data, 1650 sample intervals of 10-minute duration were examined and analyzed. We compute variance ellipsoids from which the minimum variance direction, or $\underline{k}$ ($\underline{k}$ is the vector defining the direction of the wave phase front), is determined. $\underline{k}$ shows an extraordinary peak in population in the direction of <B>, with half width at half maximum of 18°. These imply a field of Alfven waves propagating nearly along <B>. The solid angle decreases with a minimum near 45° away from <B> and reaches a secondary maximum at 90°. From calculation of e_3 $\underline{k}$ x <B> (where e_3 is the eigenvector in the direction of maximum variance), the secondary maximum can be shown to be a non-propagating mode. The angular spectrum of $\underline{k}$ has been examined for effects of both linear and non-linear wave damping. In addition, a set of 1-hour data intervals encompassing the above 10-minute samples were analyzed and their respective wave characteristics identified. As viewed from these results, a gross model of MHD waves in the interplanetary medium at 1 AU consists of a sea of isotropic turbulence upon which is superimposed a "beam" of Alfven waves propagating along the average magnetic field direction, and finally, a non-propagating field convected with the solar wind.

SS 18

DIGITAL SOLAR SPECTROGRAPH OBSERVATIONS.

D.G. Sime (Federal Institute of Technology, Zürich, Switzerland)

Observations of the solar radio event near 07.30 UT on Sept., 1, 197[illegible], are presented and used to illustrate the advantages and performance of the new digital spectrograph. The receiver and some of its features are described briefly with [illegible] sensitivity. In particular, the [illegible] of a digital [illegible] allows the [illegible] and [illegible] of the resulting spectrograms [illegible] conventional film [illegible] receiver. Further, it also allows [illegible] with [illegible] the possibilities of more [illegible] description of events. The event [illegible] patterns [illegible]. Digital processing techniques have been applied to these and the results are compared to those which might have been arrived at by conventional analysis.

SS 19

SOLAR WIND PLASMA WAVE OBSERVATIONS WITH THE HELIOS 1 AND 2 SPACECRAFT

Roger R. Anderson
Donald A. Gurnett (both at: Dept. of Physics and Astronomy, The Univ. of Iowa, Iowa City, Iowa [illegible])

The most common plasma wave phenomena observed in the solar wind by the HELIOS 1 and 2 spacecraft are electrostatic ion-acoustic waves and electron plasma oscillations. The ion-acoustic waves occur as long series of spiky bursts lasting for up to several hours and appear in the data up to about half the time at all radial distances. The amplitudes of the ion-acoustic waves tend to increase closer to the sun. Near aphelion the electron plasma oscillations usually occur as a few spiky bursts lasting from a few seconds up to a few minutes separated by many minutes to hours of no activity. Both the amplitudes and frequency of occurrence of the electron plasma oscillations tend to increase with decreasing radial distance from the sun.

Observations of these plasma wave phenomena when the HELIOS 1 and 2 spacecraft have been nearly radially aligned have allowed us to determine radial dependences independent of temporal effects. Simultaneous observations from both spacecraft show that near perihelion when the spacecraft are nearly radially aligned, the spacecraft nearer the sun observes more frequent and more intense electron plasma oscillations than the other spacecraft. The spacecraft nearer the sun usually also observes higher amplitudes for the ion-acoustic waves. The frequency of occurrence of the ion-acoustic waves are usually nearly the same for both spacecraft during radial alignment. The effect of the solar wind stream speeds on the frequency of occurrence of ion-acoustic waves when the spacecraft are not radially aligned will also be discussed. Further observations of intense and lasting electron plasma oscillations associated with type III radio bursts will also be presented.

SS 20

PLASMA WAVE ELECTRIC FIELDS IN THE SOLAR WIND: COMPARISON OF RESULTS FROM HELIOS AND VOYAGER

D. A. Gurnett (Dept. of Physics and Astronomy, The Univ. of Iowa, Iowa City, IA 52242)
F. L. Scarf (TRW Systems, One Space Park, Redondo Beach, CA 90278)
W. S. Kurth
R. R. Shaw (both at: Dept. of Physics and Astr., The Univ. of Iowa, Iowa City, IA 52242)

The preliminary results from the plasma wave electric field experiment on the Voyager spacecraft at heliocentric radial distances R ≥ 1. A.U. are compared with earlier solar wind plasma wave measurements from the Helios spacecraft at 0.3 < R ≤ 1.0 A.U. Weak bursts of electron plasma oscillations and bursts of ion-acoustic waves between the electron and ion plasma frequencies, $f_p^+ < f < f_p^-$, are occasionally observed in the solar wind with the Voyager spacecraft. These waves have characteristics qualitatively similar to the Helios observations closer to the sun. In addition to these transient bursts, a low level of electric field turbulence is almost always detected by Voyager at frequencies below the local electron gyrofrequency, $f < f_g^-$. This turbulence is tentatively identified as whistler-mode turbulence. Whistler-mode turbulence of this type has been detected by the magnetic field [illegible] Helios [illegible], but not by the electric field instrument [illegible] spacecraft. [illegible]

SS 21

A QUASILINEAR APPROACH TO WAVE-PARTICLE INTERACTIONS IN THE SOLAR WIND

C.C. Goodrich (Center for Space Research and Department of Physics, MIT, Cambridge, MA 02139)
(Sponsor: John W. Belcher)

We have developed a set of quasilinear

study comprehensively combines those studies and adds a variety of transitional trajectories which have not been examined systematically in previous studies. The amount of displacement of a particle across the tail, the amount of energization and the effect of the cross-tail electric field on the plasma sheet current are also discussed in terms of [illegible] and [illegible].

SM 29

POSSIBLE MECHANISMS OF LUNAR SEMI-DIURNAL VARIATION IN THE EQUATORIAL DST INDEX

T. Kamei (CIRES, Univ. of Colorado and NOAA/NGSDC, Boulder, Colorado 80302)

Detailed analyses of the Dst index (1957-75) show a clear lunar semi-diurnal variation whose phase is stable for various levels of geomagnetic activity (quiet or disturbed periods, etc.). Its maxima occur at 00h and 12h in Geomagnetic Lunar Time. The amplitude of the variation for quiet times (0.4nT) is smaller than for disturbed times (0.8nT).

We could explain this variation by several possible mechanisms. In this presentation only two will be discussed:

(1) Ionospheric L current system modified by the geomagnetic latitude of the Moon, and

(2) Variation of the particle population and deformation of the ring current caused by the electric field extended from the Ionosphere.

SM 30

INITIAL ISEE MAGNETIC FIELD OBSERVATIONS: THE MAGNETOPAUSE

C.T. Russell
R.C. Elphic (both at: Institute of Geophysics, University of California, Los Angeles, CA 90024)
E.W. Greenstadt (TRW Systems Group, Redondo Beach, CA 90278)
P.C. Hedgecock (Imperial College, London, England)
M.G. Kivelson
R.L. McPherron (both at: Institute of Geophysics, University of California, Los Angeles, CA 90024)

The ISEE A/B spacecraft are scheduled to be launched into highly elliptic orbits on October 13, 1977 well after this abstract is being written. One of the prime objectives of this mission is the determination of the velocities and thicknesses of the various magnetospheric boundary layers. If orbit injection and initial data reduction goes according to plan we will have initial measurements of the thickness of the magnetopause at a few locations in the range from 0600 to 1200 LT. At a very minimum we will present a status report on the magnetic field investigation.

Electric Potential Discontinuities in Laboratory and Magnetosphere

Garden (JT), Tuesday 0830h

David Evans (NOAA/ERL), Presiding

SM 31 INVITED PAPER

PRECIPITATION CHARACTERISTICS OF QUIET AURORAL ARCS

C.-I. Meng (Space Sci. Lab, Univ. of Calif., Berkeley, CA 94720)

Electron precipitations of quiet auroral arcs were examined based on a 6-channel low energy electron experiment aboard DMSP satellites. It is found that there is a striking similarity among the quiet discrete arcs observed over the late evening oval, early evening oval, and sun-earth aligned polar cap discrete arcs. Energy fluxes of these phenomena were about a few ergs/cm^2-sec-sr and their differential energy spectra were all characterized by a mono-energetic peak near 3 keV. Diffuse auroras along the evening and morning auroral oval had totally different characteristics from those of discrete auroral arcs.

(Invited paper)

SM 32 INVITED PAPER

EXPERIMENTS ON POTENTIAL DOUBLE LAYERS

A. Y. Wong (Department of Physics, University of California, Los Angeles, CA 90024)
(Sponsor: John R. Winckler)

Large localized potential double layers, $e\phi \gg kT_e$, are observed to develop from a solitary E-field struction in a plasma traversed by electron drifts, $v_d \simeq v_e$. Strong electron and ion accelerations occur across the layers. The potential layers are unstable to large localized potential fluctuations with $\frac{T_e}{T_i} \sim 2 - 3$. Ion fluctuations are also produced by counter-streaming ion beams in front of the double layer. At large electron drift velocities ($v_d > 3v_e$), layers are unstable to large ion fluctuations with $\delta n/n$ approaching unity. Double layers in the presence of a magnetic field will be discussed.

1. B.H. Quon and A.Y. Wong, Phy. Rev. Lett. 37, 1393 (1976).
2. P. Leung and A.Y. Wong, APS Bulletin.

SM 33 INVITED PAPER

A REVIEW OF PARTICLE MEASUREMENTS FROM WITHIN IONOSPHERIC STRUCTURES RESPONSIBLE FOR AURORAL ACCELERATION PROCESSES

R. D. Sharp (Space Sciences Laboratory, Lockheed Palo Alto Research Laboratory, Palo Alto, California 94304)

Large scale ionospheric structures containing field aligned d.c. electric fields are thought to be responsible for "inverted V" events and at least some types of auroral arcs. Because of its unique orbital characteristics, the S3-3 satellite is for the first time making measurements within these structures at altitudes of ≈ 1 RE in the polar regions. Particle measurements by the Aerospace group with electrostatic analyzers and by the Lockheed group with energetic ion mass spectrometers and magnetic electron spectrometers will be reviewed. Details of the energy and angular distributions of the electrons and ions in the keV range allow inference to be made about the geometry of the structures and the nature of the acceleration processes taking place within them. Some of the characteristics of the structures are similar to those which have been predicted for the "inverted V" acceleration regions. In two events which have been analyzed in detail a vertical extent of the parallel electric field of ≥ 10^{3}km is inferred. An event on 29 July 1976 in which the Berkeley group has reported intense electrostatic shocks will be described utilizing the results of both the Aerospace and Lockheed experiments. The energy of the accelerated ions in this event exceeded 1? keV.

SM 34 INVITED PAPER

S3-3 OBSERVATIONS OF ELECTROSTATIC SHOCKS

F. S. Mozer (Physics Dept. and Space Sciences Lab., Univ. of Calif., Berkeley, CA 94720)
R. B. Torbert (Space Sciences Lab., Univ. of Calif., Berkeley, CA 94720)

Potential discontinuities, called electrostatic shocks, are observed frequently on the S3-3 satellite in the auroral zone at altitudes below the satellite apogee of 8000 kilometers. They are associated with particle acceleration, field aligned ~ 100 eV electron beams, low frequency wave turbulence, electrostatic ion cyclotron wave emission, VLF saucer generations, and field aligned currents. Examples of these associations are presented and dependences of shocks on local time, altitude, magnetic activity, and other parameters are given.

(Invited paper)

*Work supported by ONR contract N00014-75-C-0294

SM 35 INVITED PAPER

ELECTROSTATIC SHOCKS, DOUBLE LAYERS, AND ANOMALOUS RESISTIVITY IN THE MAGNETOSPHERE

M. K. Hudson
F. S. Mozer (both at: Space Sci. Lab, Univ. of California, Berkeley, CA 94720)

Electrostatic shocks and double layers are defined, discussed, and compared with anomalous resistivity. A double layer or electrostatic shock is a zero frequency potential discontinuity in the lab or shock frame, respectively, with a single characteristic scale size. In contrast, anomalous resistivity results from enhanced collisions with many waves of nonzero frequency and different wavelengths. Electrostatic shocks and/or double layers are further characterized by the plasma normal mode that creates them. Ion acoustic shocks or double layers can occur in unmagnetized plasmas or with potential drops along the magnetic field line in magnetized plasmas, and their thicknesses scale with the Debye length. Ion cyclotron shocks or double layers can occur in magnetized plasmas with the major potential drop perpendicular to the magnetic field and with thicknesses that scale as the energetic ion gyroradius. It is suggested that turbulence and anomalous resistivity may provide local modification of particle distribution functions essential to the production of electrostatic shocks and double layers in space plasmas. The S3-3 measurements indicate that all such shocks are in fact accompanied by turbulence.

SM 36

FIELD-ALIGNED CURRENTS WITHIN ELECTROSTATIC SHOCKS

C. A. Cattell
F. S. Mozer (both at: Space Sciences Lab and Physics Dept., Univ. of California, Berkeley, CA 94720)
R. B. Torbert (Space Sciences Lab, Univ. of California, Berkeley, CA 94720)

Although the aspect magnetometer on the S3-3 satellite has a resolution of only 80γ on any one axis, it is stable; and the orbit and aspect of the spacecraft are ideal for measuring sheets of field-aligned currents extended in magnetic longitude. One component of the magnetic field is measured very nearly along the spin axis, which is usually aligned east-west, the direction most sensitive to perturbations produced by these currents. By averaging this component over one spin period, the field resolution can be improved by a factor of 5 to 10.

Transverse perturbations of typically one to two hundred gammas (and up to 400γ) are seen on S3-3 within regions of low frequency surrounding electrostatic shocks, as described in Mozer et al.(1977). Typically the inferred currents extend over 0.5 to 2 degrees of invariant latitude or 150 to 600 km, implying average current densities up to 5 μa/m^2; and often appear as pairs of oppositely directed currents. Both the energetic electrons and the energetic ions observed by onboard particle detectors can often account for a reasonable fraction of the observed upward current.

Mozer, F. S., C. W. Carlson, M. K. Hudson, M. C. Kelley, R. B. Torbert, B. Parady, and J. Yatteau, Observations of paired electrostatic shocks in the polar magnetosphere, Phys. Rev. Lett., 38, 292, 1977.

L.A. Fisk (Univ. of New Hampshire, Dept. of Physics, Durham, NH 03824)
J.J. O'Gallagher, (Enrico Fermi Institute, Univ. of Chicago, 5630 S. Ellis Ave., Chicago, IL 60637)

We present initial measurements from the ULECA sensor of the Max Planck Institut/University of Maryland experiment on ISEE-1. ISEE-1 was launched on 22 October 1977 into a highly eccentric orbit with apogee ~22.5 earth radii. The ULECA sensor consists of a collimator, electrostatic deflection system, and an array of solid state detectors. The position of the detector, which determines the energy per charge of an incident particle, together with the measured energy determine the particle's charge state. Preliminary analysis indicates a rich variety of phenomena are operative in the transthermal energy regime (~10 keV/Q to ~100 keV/Q) covered by ULECA. For example, for two active time periods, both when the spacecraft was near the earth's bow shock, we show that the proton spectrum gradually but consistently steepens with energy. We will also discuss our observations of alpha particles and heavier elements during these events.

SM 55

MICROPROCESSOR BASED SCIENTIFIC INSTRUMENTS IN SPACE

H. Heetderks
D. Altan
P. Harvey
R. Stauduhar
R. Torbert
F. Mozer (all at: Space Sci. Lab., Univ. of California, Berkeley, Ca. 94720)

The first microprocessor controlled scientific instrument flown in space is the Quasi-Static Electric Field Experiment carried aboard the ISEE-1 spacecraft, which was launched on 23 October, 1977. The advantages of microprocessor based control systems in scientific instruments aboard spacecraft are discussed using the ISEE-1 8080 type instrument as an example. These advantages include simplified interfacing to the spacecraft telemetry and command systems, and the ability to execute algorithms which allow the instrument to analyze the data which it is collecting, and to reconfigure itself in response to changes in that data. In addition, since the microprocessor can execute program steps which are sent to the spacecraft by ground command, it is possible for the scientist to in effect redesign his instrument after the spacecraft has been launched. Finally, problems peculiar to the design of a microprocessor system which is to operate in a space environment are discussed.

SM 56

MEASUREMENTS OF QUASI-STATIC AND LOW FREQUENCY ELECTRIC FIELDS WITH SPHERICAL DOUBLE PROBES ON THE ISEE-1 SPACECRAFT

F. S. Mozer
R. B. Torbert (both at: Physics Department and Space Sciences Laboratory, Univ. of California, Berkeley, Ca. 94720)
U. V. Fahleson
C.-G. Falthammar (both at: Plasma Physics Division, Royal Institute of Technology, Stockholm, Sweden)
A Gonfalone
A. Pedersen (both at: Space Physics Department, European Space Agency, Noordwijk, Holland)

The spherical double probe electric field experiment on the ISEE-1 spacecraft is described. It is shown that the instrument measures magnetospheric, magnetosheath, and solar wind electric fields with a sensitivity well below one mV/m. Design features and diagnostic experiments performed in orbit to understand the instrument operation are discussed.

SM 57

ISEE MAGNETIC FIELD OBSERVATIONS: INITIAL OBSERVATIONS OF SHOCK VELOCITY AND THICKNESS

C.T. Russell
R.C. Elphic (both at: Institute of Geophysics and Planetary Physics, University of California, Los Angeles, CA 90024)
E.W. Greenstadt (TRW Systems, One Space Park, Redondo Beach, CA 90278)
P.C. Hedgecock (Dept. of Physics, Imperial College, London, England)
M.G. Kivelson
R.L. McPherron (both at: Institute of Geophysics and Planetary Physics, University of California, Los Angeles, CA 90024)

The ISEE 1 and 2 spacecraft were successfully launched into highly elliptic, 23 earth radii apogee orbits on October 22, 1977. The two spacecraft are in nearly identical orbits with variable separation ranging from about 100 km to several thousand km. Initially apogee was about 1000 LT. During the first two months shock crossings were encountered as close as 20° and as far as about 90° from the earth-sun line. Examination of the initial data shows the bow shock structure and motion to be quite variable even on the time scale of one minute. In the small sample of shocks examined to date, the average velocity between the two spacecraft measured along the theoretical shock normal has been on the order of 10 km/sec, with thicknesses of the major field discontinuity ranging from 10 to 100 km. When the shock takes the order of a minute to move from one spacecraft to the other the apparent shock thickness can change significantly. Other features can change also such as the foot of the shock, and the overshoot region, or region of enhanced field strength immediately behind the shock. At times the shock can even reverse its motion after crossing one spacecraft and not reach the second spacecraft 500 km upstream.

SM 58

ISEE MAGNETIC FIELD OBSERVATIONS: INITIAL OBSERVATIONS OF MAGNETOPAUSE VELOCITY AND THICKNESS

R.C. Elphic
C.T. Russell (both at: Institute of Geophysics and Planetary Physics, University of California, Los Angeles, CA 90024)
E.W. Greenstadt (TRW Systems Group, Redondo Beach, CA 90278)
P.C. Hedgecock (Imperial College, London, England)
M.G. Kivelson
R.L. McPherron (both at: Institute of Geophysics and Planetary Physics, University of California, Los Angeles, CA 90024)

The ISEE 1 and 2 spacecraft were successfully launched into highly elliptic 23 earth radii apogee orbits on October 22, 1977. The two spacecraft are in nearly identical orbits with variable separation ranging from about 100 km to several thousand km. At this writing the spacecraft have probed the entire dawn hemisphere of the equatorial magnetosphere. However, data are still only available for the first few orbits. In the single set of magnetopause crossings that it has been possible to examine to date, the magnetopause overtook the spacecraft at 14 km sec^{-1} and the major current sheet was estimated to be 750 km thick.

Plasmas in Space 5: Micropulsations, 1

Napoleon 1 (D), Wednesday 0830h
L. J. Lanzerotti (Bell Laboratories), Presiding

SM 59 INVITED PAPER

SIMULTANEOUS MULTISATELLITE OBSERVATIONS OF HYDROMAGNETIC WAVES AT GEOSTATIONARY ORBIT

W. J. Hughes. (Blackett Laboratory, Imperial College, London SW7, U.K.)

We review the results obtained by studying simultaneous magnetic field data from the UCLA and NOAA magnetometers on board three geostationary satellites (ATS 6, SMS 1 and SMS 2). A large number of pulsation events were observed during six days when the satellites were close together. The data was compared using auto-spectral and cross-spectral techniques which allowed us to calculate the coherence and phase differences between the signals seen on the satellites. In addition we made a detailed analysis of the 0.02-80 keV plasma data from the UCSD experiment on ATS 6 for a few selected events. Three distinct types of pulsation in the pc4 band were observed. In the morning and early afternoon we found azimuthally polarised pulsations with large azimuthal wavelength which propagated away from local noon. These events fit the Kelvin-Helmholtz picture of pulsation generation. In the late afternoon, waves with large azimuthal wave number are seen which may be due to instabilities in the gradient of the energetic proton intensity. A third, rather rare type of pulsation can occur near local midnight. These waves are very monochromatic, have a large east-west wavelength, and are polarized in the meridinal plane with a large compressional component. The plasma data shows effects of both the wave electric field and magnetic pressure perturbations and estimates of these parameters suggest that these may well be guided waves.

SM 60 INVITED PAPER

KINETIC EFFECTS OF MAGNETIC PULSATIONS

Akira Hasegawa
(Bell Telephone Laboratories, Murray Hill, New Jersey 07974)

Magnetic pulsations near the resonant field lines produce oscillating parallel electric field with the same period as the pulsation itself. This electric field can resonantly accelerate charged particles with the velocity comparable to the Alfvén speed in the direction of the geomagnetic field. Electrons at the plasmapause and protons at the ring current may face this acceleration and may be precipitated to the ionosphere. Theoretical summary of such a process will be presented together with some observational evidence.

SM 61 INVITED PAPER

MODULATION OF ENERGETIC PARTICLES BY HYDROMAGNETIC WAVES

Chin S. Lin (Space Sciences Div., Geophysics Program, Univ. of Washington, Seattle, WA 98195)

Modulations of particle fluxes by hydromagnetic waves at frequencies of Pc 4-5 waves have been observed from thermal to MeV energies. The particle fluxes at thermal energies oscillate out of phase with the energetic particles. The flux modulation is largest at large pitch angles. For energetic particles (E ≥ 30 keV) the modulation can be understood by the theory that particles respond adiabatically to the magnetic field oscillations. The modulation at thermal energies depends on the type of instability that causes the modulation. We have examined as possible mechanisms for the storm associated Pc 4-5 waves the Kelvin-Helmholtz instability and the drift mirror instability coupled to the local Alfvén waves. Detailed results from the ATS-6 satellite show that these instabilities are active in the magnetosphere.

SM 62 INVITED PAPER

POLARIZATION STUDIES OF SIPLE-ROBERVAL Pc 1 MICROPULSATIONS

R. L. Arnoldy
P. H. Lewis, Jr. (both at: Space Science Center, Univ. of New Hampshire, Durham, NH 03824)
L. J. Cahill, Jr. (School of Physics and Astronomy, Univ. of Minnesota, Minneapolis, MN 55455)

Siple Pc 1 data and conjugate Siple-Roberval data are being analyzed for polarization. As has been observed in earlier studies, a structured Pc 1 event can have both right- and left-handed polarization and can rapidly change its polarization as a function of time and/or frequency, suggesting that the event might be a composite of many wave trains. Complicated rising tone structures seen in dynamic spectra can become somewhat unraveled when polarization is displayed. For example, an event which evolved into a chevron-type structure apparently was the superposition of three signals (as identified by polarization) with different fine structure repetition periods. Even though Siple-Roberval 'conjugate' events might have very similar spectrograms, the polarization of the signals can be quite different, apparently due to the different ionospheric coupling of the signals to the stabeen analyzed and are consistent with the earlier inferences. The Pioneer 11 observations of essentially a single positive polarity have been compared with simultaneous observations in the ecliptic which show the usual two sectors of opposite polarity and with maps of the solar photospheric field (courtesy of R. Howard). A large number of crossings of the interplanetary current sheet have been studied. Variance analysis has shown that the magnetic field component perpendicular to the current sheet is zero within a small statistical uncertainty and that the field tends to rotate across the current sheet from one polarity to the other. The relation between the current sheet and solar wind parameters such as density and temperature has been investigated, specifically the anticipated coincidence between the current sheet and the interface within interaction regions which separates accelerated from decelerated plasma.

SS 4

SOLAR WIND STREAM STRUCTURE DURING THE EARLY PHASE OF SOLAR CYCLES 20 AND 21

J.T. Nolte
J.M. Davis (both at: American Science and Engineering, Inc., Cambridge, MA 02139)
A.J. Lazarus
J.D. Sullivan (both at: Center for Space Research and Department of Physics, MIT, Cambridge, MA 02139)

We have extended the investigation of the variation of the solar wind flow associated with the solar cycle by comparing solar wind stream parameters for periods of ~ 1 year shortly after the minima preceding Solar Cycles 20 and 21. During the first year of Cycle 20, solar wind data are available from the MIT detector on Mariner 4, and average stream parameters have been determined by Bame et al. (1976, Ap. J. 207, 977) using near-Earth satellites. For all streams with amplitude ≥ 150 km/s, the average amplitude A = (204 ± 13) km/s, average maximum velocity V = (509 ± 14) km/s, and average half-width W = (3.3 ± 0.5) days, all derived from the Mariner 4 data for January - July, 1965, are not significantly different from the values found by Bame et al. for all of 1965. The slight (< 2σ) difference in average maximum velocity may be due to development of individual high speed streams with heliocentric distance. We have used data from the MIT instruments on IMP 7 and 8 during the comparable period of Cycle 21 (June 1976 - May 1977). The averages of A = (236 ± 13) km/s and W = (2.8 ± 0.24) days were not significantly different. However, V = (587 ± 12) km/s was ~ 3σ higher than the value for all of 1965, indicating that high speed streams in the ecliptic plane were faster during the time following the most recent minimum.

SS 5

LOW FREQUENCY ELECTRON DENSITY FLUCTUATIONS IN THE SOLAR WIND MEASURED BY SPACECRAFT RADIO PHASE SCINTILLATIONS

R. Woo
J. Armstrong (both at: Jet Propulsion Laboratory, Pasadena, Ca. 91103)

Interplanetary electron density fluctuations in the frequency range 10^{-4} - 10^{-2} Hz have been studied using extensive 1976 Viking dual frequency (2.3 and 8.4 GHz) phase scintillation measurements. These observations covered the heliocentric distance range of $2R_\odot$ to 1 AU. At 1 AU the power spectrum of the density fluctuations is power-law with an approximate one-dimensional spectral index of 1.6, and is consistent with direct spacecraft measurements. Fluctuations in the frequency range 3 x [illegible] - 1 Hz were measured at [illegible]$R_\odot$, and the power spectrum was again power law with a one-dimensional spectral index of 1.6 over this extensive frequency range. The results also show that, as expected, phase scintillations are lower in the anti-solar direction, so that future searches for gravitational radiation using spacecraft radio signals would be most promising if observed in that direction

SS 6

ENERGY SPECTRA OF ELECTRONS AND PROTONS ACCELERATED IN THE BOW SHOCK

K. A. Anderson (Physics Department and Space Science Laboratory, Univ. of California, Berkeley, Ca.)
R. P. Lin
D. Potter (both at: Space Science Laboratory, Univ. of California, Berkeley, Ca. 94720)
S. C. Lin
G. K. Parks (both at: Geophysics Program, Univ. of Washington, Seattle)
F. Martel
H. Reme (both at: Centre d'Etude Rayonnements Spatiale)

The ISSE-1 and -2 spacecraft experienced multiple bow shock crossings at about 1719 UT on 27 October 1977. The bow shock crossings were identified by large increases in proton fluxes in the range 2 to 30 keV when the shock moved Earthward of the spacecraft. The shock apparently passed over the spacecraft four times with an average time interval of 8 seconds. The bow shock proton fluxes were 1000 cm^{-2} st^{-1} sec^{-1} eV^{-1} at 1.5 keV, 50 at 6 keV, and 0.2 at 30 keV. These fluxes are comparable to, but somewhat lower than, those previously reported by Lin et al. (1974).[1] The new result is that a steady flux of electrons in the range 2-6 keV was found to accompany the upstream protons. The fluxes were 200 cm^{-2} st^{-1} sec^{-1} eV^{-1} at 1.5 keV and 2.5 at 6 keV. No electron flux at 30 keV could be detected above the background flux of 10^{-3} in the above units. Spikes of electrons upstream from the bow shock are well known from previous work, but no steady upstream electron component has been reported.

1. Lin, R. P., C.-I. Meng, and K. A. Anderson, J. Geophys. Res., 79, 489 (1974).

SS 7

OBSERVATIONS OF PARTICLE BURSTS AND UPSTREAM WAVES FROM THE MAGNETOSPHERE AT > 400 R_E WITH THE VOYAGER-1 SPACECRAFT

S. M. Krimigis
E. P. Keath (representing the LECP Team)*
(both at: APL/JHU, Laurel, Maryland 20810)
M. H. Acuna
K. W. Behannon
R. P. Lepping
N. F. Ness (representing the MAG Team)**
(all at: NASA/GSFC, Laboratory for Extraterrestrial Physics, Greenbelt, Maryland 20771)

The Voyager-1 spacecraft was launched towards Jupiter and Saturn on September 5, 1977 on a trajectory off the dawn side of the earth's magnetosphere at a sun-earth-spacecraft angle of ~ 95 to ~ 100°. The experiment complement includes a low energy charged particle instrument (LECP) and two fluxgate magnetometers. Several energetic (≥ 25 keV) ion bursts (presumed to be protons) were observed well after the last crossing of the bowshock (at ~ 1750 UT on the 5th) in association with upstream waves in the magnetic field. The duration of the bursts ranged from ~ 2 minutes to over 1 hour, and extended in energy to ~ 100 keV. Anisotropy measurements showed maximum-to-minimum ratios extending to ≥ 100:1, with the peak intensity coming from the direction of the magnetosphere. Decreases in the field magnitude, enhancements in rms noise, and changes in field direction were observed simultaneously with the particle bursts. Our tentative interpretation is that the observed ions originated in the magnetosphere, and propagated upstream to the position of the spacecraft and excited the waves. The implications of the magnetosphere as a source of ions in the local interplanetary medium will be discussed.

* Voyager LECP Team Members: T. P. Armstrong, W. I. Axford, C. O. Bostrom, C. Y. Fan, G. Gloeckler, S. M. Krimigis (PI) and L. J. Lanzerotti

** Voyager MAG Team Members: N. F. Ness (PI), M. H. Acuna, K. W. Behannon, L. F. Burlaga, R. P. Lepping and F. M. Neubauer

SS 8

[illegible]

Ion-acoustic-like waves, similar to those previously detected by the Helios spacecraft from 0.3 to 1.0 A.U., have now been detected by the Voyager spacecraft in the solar wind at heliocentric radial distances out to 1.7 A.U. High bit rate waveform measurements from the Voyager plasma wave experiments provide the first high resolution frequency-time spectrograms of these waves. The Voyager spectrograms show that the ion-acoustic waves consist of narrow-band bursts which last for a few seconds or less. The center frequency of the bursts fluctuate rapidly in frequency, usually in the range between the electron and ion plasma frequency, f_p^- and f_p^+. (These waves have previously been referred to as $f_p^+ < f < f_p^-$ noise.) Comparisons of the Voyager spectrograms with similar measurements from the OGO 5, IMP 6, IMP 8, and Hawkeye 1 spacecraft show that the spectrum of the ion-acoustic waves detected by Voyager far from the earth are essentially identical to electrostatic waves detected upstream of the earth's bow shock, driven by protons streaming into the solar wind from the bow shock. This close similarity provides added evidence that the ion-acoustic-like waves detected in the solar wind by Helios and Voyager are probably driven by an ion beam instability, as has recently been suggested by Gary [1977].

SS 9

HIGH TIME-RESOLUTION OBSERVATIONS OF ELECTROMAGNETIC WAVES GENERATED AT DISCONTINUITIES IN THE SOLAR WIND: HELIOS 1 AND 2 "MEMORY MODE"

H. F. Barnstorf
F. M. Neubauer (both at: Institut fuer Geophysik, 3300 Braunschweig, Fed. Rep. Germany)

The "memory mode" of the Helios spacecrafts is triggered by event detecting algorithms using magnetic and electric field characteristics. The "magnetic" algorithm is sensitive to large field gradients. The memory-readouts contain search-coil data with up to 300 waveform samples per second.
Most of the events detected during the primary missions of Helios 1 and 2 were directional discontinuities with an appreciable |ΔB|. Near the current sheets of several discontinuities well-defined wavetrains and magnetic noise in a frequency interval between the lower hybrid and about half the electron gyro-frequency were observed. Analyses of some events will be presented including a wavenormal analysis and interpretation in terms of current instabilities parallel and perpendicular to the magnetic field.

SS 10

PROPERTIES OF MICROSCALE FLUCTUATIONS IN THE SOLAR WIND BETWEEN 0.3 AND 0.5 AU: HELIOS 1

K. U. Denskat
F. M. Neubauer (both at: Inst. Geophys., Techn. Univ. Braunschweig, F.R.G.)
R. Schwenn (Max-Planck-Inst., Physik und Astrophysik, Inst. extraterr. Phys., Garching, F.R.G.)

Helios-1 plasma and magnetic field data between 0.3 and 0.5 AU obtained during the primary mission were used to study microscale fluctuations in the solar wind. Correlating the directional fluctuations in the solar wind speed and the interplanetary magnetic field periods of Alfvénic wave activity were separated. For these periods we used a variance technique to determine the plane of polarization of the waves. Since these methods have been used before by other authors who studied MHD-fluctuations in the solar wind at 1 AU, we are able to compare their observations

GURNETT D. A., ANDERSON R. R. (both at University of Iowa, Iowa City, Iowa USA), SCARF F. L., FREDRICKS R. W. (both at TRW, Redondo Beach, CA USA) and SMITH E. J. (JPL, Pasadena, CA USA). A Survey of Plasma Wave Observations from ISEE 1 and 2.

The plasma wave experiments on the ISEE 1 and 2 spacecraft are operating satisfactorily and have now provided a wide variety of measurements of plasma and radio wave phenomena in the magnetosphere, magnetosheath and solar wind. Essentially every crossing of the earth's bow shock can be associated with an intense burst of electrostatic and whistler-mode turbulence at the shock, with substantial wave intensities in both the upstream and downstream regions. Usually the electric and magnetic field spectrums at the shock are quite similar for both spacecraft, although small differences in the detailed structure are sometimes apparent upstream and downstream of the shock, probably due to changes in the motion of the shock or propagation effects. Upstream of the shock emissions are often observed at both the fundamental, f_p^-, and second harmonic, $2f_p^-$, of the electron plasma frequency. In the magnetosphere high resolution spectrograms of the electric field show an extremely complex distribution of plasma and radio emissions, with numerous resonance and cutoff effects. Electron density profiles can be obtained from emissions near the local electron plasma frequency. Comparisons of high resolution spectrograms of whistler-mode emissions such as chorus usually show a remarkably close similarity between the two spacecraft with small propagation delays. Other types of locally generated waves, such as the $(n + 1/2)f_g^-$ electron cyclotron waves, show more pronounced differences between the two spacecraft. High resolution spectrograms of kilometric radio emissions are also presented which show an extremely complex frequency-time structure with many closely spaced narrow-band emissions.

GROUP 4: WORKSHOPS

NOTICE OF ISEE WORKING GROUP MEETING NO. 1

TIME:	9:00 a.m., 10 December 1977
PLACE:	Room 160 (The Library) Space Sciences Laboratory University of California, Berkeley
ATTENDANCE:	Principal Investigators, Co-Investigators, and Invitees of Principal Investigators

AGENDA

9:00- 9:45	"The Present State of Knowledge with Respect to the Structure and Motions of the Earth's Bow Shock," by G. Greenstadt
10:15-11:00	"The Present State of Knowledge of the Magnetopause," by B. Sonnerup
11:30-12:00	Aims of Magnetosphere and Bow Shock Workshop
12:30	Lunch
1:00- 2:00	Experimenter Reports--if needed
2:00- 5:00	Discussion of: Review of dates for special study Arrangements for next meeting Discussions of data

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Experimenters who wish to work together informally on Friday 9 December are invited to use the Space Sciences Laboratory. Work space is available, as well as office support (e.g., travel arrangements, secretarial, xerox, etc.).

Maps are enclosed for those who wish to drive. You can also use BART. That service begins about 8:00 a.m. from San Francisco. If you get the first or second train you will be at SLL by 9:00. (Take BART to downtown Berkeley, Humphrey Go-Bart to the Central Campus; the SSL shuttle bus stops in the parking lot at the north end of the carillon plaza at 8:40, 9:10, 9:40, etc.)

On Saturday we will meet the first two trains with SSL vans. Look for them in front of the Bank of America across the street from the Downtown Berkeley BART station.

While most people will probably choose to stay in San Francisco, anyone who would like accomodations in Berkeley for the nights of 9 and 10 December should contact Dr. Kinsey Anderson (415/642-1313) or Gerry Kelley (415/642-7297).

2464

VISITOR CONTROL PASS

NAME (Last, first and middle)							CITIZENSHIP
GREENSTADT E.W.						SECURITY CLEARANCE	[X] UNITED STATES [ ] IMMIGRANT ALIEN [ ] FOREIGN NATIONAL
FIRM OR AGENCY: TRW							
BADGE NO. 1476	DATE 4/14/78			TIME ISSUED 10:00 AM			TIME RETURNED
PERSON(S) TO BE VISITED	BLDG.	ROOM	TO BE COMPLETED BY PERSON VISITED: TIME ARRIVED	TIME DEPARTED	INITIALS		PURPOSE OF VISIT
K. OGILVIE	26	200					ISEE WORKSHOP

VISITOR CARRYING
- [ ] PACKAGE
- [ ] BRIEFCASE
- [ ] SATCHEL
- [ ] ______

VISITOR PLEASE READ AND SIGN

✓ I understand that I shall: wear the badge in plain view, return this pass, the badge and auto permit at the Visitor Control Point and not visit employees or offices without prior approval.

E W Greenstadt
Signature of Visitor

GSFC 24-4 (10/61)

076

VISITOR CONTROL PASS

NAME (Last, first and middle)							CITIZENSHIP
Greenstadt E.W.						SECURITY CLEARANCE	[X] UNITED STATES [ ] IMMIGRANT ALIEN [ ] FOREIGN NATIONAL
FIRM OR AGENCY: TRW							
BADGE NO. 1423	DATE 4/15/78			TIME ISSUED 0930			TIME RETURNED
PERSON(S) TO BE VISITED	BLDG.	ROOM	TO BE COMPLETED BY PERSON VISITED: TIME ARRIVED	TIME DEPARTED	INITIALS		PURPOSE OF VISIT
K. Ogilvie							ISEE Workshop

VISITOR CARRYING
- [ ] PACKAGE
- [ ] BRIEFCASE
- [ ] SATCHEL
- [ ] ______

VISITOR PLEASE READ AND SIGN

I understand that I shall: wear the badge in plain view, return this pass, the badge and auto permit at the Visitor Control Point and not visit employees or offices without prior approval.

E W Greenstadt
Signature of Visitor

GSFC 24-4 (10/61)

GROUP 5: RELATED REPORTS

30435-6002-RU-00

CORRELATION OF GEOMAGNETIC PULSATION SIGNALS IN THE 10 TO 150-SECOND PERIOD RANGE WITH CONCENTRATION OF IMF ORIENTATIONS NEAR THE SUN-EARTH LINE

by

E. W. Greenstadt
Space Sciences Department
TRW Defense & Space Systems Group
Redondo Beach, California 90278

and

J. V. Olson
Institute of Earth & Planetary Physics
University of Alberta
Edmonton 7, Alberta, Canada

30 June 1977

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Space Sciences Department
TRW Defense & Space Systems Group
One Space Park
Redondo Beach, California 90278

for the magnetic H-component data from Pittsburg, N. H. (L = 3.5). The period bands 30-60 sec, 60-120 sec and 120-240 sec are investigated for local daytime hours for a fifteen day interval in 1975 when good interplanetary data coverage from IMP J exists. The integrated power (γ^2) in the band 120-240 sec tends to increase with an increase in solar wind velocity while the power is essentially independent of the interplanetary field magnitude. Additional correlations and interpretations will be presented.

SM 95

IMF ORIENTATION, SOLAR WIND VELOCITY, AND Pc 3-4 SIGNALS: A JOINT DISTRIBUTION

E.W. Greenstadt (Space Sciences Department, TRW Defense and Space Systems Group, Redondo Beach, CA 90278).
H.J. Singer (Institute of Geophysics and Planetary Physics, University of California Los Angeles, CA 90024. Also Department of Earth and Space Science.
C.T. Russell (Institute of Geophysics and Planetary Physics, University of California Los Angeles, CA 90024.
J.V. Olson (Institute of Earth and Planetary Physics, University of Alberta, Edmonton, Alberta, Canada T6G2J1).

Separate studies using the same micropulsation data base in the period range 10-150 seconds have shown that signal levels recorded during Sept., Oct., and Nov. 1969 at Calgary correlated positively with both solar wind alignment of the IMF and solar wind speed, but each correlation contained enough scatter to allow for influence of the other factor, and perhaps other factors as well. Now joint correlations of velocity and field direction with parameters representing hourly distributions rather than minima of IMF orientation angle display the relative effect of the two agents on micropulsation signal levels, with threshold effects and a reduction in overall scatter.

SM 96

THE AFGL MAGNETOMETER NETWORK: A BRIEF DESCRIPTION

David J. Knecht
R. O. Hutchinson
C. W. Tsacoyeanes (all at: Air Force Geophysics Laboratory, Hanscom AFB, MA 01731)

The seven-station magnetometer network of the Air Force Geophysics Laboratory is currently in continuous operation. Five data-collection stations (Newport, WA, Rapid City, SD, Camp Douglas, WI, Mount Clemens, MI, and Sudbury, MA) form a 3800-km east-west chain at 55 °N corrected geomagnetic latitude. Two others (Lompoc, CA, and Tampa, FL) are separated by 3800 km at 40 °N corrected geomagnetic latitude. The principal instruments, identical at all stations, include a three-component saturable-core magnetometer to measure the surface field and a three-component induction-coil magnetometer to measure its time derivative. Sensitivities are about 0.1 gamma and 0.001 gamma-Hz, and sampling frequencies are one and five samples per second, respectively. The data-collection stations are not manned; measurements are made and processed automatically by microprocessor-based equipment at each station. Stations are synchronized and controlled remotely from the data-acquisition station at AFGL in Massachusetts. Outbound control and inbound data-return signals are transmitted on dedicated commercial voice-grade phone lines. Signal-propagation times to and from all stations are artificially made to be identical, so sampling times are simultaneous to within about one millisecond. Forward-error-correction techniques are used to assure accurate data transmissions. Data from all seven stations are processed and archived in near-real time by a dedicated minicomputer; values of the field and its time derivative are available within twenty seconds of the sampling time.

SM 97

HIGH-TIME-RESOLUTION STUDY OF SUDDEN COMMENCEMENTS USING AFGL MAGNETOMETER DATA

P. F. Fougere
D. J. Knecht (both at Air Force Geophysics Laboratory, Hanscom AFB, MA. 01731

Using high-time-resolution magnetograms from the AFGL magnetometer network, we have observed storm sudden commencements (ssc's) traveling across the earth from local noon toward local midnight at speeds of several hundred km/sec. Direction of travel is from east to west in the morning hemisphere and from west to east in the afternoon hemisphere. The ssc signal broadens as it travels; i.e., later features travel more slowly than early ones. The sharpest field changes occur at the stations closest to local noon. For those ssc's which have been related to a specific solar flare, average propagation speeds have been determined. Details of several ssc's are presented and an overall ssc picture is outlined.

Plasma Convection, 2

Banyan West (C), Thursday 0830h
***J. D. Craven* (University of Iowa), Presiding**

SM 98

FIELD-ALIGNED CURRENTS, CONVECTION ELECTRIC FIELDS AND ULF-ELF WAVES IN THE CUSP

N. A. Saflekos
T. A. Potemra (both at: APL/JHU, Laurel, Md. 20810)
P. M. Kintner, Jr. (School of Electrical Engineering, Cornell University, Ithaca, N. Y. 14853)
J. L. Green (U of Iowa, Iowa City, Iowa 52242)

We present two sets of simultaneous observations from the TRIAD and HAWKEYE spacecraft at low altitudes over the south polar cap. These data show that in and near the polar cusp there exist several relationships between field-aligned currents, convection electric fields, ULF-ELF magnetic noise, broad-band electrostatic noise and interplanetary magnetic fields. The most important relationships are:

1. The Region 1 permanent field-aligned currents are located inside the region of sunward convection and therefore on closed field-lines.

2. The polar cusp field-aligned currents are located inside the regions of antisunward convection.

3. The observations are consistent with a two-cell convection pattern symmetric in one case and with stronger convection on the dusk side in the other. This is explainable by models which require interconnection of interplanetary magnetic field lines with those of the geomagnetic field. Furthermore, this region of maximum merging appears to shift to either side of local noon depending upon the sense of the interplanetary magnetic field sector.

4. In and near the polar cusp, field-aligned currents and convection velocity gradients coincide with regions of ULF-ELF magnetic noise and broad-band electrostatic noise. We offer this as evidence for the generation of these waves by the field-aligned currents.

SM 99

BOW SHOCK PROTON BEAM WIDTH AND OBSERVATIONS OF BOW SHOCK ALPHA PARTICLES.

J. Benson
G. D. Sanders
H. K. Hills
J. W. Freeman (all at: Dept. of Space Physics and Astronomy, Rice University, Houston, Tx. 77001).

Analysis of data from the Apollo Suprathermal Ion Detector Experiment (SIDE) in conjunction with Explorer 35 magnetometer data has shown that the flux of bow shock ions (energy .1 to 3.5 keV/q)* depends on the orientation of the local interplanetary magnetic field (IMF). The distribution of the flux of ions into the detector as a function of the angle between the detector look direction and the IMF has been determined for a time when simultaneous SIDE and Exp 35 data were available. The width of the distribution determined in this manner is about 20 to 30 degrees. However some bursts of bow shock ions have been observed simultaneously in all three SIDEs, which implies a beam whose width is at least 56 degrees. In some individual bow shock ion spectra a peak with twice the energy of the proton peak is observed. The ratio of the flux of the secondary peak to that of the proton peak is a few percent. These spectra are consistent with those that would be expected from solar wind protons and α-particles which are reflected from the bow shock into the foreshock region.

*(3.5 keV/q is the maximum energy per charge observable with SIDE).

SM 100

RAPID ANTISUNWARD FLOWS IN THE DISTANT GEOMAGNETIC TAIL.

P. Shull
D. A. Hardy
H. K. Hills
J. W. Freeman (all at: Dept. of Space Physics and Astronomy, Rice University, Houston, Tx. 77001).

Observations in the geomagnetic tail at lunar distance with ALSEP SIDE indicate high velocity plasma streaming in the anti-sunward direction along the field lines of the high latitude tail during quiet times in the magnetosphere. Bulk velocities range upward from 250 km/sec, kT_i ≈50 -200 eV, and n ≈10^{-3} - 10^{-2} ions/cm³. These ions differ from the lobe plasma, which is much cooler, and from the plasma sheet, where the bulk velocities are near zero. Also, these number densities are less by a factor of ~100 than those usually found in the lobe plasma or plasma sheet. Sporadic double-peaked energy spectra are observed. It is speculated that this flowing plasma was accelerated out of the polar ionosphere. This flow appears sufficient to maintain the plasma sheet, at least during the quiet times when it is observed.

SM 101

EVIDENCE FOR HEAVY IONS IN MAGNETOSHEATH FLOW

H. K. Hills
G. D. Sanders
J. W. Freeman (all at: Dept. of Space Physics and Astronomy, Rice University, Houston, Tx. 77001).

A search was made for heavy ions in the magnetosheath flow using the suprathermal ion detector experiments deployed on the lunar surface. These instruments measured the energy per charge on positive ions in the range from 10 ev/q to 3500 ev/q. Recent analysis of magnetosheath data at high time resolution reveals the existence of secondary peaks in the counting rate data having energies per charge of 4 and 8 times that of the primary proton peak. It is believed that these secondary peaks are due to the presence of heavy ions and are interpreted as evidence for the existence of He^{+} and O^{++} ions in the magnetosheath flow. These He^{+} and O^{++} peaks are seen at different times suggesting independent sources for the ions.

SM 102

ELECTRIC FIELDS AT HIGH LATITUDES NEAR THE DAWN DUSK MERIDIAN

M. Smiddy (Air Force Geophysics Laboratory Hanscom AFB, MA 01731)
W.J. Burke (Regis College Research Center, Weston, MA 02193)
M.C. Kelley (Cornell University, Ithaca, N.Y. 14853)
S.T. Lai (Logicon, Inc., 18 Hartwell Ave., Lexington, MA 02173)

Measurements from a double probe experiment aboard the Air Force satellite S3-2 are used to investigate vector electric field patterns at high geomagnetic latitudes. Data were taken during the August-November 1976 period when the satellite's orbit was near the dawn-dusk meridian. The present analysis extends previously reported results from experiments measuring only one component of the electric field. Although our observations along the satellite trajectory generally agree with morphological patterns deduced from OGO-6 data (Heppner, 1972) we find that during geomagnetically quiet times antipoleward directed fields are not consistently measured in the morning sector of the auroral zone. It is also found that in cases of B or C type morphologies, S3-2 measures strong westward directed field components in the evening sector of the northern polar cap.

IMF ORIENTATION, SOLAR WIND VELOCITY, AND Pc 3-4 SIGNALS: A JOINT DISTRIBUTION

by

E. W. Greenstadt[1], H. J. Singer[2]
C. T. Russell[2], and J. V. Olson[3]

[1]Space Sciences Staff, TRW Defense & Space Systems Group, One Space Park, Redondo Beach, California 90278

[2]Institute of Geophysics & Planetary Physics, University of California, Los Angeles, Los Angeles, California 90024

[3]Institute of Earth & Planetary Physics, University of Alberta, Edmonton, Alberta, Canada T6G2J1

April 1978

Space Sciences Staff
TRW Defense & Space Systems Group
One Space Park
Redondo Beach, California 90278

3. NEW RESEARCH

We list below additional projects initiated under this contract but still awaiting completion.

1. IMP-7 diffuse boundary crossings.
2. IMP-7,8 interplanetary shock observations.
3. Voyager-Helios wave comparisons.
4. IMP-7, Voyager shock and solar activity observations, September 1977.
5. IMP-7, ISEE-1,-2, Voyager-1,-2, Helios-2 interplanetary shock observations of October 1977.
6. Fireball phenomena, IMP-7 and other spacecraft.
7. Foreshock dynamics, IMP-7,8 observations, July 1974.