STUDY OF TRAVELLING INTERPLANETARY PHENOMENA

(STIP) WORKSHOP TRAVEL

FINAL REPORT

NAGW-743

Submitted to

Environment Observation Branch
Attn: J. T. Lynch, EES
Earth Science and Application Division
Office of Space Science and Application
NASA Headquarters
Washington, DC 20546

Prepared by

S. T. Wu
The University of Alabama in Huntsville

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January 1986

This grant supported six American scientist participation at the SCOSTEP/STIP Symposium on Retrospective Analyses and Future Coordinated Intervals held at Le Diablerets, Switzerland on June 10 - 12, 1985. Without this support the American participation would have been decreased. A strong tie among the international scientists working on retrospective analyses and future coordinated intervals was developed. A proceedings of the workshop will be completed and published within the year. A copy of the book of abstracts is included in the appendix. The American Scientists supported by this grant delivered six papers. The titles are as follows:

1. An Analysis of Near-Surface and Coronal Activity During STIP Inverval XII, Dr. Thomas E. Gergely, Astronomy Program, University of Maryland, College Park, MD 20742

2. Helios Images of STIP Intervals VI, B. V. Jackson, Department of Electrical Engineering/Computer Science, University of California, San Diego, La Jolla, CA 92093.

3. Results from the Analysis of Solar and Interplanetary Observations During STIP Interval No. VII, August - September 1979, S. R. Kane, Space Science Laboratory, University of California at Berkeley, Berkeley, CA 94720.

4. STIP Interval XIV, 20 May to 20 July 1982, E. Cliver and S. Kahler, AFGL/PHG, Hanscom Air Force Base, Bedford, MA 01731.

5. Hydromagnetic Buoyancy Force in the Solar Atmosphere, T. Yeh, University of Colorado, Boulder, CO 80309.

6. A Combined MHD Modes for the Energy and Momentum Transport From Solar Surface to Interplanetary Space, S. T. Wu, Department of Mechanical Engineering, The University of Alabama in Huntsville, Huntsville, AL 35899.

It is our strong belief that NASA's support for this kind of international activity is necessary so that our scientific community is not isolated to support our continued work with the broadest possible spectrum.

STIP SYMPOSIUM

ON RETROSPECTIVE ANALYSES AND FUTURE COORDINATED INTERVALS

BOOK OF ABSTRACTS

Les Diablerets, Switzerland

10-12 June 1985

Sponsored by SCOSTEP, COSPAR, IAU and IUPAP

SCIENTIFIC PROGRAM COMMITTEE:

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LIST OF STIP INTERVALS:

STIP Interval No. I	-	September - October 1975
STIP Interval No. II	-	15 March - 15 May 1976
STIP Interval No. III	-	15 March - 15 May 1977
STIP Interval No. IV	-	15 October - 15 December 1977
STIP Interval No. V	-	June - July 1978
STIP Interval No. VI	-	15 April - 15 June 1979
STIP Interval No. VII	-	August - September 1979
STIP Interval No. VIII	-	15 October - 15 December 1979
STIP Interval No. IX	-	15 February - 16 March 1980
STIP Interval No. X	-	26 April - 27 June 1980
STIP Interval No. XI	-	October - November 1980
STIP Interval No. XII	-	10 April - 21 June 1981
STIP Interval No. XIII	-	1 December 1981 - 31 January 1982
STIP Interval No. XIV	-	20 May - 20 July 1982
STIP Interval No. XV	-	12-21 February 1984
STIP Interval No. XVI	-	24 - 30 April 1984
STIP Interval No. XVIII	-	September 1985 (Comet Giacobini-Zinner)
STIP Interval No. ~~XVIII~~ XIX	-	March 1986 (Comet Halley)
STIP XVII		May 15 - June 30 1985

STIP SYMPOSIUM ON RETROSPECTIVE ANALYSES AND
FUTURE COORDINATED INTERVALS

June 10 - 12, 1985
Les Diablerets, Switzerland

Sponsored by
SCOSTEP, COSPAR, IUPAP, and IAU

TENTATIVE PROGRAM

Monday, June 10, 1985 [AM]

0830 - 0930: REGISTRATION [Please provide 75 dollar Registration Fee in U.S. $. Gala Banquet and Proceedings Volume are included.]

0930 - 0940: WELCOMING REMARKS (M. Dryer)

SESSION 1 (Chairman: M. Dryer)

0940 - 1005: "OVERVIEW OF STIP INTERVALS I - XIV." (M.A. Shea and M.Dryer). [Invited]

1005 - 1030: Coffee.

1030 - 1100: "SCIENTIFIC RESULTS OBTAINED DURING STIP INTERVALS I AND II." (M.A. Shea and D.F. Smart). [Invited] Geometry | magnetic field.

1100 - 1120: "A REVIEW OF DISTINCTIVE FEATURES OF THE COSMIC RAY NEUTRON INTENSITIES DURING THE RETROSPECTIVE WORLD INTERVAL II." (H. Takahashi, T. Chiba, and N. Yahagi).
deleted

1120 - 1150: "STUDY OF INTERPLANETARY PROPAGATING PHENOMENA DURING THE STIP INTERVALS III AND IV." (J.-K. Chao). [Invited]
deleted

→ 1150 - 1210: "INTERPLANETARY FLARE-GENERATED OBLIMAKS." (K.G. Ivanov, A.F. Harshiladze, N.V. Mikerina, and P.P. Pavlov).

1210 - 1240: "STUDY OF INTERPLANETARY SPATIAL STRUCTURES DURING STIP INTERVAL V (June-July 1978)." (R. Gold and D. Venkatesan). [Invited]

1240 - 1300: "PERSISTENCE OF SOLAR WIND FEATURES." (H.O. Rucker, M.D. Desch, and G.K. Rabl).

Jackson moved from Wed.

1300 - 1400: LUNCH.

MONDAY, JUNE 10, 1985 [PM]

SESSION 2 (Chairman: T. Watanabe)

1400 - 1430: "STIP INTERVAL VI: 15 April - 15 June 1979." (B.V. Jackson) [Invited]

1430 - 1500: "RESULTS FROM THE ANALYSIS OF SOLAR AND INTERPLANETARY OBSERVATIONS DURING STIP INTERVAL NO. VII, AUGUST - SEPTEMBER 1979." (S.R. Kane). [Invited]

1500 - 1530: "SOLAR, INTERPLANETARY AND GEOMAGNETIC DISTURBANCES DURING STIP INTERVAL VIII." (C.S. Wright and R.J. Thompson). [Invited]

1530 - 1600: Coffee.

1600 - 1630: "IPS AND SPACECRAFT OBSERVATIONS RELEVANT TO STIP INTERVAL IX (Feb. 15 - Mar. 15, 1980). (T. Watanabe and A. Barnes). [Invited]

1630 - 1700: "A SUMMARY OF THE SCIENTIFIC PROGRESS GAINED FROM THE STUDY OF STIP INTERVAL X (26 April - 30 June 1980)." (R.A. Harrison). [Invited]

1730 - 1800: (Title to be Supplied) (J.-L. Bougeret). [Invited]
Some New Results of STIP XI: Coronal explosions and Fund. Harmonic Pairs in Interpl. Type II. Bursts

1800 - 2000: DINNER.

2000 - 2100: OPEN BUSINESS MEETING

TUESDAY, JUNE 11, 1985 [AM]

SESSION 3 (Chairman: D.F. Smart)

0900 - 0930: "AN ANALYSIS OF NEAR-SURFACE AND CORONAL ACTIVITY DURING STIP INTERVAL XII." (T.E. Gergely). [Invited]

0930 - 0950: "INTERPLANETARY SHOCK WAVES: NEW RESULTS ON SOLAR WIND OBSERVATIONS DURING STIP INTERVAL XII. (G.N. Zastenker and N.L. Borodkova).

0950 - 1010: "ENERGETIC PARTICLE EVENTS DURING STIP INTERVAL XII." (B. Sanahuja).

1010 - 1030: "IPS AND SPACECRAFT OBSERVATIONS OF THE INTERPLANETARY DISTURBANCES DURING MAY 1981 IN STIP INTERVAL XII." (T. Watanabe, T. Kakinuma, and M. Kojima).

1030 - 1050: Coffee.

1050 - 1120: "SOLAR VARIATIONS AND RELATED INTERPLANETARY FIELD AND PARTICLE BEHAVIOR OBSERVED DURING STIP INTERVAL XIII. (H.A. Taylor). [Invited]

1120 - 1140: "AN EXAMPLE OF RELATED SOLAR PERTURBATIONS OBSERVED AT EARTH AND VENUS DURING STIP INTERVAL XIII." (H.A. Taylor)

1140 - 1210: "STIP INTERVAL XIV, 20 MAY TO 20 JULY 1982." (E. Cliver and S. Kahler). [Invited]

1210 - 1400: LUNCH.

TUESDAY, JUNE 11, 1985 [PM]

SESSION 4 (Chairman: S. Pinter)

1400 - 1430: "STATUS OF THE INTERNATIONAL HALLEY WATCH (IHW)." (R.L. Newburn, Jr. and J. Rahe). [Invited]

1430 - 1500: "THE LARGE-SCALE PHENOMENA NETWORK OF THE INTERNATIONAL HALLEY WATCH (IHW)." (J.C. Brandt, M.B. Niedner, and J. Rahe). [Invited]

1500 - 1520: "SOFT X-RAY BURSTS ASSOCIATED WITH CORONAL MASS EJECTION ONSETS." (R.A. Harrison and G.M. Simnett).

1520 - 1540: "THE INITIAL FLARE DISTURBANCE." (D.S. Spicer)

1540 - 1600: Coffee.

1600 - 1620: "HYDROMAGNETIC BUOYANCY FORCE IN THE SOLAR ATMOSPHERE." (T. Yeh).

1620 - 1640: "RELATIONSHIP BETWEEN U-BURSTS, TYPE II BURSTS AND CORONAL TRANSIENTS." (Y. Leblanc).

1640 - 1700: "COMMENTS ON SHOCK WAVES GENERATED BY SOLAR FLARES." (A. Maxwell).

1700 - 1720: "A HYBRID MHD MODEL FOR THE ENERGY AND MOMENTUM TRANSPORT FROM SOLAR SURFACE TO INTERPLANETARY SPACE." (S. T. Wu).

1720 - 1740: "VOYAGER OBSERVATIONS ~~OF LOW AND HIGH~~ COSMIC RAY INTENSITY DURING 1980." (D. Venkatesan, R.B. Decker and S.M. Krimigis).

1740 - 1800: "INTERPLANETARY SHOCK WAVES OBSERVED DURING APRIL 17, 1978 EXPERIMENT BY THE VOYAGER RADIO ASTRONOMY." (Y. Leblanc and D.F. Smart).

1830 - 2030: GALA BANQUET

WEDNESDAY, JUNE 12, 1985 [AM]

SESSION 5 (Chairman: J.-K. Chao)
Y. Leblanc

0900 - 0920: "INTERPLANETARY ACCELERATION AND CONFINEMENT OF LOW ENERGY SOLAR PARTICLES BY THE FLARE PLASMA DISTURBANCE." (E.C. Roelof, P. van Nes, R. Reinhard, T.R. Sanderson and K.-P. Wenzel).

0920 - 0940: "VARIATION IN ELEMENTAL COMPOSITION OF SEVERAL MeV/NUCLEON PARTICLES OBSERVED IN INTERPLANETARY SPACE." (R.E. McGuire, T.T. von Rosenvinge, and D.V. Reames).

0940 - 1000: "A SIMULATION STUDY OF TWO MAJOR EVENTS IN THE HELIOSPHERE DURING THE PRESENT SUNSPOT CYCLE." (S.-I. Akasofu, Wei Sun, C. Fry, W. Fillius, and M. Dryer).

1000 - 1020: "A TRANSIENT, THREE-DIMENSIONAL MHD MODEL FOR NUMERICAL SIMULATION OF INTERPLANETARY DISTURBANCES." (S.M. Han, S.T. Wu, and M. Dryer).

1020 - 1040: Coffee.

1040 - 1100: "PRELIMINARY SUMMARY OF THE OBSERVATIONS MADE DURING STIP INTERVAL NO. XV, 12-21 FEBRUARY 1984." (S.R. Kane).

1100 - 1120: "UNUSUAL RECURRENCY OF ERUPTIVE PROMINENCES OF 20 APRIL 1984." (B. Rompolt). Replaced by Pinter / Dryer

1120 - 1140: "THE VARIABLE NATURE OF THE SOLAR WIND INTERACTION WITH COMET HALLEY AS IT APPROACHES THE SUN." (K.F. Flammer, D.A. Mendis, and H.L.F. Houpis)

1140 - 1400: LUNCH. Barbecue

WEDNESDAY, JUNE 12, 1985 [PM]

SESSION 6 (Chairman: K.G. Ivanov)

1400 - 1420: "THE INTERNATIONAL COMETARY EXPLORER MISSION." (J.C. Brandt)

1420 - 1440: "ELECTROSTATIC POTENTIAL BARRIER AT THE INTERPLANETARY SHOCK FRONT ACCORDING TO SOLAR WIND MEASUREMENTS ONBOARD THE "PROGNOZ-7,8" SATELLITES." (N.L. Borodkova and G.N. Zastenker).

1440 - 1500: "EMPIRICAL TECHNIQUE FOR PREDICTING TIMES-OF-ARRIVAL OF SHOCKS FROM POWERFUL FLARES." (S. Pinter and M. Dryer). moved.

1500 - 1520: "INTERPLANETARY SHOCK WAVE INTERACTIONS AND THE RESULTING ENERGY CHANGES DURING STIP INTERVALS." (S.A. Grib) withdrawn

Preliminary IMF Results Vega I & II, by Riedler et al. (Ye. Yeroshenko)

1520 - 1540: Coffee.

1540 - 1600: "HELIOS IMAGES OF STIP INTERVAL VI: APRIL 15 - JUNE 15, 1979." (B.V. Jackson). moved.

1600 - 1620: "OBSERVATIONS OF THE QUIET SUN AT DECAMETER WAVELENGTHS." (Ch. V. Sastry)

1620 - 1630: "GLOBAL STRUCTURE OF THE SOLAR CORONA DURING STIP INTERVAL VI" (R. A. Howard, M.J. Koomen, D.J. Michels, and N. R. Sheeley, Jr.)

1630 - 1650 "ACCELERATION OF CORONAL MASS EJECTIONS AT LARGE HELIOCENTRIC DISTANCES." (D.J. Michels, R.A. Howard, M. J. Koomen, and N.R. Sheeley, Jr.)

1650 - 1710 "THE GREAT SOLAR FLARE OF APRIL 24, 1985, AND ITS EFFECT ON INTERPLANETARY SCINTILLATION." (R. V. Bhonsle et al.)

1710 - Late Abstracts

Closing Session

OVERVIEW OF STIP INTERVALS I-XIV

M. A. Shea
Air Force Geophysics Laboratory
Bedford, Massachusetts 01731, U.S.A.

M. Dryer
Space Environment Laboratory
NOAA, Boulder, Colorado, U.S.A.

ABSTRACT

During the past ten years special periods of time have been established by the Study of Travelling Interplanetary Phenomena (STIP) scientific study group for the study of solar and interplanetary phenomena. Designated as STIP INTERVALS, these periods, most of which have been approximately two months in length, were either designated in advance, in anticipation of planned spacecraft configurations, or selected retrospectively, in an effort to have concentrated studies of specific solar-initiated activity. In this overview we present the historical background of these STIP Intervals and a summary of the rationale in the selection of the first 14 intervals.

SCIENTIFIC RESULTS OBTAINED DURING STIP INTERVALS I AND II

M. A. Shea and D. F. Smart
Air Force Geophysics Laboratory
Hanscom AFB, Bedford, Massachusetts 01731, U.S.A.

ABSTRACT

A summary is presented of the scientific results obtained during studies of solar and interplanetary phenomena that occurred during STIP Interval I (September-October 1975) and STIP Interval II (15 March - 15 May 1976). Although both of these time periods were within a year of the solar minimum between the 20th and 21st solar cycles, the periods were extremely different in terms of solar activity and related interplanetary phenomena. STIP Interval I was characterised by a sparsity of significant solar activity as typical of solar minimum conditions, whereas STIP Interval II was more typical of conditions closer to solar maximum. This unexpected solar activity during solar minimum included several flares of importance 1, solar-initiated interplanetary shock waves with detection at 9.7 AU, and a relativistic solar particle event detected at the earth. The configuration of spacecraft from 0.3 to 9.7 AU and at different heliospheric longitudes throughout the solar system enabled unique measurements of these phenomena.

A REVIEW OF DISTINCTIVE FEATURES OF THE COSMIC RAY NEUTRON INTENSITIES DURING STIP INTERVAL II

Takahashi, H., T. Chiba, and N. Yahagi
Department of Physics, Iwate University
Morioka 020, Japan

ABSTRACT

The following distinctive features on the cosmic ray neutron intensity variations have been observed during STIP Interval II, 20 March - 15 May, 1976:

(1) The storm-time increase due to the ring current effects on cosmic rays on 26 March and 1 April, 1976, respectively.

(2) The solar cosmic ray increase on 30 April, 1976. This phenomenon was not observed at the stations in Japan.

(3) The three consecutive Forbush decreases started on 25 March, 29 March, and 1 April, 1976

(4) Intensity decreases started on ≈11 April, 1976.

The mechanisms and discussions of these features as well as the associated phenomena will be reviewed and discussed together with our results concerning these features.

STUDY OF INTERPLANETARY PROPAGATING PHENOMENA DURING STIP INTERVALS III AND IV

Jih K. Chao
Department of Atmospheric Physics
National Central University
Chung-Li, Taiwan 320
R. O. C.

A review of some of the results of interplanetary propagating phenomena for the periods from 15 March - 15 May and 15 October - 15 December, 1977 is given. Especially the shock events of November 22 - December 6, 1977 will be discussed in detail. Based on these and some other observational results a model for the propagation of a solar flare- or CME (Coronal Mass Ejection)-associated interplanetary shock wave is given. A physical mechanism is described to calculate the probability that a weak shock which enters a turbulent solar wind region will degenerate into a MHD wave. That is, the shock would disappear as an entropy-generating entity. This model also suggests that most interplanetary shock waves cannot propagate continuously with a smooth shock surface. It is suggested that the surface of an interplanetary shock will be highly distorted and that parts of the shock surface can degenerate into MHD waves or even disappear during its global propagation through interplanetary space. A few observations to support this model will be briefly described.

Finally, this model of shock propagation also applies to corotating shocks. As corotating shocks propagate into fluctuating ambient solar wind regions, shocks may degenerate into waves or disappear.

INTERPLANETARY FLARE-GENERATED OBLIMAKS

K.G. Ivanov, A.F. Harshiladze, N.V. Mikerina, and
P.P. Pavlov

Institute of Terrestrial Magnetism,
Ionosphere and Radio Wave Propagation
Of the Academy of Sciences
Troitsk, Moscow Region
142092, USSR

It is supposed that an interplanetary hydromagnetic cloud can be considered as an flare-generated oblate spheromak or "oblimak" with a predominantly force-free magnetic field. The magnetic field of the oblimak can be approximately described by

$$B = \vec{n} \times \nabla\Psi + \frac{1}{K} \nabla \times (\vec{n} \times \nabla\Psi),$$

where $\Psi = \Sigma\Sigma a_{mn} \Psi_{mn}$, the double set of the spheroidal wave functions. In a low approximation

$$\Psi \cong A_{00} \frac{\sin c\eta}{c\eta} - A_{01} \frac{\eta c \cos c\eta + \sin c\eta}{c^2 \eta^2} \xi,$$

where η and ξ are the spheroidal coordinates; c is a constant. These theoretical considerations have been applied to the hydromagnetic cloud from the isolated solar flare on 22 November 1977 (STIP Interval IV) Under some conditions a satisfactory agreement between the theory and the observations has been achieved.

STUDY OF INTERPLANETARY SPATIAL STRUCTURES DURING STIP INTERVAL V (JUNE-JULY 1978)

R. E. Gold[1] and D. Venkatesan[1,2]

[1]The Johns Hopkins University
Applied Physics Laboratory
Laurel, Maryland, 20707, USA

[2]The University of Calgary
Calgary, Alberta, T2N 1N4, Canada

ABSTRACT

STIP Interval V, June-July 1978, is an unusually interesting period. The interval is within the fast rising portion of sunspot cycle 21 and it is rich in solar flare effects. However, direct propagation of flare particles is observed near-earth only in May and August 1978, flanking the interval of study. During STIP interval V we observe several well formed interplanetary structures sweeping past the earth. Numerous low energy particle increases are observed as well as four Forbush decreases in ground-based neutron monitors. This paper will discuss the various interplanetary spatial structures using ion and electron data from the IMP spacecraft near-earth in the energy range of 0.2 to 500 MeV, complemented by data from Voyagers 1 and 2 at ~ 3.5 AU and separated from earth by ~ 180° of helio-longitude.

PERSISTENCE OF SOLAR WIND FEATURES

H.O. Rucker[1], M.D. Desch[2], and G.K. Rabl[1]

[1] Space Research Institute, Austrian Academy of Sciences, Observatory Lustbuehel, A-8042 Graz, Austria.

[2] NASA/GSFC, Laboratory for Extraterrestrial Physics, Greenbelt, MD 20711, USA.

Using data from the plasma and magnetometer experiments of Voyagers 1 & 2 during the approach to Jupiter, the analysis covers the period from January 1978 (Voyager 1 passing over Voyager 2) through February 1979. The trajectories of both spacecraft provided a unique opportunity to study the radial evolution and variation of the solar wind over about 3 AU, and to analyse the persistence of solar wind features along the radially increasing separation distance of both Voyagers.

Special emphasis is laid on a period of DOY (day of year) 166 through 210, 1978, in which the observed propagation delay time of solar wind signatures between both Voyagers significantly deviates from the expected delay time. A drop-down of the correlation coefficient of the corresponding Voyager 1 & 2 data profiles indicates a change from recurrent to nonrecurrent solar wind flow. This period in question coincides to a great extent with STIP interval V of June - July 1978.

STIP Interval VI: 15 April - 15 June, 1979

B. V. Jackson

University of California, San Diego, La Jolla, California 92093, U.S.A.

The analysis of STIP Interval VI generally involves several large coronal mass ejections and interplanetary shocks which occurred during this time period. In retrospect, this interval was significant because the first data from the NRL coronagraph became available (on 28 March 1979) to be coordinated with several well-placed spacecraft _in situ_ and remote sensing measurements within 1 AU of the Sun.

Examples of the interplanetary data include: 1) An event on 22-27 April which gives evidence that a proton event and shock observed at Earth and by the Venera 11 and 12 space probes was associated with a flare and filament eruption near Sun center. 2) A coronal mass ejection on 8 May that can be followed by _in situ_ spacecraft observations up to and beyond the orbit of Venus giving associated interactions with the Venusian atmosphere. 3) Two mass ejections on 7 May and 24 May which appear to accelerate near the outer edge of the NRL coronagraph field of view (near 10 R_0). They are observed later in Helios white light photometer data over periods of several days as they move outward from the Sun.

In addition, near solar surface analyses include several studies of metric radio bursts and their comparison with solar surface features during this interval.

RESULTS FROM THE ANALYSIS OF SOLAR AND INTERPLANETARY OBSERVATIONS DURING STIP INTERVAL NO. VII, AUGUST - SEPTEMBER, 1979

S. R. Kane

Space Sciences Laboratory, University of California, Berkeley, California, USA

The solar activity during STIP Interval No. VII was characterized by several major flares such as those on August 14 (∿1244 UT), August 18 (∿1405 UT) and August 21 (∿0615 UT). The August 14 and 18 flares produced intense X-ray and radio emissions as well as energetic particles. On the other hand, the August 21 flare produced relatively weak X-ray and radio emissions but very energetic particles which were detected by ground level neutron monitors. These flares produced coronal transients and interplanetary shocks. Instruments aboard several spacecraft and ground-based observatories were operating during STIP Interval No. VII. Many aspects of the solar-interplanetary phenomena were therefore observed through in-situ measurements and/or remote sensing techniques. Analysis of these measurements has led to theoretical studies such as numerical simulation and dynamical modeling. These studies are expected to help in the understanding of processes such as particle acceleration and generation and propagation of coronal shocks and interplanetary disturbances. A summary of such observational and theoretical studies will be presented.

SOLAR, INTERPLANETARY AND GEOMAGNETIC DISTURBANCES DURING STIP INTERVAL VIII.

C.S. Wright and R.J. Thompson
Department of Science, Ionospheric Prediction Service
P.O. Box 702, Darlinghurst, 2010, AUSTRALIA

ABSTRACT

Several major solar flares and filament disappearances, which were comparatively well-observed, occurred during STIP Interval VIII, 15 Oct. 79 - 15 Dec. 79. Interdisciplinary observations include simultaneous gamma-ray, x-ray, H-alpha and microwave measurements of flares; indirect (radio) and *in situ* measurements of coronal and interplanetary shocks; coronagraph and satellite occultation measurements of coronal transients, including what seems to be the first reported 'head-on' observation of a white-light coronal transient following a filament disappearance. In spite of the substantial flare and filament activity, the geomagnetic field remained relatively undisturbed.

An overview of the main observations and results is provided. The results for individual coronal and interplanetary transient events are examined in the light of conclusions drawn from statistical studies of the effects of flares and filament disappearance upon the geomagnetic field.

IPS and Spacecraft Observations Relevant to STIP Interval IX

(Feb. 15 - March 15, 1980)

coordinated by

Takashi Watanabe

Research Institute of Atmospherics, Nagoya University

Toyokawa 442, Japan

and

Aaron Barnes

Ames Research Center, NASA

Moffet Field, California, U.S.A.

The solar-interplanetary events which took place around the STIP Interval IX are discussed on the basis of the solar wind data obtained with IPS observations and spacecrafts. At least three solar-flare associated shock wave disturbances and two NCDE (non-compressive density enhancement) events were observed near 1 AU heliocentric distance in the interval from Feb. 12, 1980 to March 22, 1980. The NCDEs were observed at Helios A on March 18 and on March 22 respectively. The IPS observations shows that the NCDEs were the expanding shells of high density plasma with the speed of 300-400 km s^{-1}.

A SUMMARY OF THE SCIENTIFIC PROGRESS GAINED FROM THE STUDY OF STIP INTERVAL X (26 APRIL - 30 JUNE, 1980)

Richard A. Harrison
High Altitude Observatory
National Center For Atmospheric Research*
Boulder, colorado, USA

ABSTRACT

A summary is presented of progress made in the understanding of the solar corona through studies of activity within STIP Interval X (26 April - 30 June, 1980). There were many notable and extremely fruitful features of this period. For example, in late June solar activity was dominated by the limb crossing of a vast complex of active regions whose recurrent flaring was (a) ideally placed for the correlation of solar surface and coronal activity, and was (b) well suited to studies of homology and coronal recovery. Despite flare activity and mass ejection, this complex displayed a remarkably stable hierarchy of X-ray emitting coronal arches achieving altitudes of $> 1.5 \times 10^5$ km. Earlier in the Interval, on May 21-22, a similar X-ray emitting arch was seen after the eruption of a classical two-ribbon flare. This arch was located under a vast stationary post-flare noise storm and together they are thought to be signatures of a magnetic bottle extending beyond $1R_o$ from the limb. Fortuitious observational sequences made on June 29 and April 27 have allowed detailed study into the relationships between coronal transients and Type II and Type IVm radio bursts, respectively. There is evidence to suggest that the Type II related disturbance is faster than, but has a later onset time than, the transient, and it has been shown that the density in Type IVm emitting regions is high enough for plasma emission, a point that had been in some doubt. Fo two periods within STIP Interval X a survey of the corona above Type III producing regions has been performed, leading to the suggestion that, in visible light, such a region characteristically has a complex structure of small short-lived, dense blobs. Towards the end of the Interval, on June 21, the first direct observation of solar neutrons was made at 1 A.U. The boundaries of this STIP Interval have no physical significance. The scientific gains are varied due to a large spectrum of activity, and are mainly due to an unusually rich data-set, primarily because of the fully operational Solar Maximum Mission.

*The National Center for Atmospheric Research is sponsored by the National Science foundation.

Invited Paper by J.-L. Bougeret -

Title and Abstract Not Available

AN ANALYSIS OF NEAR-SURFACE AND CORONAL ACTIVITY DURING STIP INTERVAL XII

T.E. Gergely
Astronomy Program
University of Maryland
College Park, MD 20742

STIP Interval XII which extended from April 10 to July 1, 1981 was characterized by some of the largest flares of solar cycle 21. Most major activity took place in April and the first half of May, the second half of the Interval was relatively quiet. A summary of the events that occurred during this period was given by Gergely (1983)*. Although relatively recent, the wealth of information acquired during this Interval already produced a large number of analysis. Most deal with the large flares that occurred on April 24 and 27 and on May 8, 13 and 16. I review in this paper the progress made in analyzing these events, with particular attention to the nature of the regions where they originated from, and to their effects near the solar surface and the inner corona. Many of these events produced large interplanetary disturbances, which will be discussed elsewhere.

*Gergely, T.E.: 1983, Adv. Space Res., 2, 271.

INTERPLANETARY SHOCK WAVES: NEW RESULTS ON SOLAR WIND OBSERVATIONS DURING STIP INTERVAL XII

Zastenker G.N., and Borodkova N.L.

Space Research Institute, Academy of Sciences
Moscow, USSR

Some new peculiarties of the interplanetary shock waves observed after strong solar flares in April - June 1981 are described. Comparison of energy released by flares and measured later in the interplanetary medium with magnitudes of mean and local propagation velocities shows that the shock velocity is defined mostly by preceeding interplanetary conditions rather than by flare energy. Observed shocks show rather low deceleration on the way from the Sun to the Earth for a considerable number of events.

In the sequence of events observed after a series of strong flares separated by no more than two days, the disturbance at the Earth's orbit appeared as a monotonic and very strong increase of solar wind density without detectable shocks. This can result from interaction of shocks during their propagation from the Sun.

Calculation of the kinetic parameter jumps on the interplanetary shocks from selective ion measurements shows that, in most cases, the velocity of α-particles increases less and the temperature of α-particles increase more than those for protons. Estimation of potential jumps of shock fronts with use of selective ion measurements suggests that the potential jump magnitude depends on Mach number.

ENERGETIC PARTICLE EVENTS DURING STIP INTERVAL XII

BY

B. Sanahuja

Departamento de Fisica de la Tierra y del Cosmos, Universidad de Barcelona and Grup d'Astrofisica de la Secció de Ciencies del IEC. Barcelona, Spain.

ABSTRACT

We present an analysis of several large particle events -mainly protons- observed between 8 April and 26 June 1981, by near-Earth and interplanetary spacecrafts. The most interesting proton events took place on April 10, 24 and 27 and May 8 and 16. They have been studied in detail considering their association with interplanetary shocks, the solar activity that can trigger each disturbance, and their propagation through the interplanetary medium. Results will be also discussed in view of the current theories on particle acceleration.

IPS and Spacecraft Observations of the Interplanetary Disturbances During May 1981 in STIP Interval XII

Takashi Watanabe, Takakiyo Kakinuma, and Masayoshi Kojima
Research Instutute of Atmospherics, Nagoya University
Toyokawa 442, Japan

Three-dimensional propagation properties of the solar-flare generated interplanetary disturbances observed in May 1981 are discussed on the basis of IPS and spacecraft observations. On the interplanetary disturbance associated with the solar flare of 2232 UT, May 8, 1981 (2B, N09E38), the propagation speed at 1 AU heliocentric distance was similar (500-600 km s^{-1}) over the longitudinal range of 100^{o} around the flare normal. The interplanetary disturbance associated with the solar flare of 0312 UT, May 13, 1981 (3B, N10E56) showed highly anisotropic configuration; very high shock speed (1200 km s^{-1}) was obtained in the region to the east of the flare normal. Similar configuration is seen for the disturbance associated with the solar flare of 0824 UT, May 16, 1981 (3B, N11E16).

SOLAR VARIATIONS AND RELATED INTERPLANETARY FIELD AND PARTICLE BEHAVIOR OBSERVED DURING STIP INTERVAL XIII

H.A. Taylor, Jr.
Laboratory for Planetary Atmospheres
NASA Goddard Space Flight Center
Greenbelt, Maryland 20771, USA

ABSTRACT

The variability of the Sun and related interplanetary effects are examined for the STIP Interval XIII, which extends from December 1981 through February 1982. The solar variations exhibit relatively complex behavior with a mixture of active regions, flares, and small scale coronal holes interspersed across the interval. The coronal hole development during this interval is seen to be part of the preliminary growth of the more extensive hole formations observed later in 1982-1984. In this early stage, the coronal holes are sufficiently small and irregular that the dominant, recurrent patterns of field and particle modulations observed in the declining phase of the prior solar cycle are not yet established. Nevertheless, the various solar perturbations are sufficiently unique and pronounced during this period that correlated modulations of field and particle distributions are observed both within and beyond 1 AU. These observations indicate an impressive coherence sometimes present in the communication of solar effects to widely different regions in the ecliptic plane. STIP Interval XIII is located within the period identified by Fillius and Axford [1985] as a "false recovery" of the solar cycle modulation in galactic cosmic rays, and as such offers interesting possibilities for future investigations of both interplanetary and solarterrestial responses.

AN EXAMPLE OF RELATED SOLAR PERTURBATIONS OBSERVED AT EARTH AND VENUS DURING STIP INTERVAL XIII

H.A. Taylor, Jr.
Laboratory for Planetary Atmospheres
NASA Goddard Space Flight Center
Greenbelt, Maryland, 20771, USA

ABSTRACT

During the latter portion of STIP Interval XIII (December 1981-February 1982) Earth and Venus were nearly co-aligned with the Sun, permitting comparisons of the environmental response at both planets for similar solar disturbances. During February 15-17, a high speed stream passed Venus and Earth with a separation of only a few hours. Using observations from instruments on the Pioneer Venus Orbiter and on ISEE-3, the interplanetary magnetic field and solar wind perturbations associated with this stream are seen to be quite comparable at the two planets. At Venus, the response to the stream passage is evident in the inward displacement of the bowshock and at Earth the response is indicated in the expansion of the auroral oval determined form observations on the Dynamics Explorer. In both locations, the signature of the stream passage exhibits a rather complex time sequence of enhancements in momentum flux and in IMF geometry. Such non-alignment of the field and particle parameters in a high speed stream are not unusual and are indicative of the complexity involved in sorting out the mechanisms responsible planetary responses.

STIP Interval XIV, 20 May -- 20 July 1982

E. W. Cliver
Space Physics Division
Air Force Geophysics Laboratory
Hanscom AFB, MA 01731 USA

S. W. Kahler
Physics Research Division
Emmanuel College
Boston, MA 02115 USA

ABSTRACT

This interval is noteworthy for its high level of solar activity. Various statistical studies of phenomena such as flare white light emission, coronal mass ejections, and interplanetary Type II bursts are based at least in part on events observed during this interval. In addition, analyses have been made of the optical and radio evolution of major active regions during this period and several flares have been analyzed in detail. We focus on the solar aspects and interplanetary effects of three major flares: 03 June, 06 June, and 12 July. The 03 June flare provided the first case of a solar neutron event that was observed by ground based neutron monitors and detected via decay neutrons in space. The 06 June event was observed in X-rays, optically, and at radio wavelengths and exhibited well-defined impulsive and gradual phases. Electrons above 20 keV deposited 10^{33} ergs in this event, more than previously estimated for large flares. The 12 July flare had a profound effect on the outer heliosphere. The Forbush decrease associated with this event is clearly observed at Pioneer 11 at ~ 12 AU and, in two studies, this event is tentatively linked with a later disturbance at Pioneer 10, ~ 28 AU from the sun and ~ 150° in azimuth from Pioneer 11. The disturbance at Voyager 2 (near Pioneer 11) has been characterized as a magnetic cloud overtaking a corotating interaction region.

STATUS OF THE INTERNATIONAL HALLEY WATCH (IHW)

Ray L. Newburn, Jr.
Jet Propulsion Laboratory
Pasadena, CA 91109, USA

Juergen Rahe
Dr. Remeis Sternwarte
Bamberg, FRG

In the three years since Maynooth, Comet Halley has been recovered (Oct. 16, 1982), has developed a coma, and has begun to show emission lines in its spectrum. The IHW has been formally recognized by the International Astronomical Union and has developed eight observing networks with over 900 astronomers in 47 countries as members. The nets held a trial run on Comet Crommelin (March 1984), and the Astrometry, Photometry, Spectroscopy, and Infrared Nets have obtained a large amount of useful data on Halley. Meanwhile IHW members recovered Comet Giacobini-Zinner (Apr. 3, 1984), and coverage of this comet, which is the target of the ICE space craft on Sept. 11, 1985, has been added to that of Halley. The IHW and all cometary space missions are cooperating closely in every useful way. The Giotto, VEGA, Planet-A, and Astro 1 missions all have agreed to include their data in the Halley Archive, as has ICE (in a separate G-Z volume). We appreciate the close cooperation of STIP as well in this growing international scientific cooperation.

The Large-Scale Phenomena Network of the International Halley Watch (IHW)

John C. Brandt, Malcolm B. Niedner
Laboratory for Astronomy and Solar Physics
NASA-Goddard Space Flight Center

and

Jürgen Rahe
Remeis Observatory

The goal of the Large-Scale Phenomena Network is to obtain wide-band visual wavelength photographs of Comets Halley and Giacobini-Zinner with fields of view $\gtrsim 5°$ and on a nearly continuous basis during the periods of cometary development or specific interest. A selected number of these images will be fully processed, i.e., digitized and reduced to a standard magnitude system. These efforts should naturally concentrate on spectacular events occuring over an extended time period; an example is the disconnection event or DE.

The network currently contains approximately 90 fixed observatory sites with stated interest in participation. The distribution is not ideal in the S. hemisphere and an "island network" was created to fill the gaps produced by the Pacific, Atlantic and Indian Oceans. Two island sites have been established for each ocean. Mobile observing teams will supply additional coverage.

The first intensive use of the networks will be for Comet Giacobini-Zinner and will serve as a dress rehearsal for Comet Halley. The intention is to cover the comet for a 28-day period (one solar rotation) centered on the intercept date of September 11, 1985. This corresponds to STIP interval No. XVIII and clearly we expect a productive interaction.

The Halley's Comet activities are set for periods of general monitoring, geometrical alignments, and cometary activity. The most active period will be March-April 1986. The March portion corresponds to the time of the Halley intercepts and is of prime importance. This corresponds to STIP interval No. XIX. The triad of IHW, *in situ*, and STIP data should be very powerful.

The kinds of STIP data believed to be useful for the cometary research will be briefly summarized.

Soft X-ray Bursts Associated With Coronal Mass Ejection Onsets

Richard A. Harrison
High Altitude Observatory
National Center For Atmospheric Research *
Boulder, Colorado, USA.

and

George M. Simnett
Dept. of Space Research
University of Birmingham
Brimingham, U.K.

ABSTRACT: We present a summary of recent work which has shown that a weak, soft X-ray burst is a signature of the coronal mass ejection onset phase. In many cases a flare follows the burst prompting us to label it a precursor. These bursts commonly occupy much larger magnetic loop systems than the flares, even interconnecting active regions. We show that not only are the bursts temporally associated with ejection onsets but that their location, physical extent and morphology are remarkably consistent with those of ejection.

* The National Center For Atmospheric Research is sponsored by the National Science Foundation.

THE INITIAL FLARE DISTURBANCE

BY

D.S. Spicer*
Astrophysics Division
NASA Headquarters
Washington, DC 20546 USA

ABSTRACT

A brief Synopsis of the physical mechanism believed responsible for solar flares will be presented. In particular, how each flare mechanism manifests itself energetically will be reviewed, with particular emphasis on identifying those mechanisms which can lead to a highly localized rapid energy release and, thus, be construed as causing point explosions.

*On leave from the E.O. Hulburt Center for Space Research, U.S. Naval Research Laboratory, Washington, DC 20375 USA.

HYDROMAGNETIC BUOYANCY FORCE IN THE SOLAR ATMOSPHERE

TYAN YEH

Cooperative Institute for Research in the Environmental Sciences
University of Colorado, Boulder, Colorado 80307

Abstract An extraneous magnetized body, either a magnetic rope or a plasmoid, immersed in the solar atmosphere is subjected to a hydromagnetic buoyancy force. It results from the peripheral inhomogeneity of ambient hydromagnetic pressure, which is caused or enhanced by the presence of the extraneous body. This extra-caused force acts at various mass elements of the immersed body through its distribution as a nearly uniform force density, just like the gravitational force. Since hydromagnetic buoyancy force comprises hydrostatic buoyancy force, hydrodynamic lift force, and magnetostatic diamagnetic force, this constitutes a magnetohydrodynamic generalization of Archimedes' principle which deals with hydrostatic buoyancy force.

In the solar atmosphere hydromagnetic buoyancy force has an obliquely upward direction, with a component in the direction opposite to the downward gravity. It provides an upward force to counterbalance or even to exceed the downward gravitational force. Such an upward force is the dynamic cause for the stationary equilibrium of quiescent prominences and outward motion of coronal transients.

Relationship between U-bursts, Type II bursts and coronal transients

Yolande LEBLANC

Observatoire de Paris, Section de Meudon
LA CNRS 324
92195 Meudon Principal Cedex, France

ABSTRACT

Radio observations of U-bursts have provided important information on loop transients and coronal structures. The results given in Leblanc and Hoyos (1985) and Leblanc et al. (1983) are discussed after two recent papers of Sime et al. (1984) and Cane (1984).

It is shown that the evolution of the electron density in loop transients derived from radio observations is in agreement with that obtained from coronograph observations. The relationship between the occurrence of a Type II burst and groups of U-bursts can be explained by the model proposed by Cane where a coronal shock catches up a loop mass ejection. It is suggested that the storm emission following generally the Type II burst is located in the remaining legs of the loop transient.

STIP Meeting
Les Diablerets, Switzerland
10-12 June, 1985

ABSTRACT

COMMENTS ON SHOCK WAVES GENERATED BY SOLAR FLARES

Alan Maxwell

Harvard-Smithsonian Center for Astrophysics
Cambridge MA 02138, U.S.A.

Recent radio data on flare-generated shocks, both piston-driven and blast-wave, are reviewed. Most of the shocks seem to have velocities of the order of 750-1500 km s^{-1} whilst they traverse the solar corona but, for the most energetic flares, the velocities may range up to about 3500 km s^{-1}. Depending on the amount and duration of the energy input at the flare site, the piston-driven shocks appear to propagate at constant velocity out to 10-30 R_0 and thereafter to continue as decelerating blast waves. The relation of the shocks to optical coronal transients is also examined.

A HYBRID MHD MODEL FOR THE ENERGY AND MOMENTUM TRANSPORT FROM SOLAR SURFACE TO INTERPLANETARY SPACE

by

S. T. Wu
Department of Mechanical Engineering,
Univ. of Alabama in Huntsville
Huntsville, AL 35899, USA

ABSTRACT

A hybrid magnetohydrodynamic (MHD) model is suggested for the study of the energy and momentum transport and its subsequent propagation into interplanetary space. This hybrid model consists of four parts (i) by introducing a disturbance in the photospheric level, then the amount of energy and momentum resulted from this disturbance can be determined. (ii) This additional energy and momentum will cause heating, leading to development of a pressure pulse through wave dissipation and compression. (iii) This computed pressure pulse is then input at the base of the corona (∿20,000 km) producing a disturbance that propagates through the coronal region. (iv) Finally, we input the outer coronal results at $18R_{\odot}$ and, using our MHD code (Wu et al. 1983), compute the response in heliospheric space.

The reason for separating this problem into four different parts, thereby forming a "hybrid" system is because there are three different physical characteristics (i.e., spatial and time scales) in these regions (photosphere/chromosphere, corona, and interplanetary space). A numerical example is presented to illustrate this hybrid approach.

Wu, S. T., M. Dryer and S. M. Han, Solar Physics, 84, (1983) 395-418.

Abstract submitted to the STIP Symposium on Retrospective Analyses and Future Coordinated Intervals, Les Diablerets, Switzerland, 10-12 June 1985.

VOYAGER OBSERVATIONS OF LOW AND HIGH COSMIC RAY INTENSITY DURING 1980

D. Venkatesan[1,2], R. B. Decker[2] and S. M. Krimigis[2]

[1]The University of Calgary
Calgary, Alberta, T2N 1N4, Canada

[2]The Johns Hopkins University
Applied Physics Laboratory
Laurel, Maryland, 20707, USA

ABSTRACT

The onset of the decline of the sunspot cycle 21 from its maximum began with 1980; during the sunspot maximum, solar polar coronal holes retreated towards their minimal areas around the pole. Thus this epoch as well as the beginning period of the sunspot decline are ideal intervals for observing heliospheric phenomena not directly influenced by coronal holes. Twenty-seven day recurrent structures were seen in the data of the two Voyager spacecraft, during a period of relatively little solar flare activity. Some of these features are absent in the data from the earth-orbiting spacecraft IMP-8. A suggestion has been made in an earlier work from our group (Venkatesan et al., 1984) that these may well arise from corotating interaction regions.

Data from the detectors onboard the Voyagers enable us to study the following energy ranges: ~ 50-80 keV (Z > 1); ~ 0.5-1.4 MeV (Z = 1); ~ 4-10 MeV (Z = 1); $19 \lesssim E_p \lesssim 31$ MeV; $3 \lesssim E_p \lesssim 17$ MeV; $E_p \gtrsim 210$ MeV; $E_e \gtrsim 2.5$ MeV and the M-scintillator ($E \gtrsim 35$ MeV) onboard IMP-8. The differences are investigated in terms of forward and reverse shocks and corotating interaction regions. The study reveals the complex nature of the interplanetary conditions during the year 1980.

INTERPLANETARY SHOCKWAVES OBSERVED BY THE VOYAGER RADIO ASTRONOMY EXPERIMENT DURING APRIL 1978

Yolande Leblanc
Observatoire de Paris
92195 Meudon Principal Cedex, France

D.F. Smart
Air Force Geophysics Laboratory
Hanscom AFB, Bedford, MA 01731, U.S.A

ABSTRACT

We analyzed the interplanetary shocks that were the source of five well defined kilometric type II radio bursts observed in April 1978 by the radio astronomy experiment (PRA) carried on the Voyager spacecraft. The initial speed of each of the shocks was determined from the observed frequency drift rate. The results of this analysis show satisfactory agreement with the hypothesis that the shocks were initially driven, and then propagated as blast waves in the solar wind. We also deduce the probable source location for the kilometric type II event observed by the Voyager spacecraft on 17 April 1978 from the shock observations at Helios 2, at 0.4 AU, Voyager at 2.9 AU, Pioneer 10 at 6.8 AU, and Pioneer 11 at 16 AU.

INTERPLANETARY ACCELERATION AND CONFINEMENT OF LOW ENERGY SOLAR PARTICLES BY THE FLARE PLASMA DISTURBANCE

E. C. Roelof[1], P. van Nes[2], R. Reinhard[3], T. R. Sanderson[3] and K.-P. Wenzel[3]

[1]Johns Hopkins University, Applied Physics Laboratory, Laurel, Maryland 20707,

[2]Harshaw Chemie, 3454 PK DeMeern, The Netherlands

[3]European Space Research and Technology Center, ESA, 2200 AG Noordwijk, The Netherlands

Low energy ions (~ 100 keV) in solar flare events are strongly affected by the subsequent propagation of the flare plasma disturbance through two mechanisms: (1) acceleration near the shock, and (2) partial confinement behind the compressed magnetic fields behind the shock. These effects are strongest at the lower energies, so they are graphically revealed in the comparison of time histories of ion intensities from 35 keV to 1.6 MeV as measured by the DFH experiment on ISEE-3. The two effects are usually difficult to separate, because particles accelerated and left downstream of the shock will also propagate into (and behind) the comppression region. However, the separation was possible in the event of June 6, 1979 (during STIP Interval No. VI), the second largest event observed on ISEE-1 (van Nes et al., JGR, 90, in press). The DFH anisotropy measurements establish that the low-energy ions passed nearly adiabatically through an almost perpendicular shock and that they were confined behind a series of complex discontinuities in the compressed magnetic field (~ 40 nT), the first of which followed the shock by 4 minutes. We suggest that this confinement by magnetic discontinuities may also be an essential part of the structure of ESP events where the more usual observational conditions do not allow the clear separation of acceleration from confinement effects.

Variation in Elemental Composition of Several MeV/Nucleon Particles Observed in Interplanetary Space

R.E. McGuire†, T.T. von Rosenvinge, and D.V. Reames

Code 661, NASA/Goddard Space Flight Center,
Greenbelt, MD 20771 USA
†Also Dept. of Physics and Astronomy, University of Maryland,
College Park, MD 20742 USA

We have surveyed over six years of accumulated ISEE-3 and IMP-8 data to study variations in elemental relative abundances among the different populations of energetic (1.5 to >10 MeV/nuc) ions seen in interplanetary space. We want to determine what systematic differences in composition might exist between flare-accelerated particles and the locally-accelerated particle populations associated with some interplanetary shocks. By more clearly distinguishing local shock effects, we hope to better establish the criteria governing the selection of those solar events from which a baseline of solar energetic particle composition is defined. We examine elemental composition in solar events as a function of relative connection longitude between the flare site and the observing spacecraft, specifically to search for any signatures which might help to distinguish coronal transport effects from the direct acceleration of particles over an extended range of solar longitudes by coronal or interplanetary shocks. We will also address the question of source population signatures in other kinds of energetic particle events; e.g. corotating nucleon streams.

To be presented by: R.E. McGuire

Correspondence address: Dr. Robert E. McGuire
Code 661
NASA/Goddard Space Flight Center
Greenbelt, MD 20771 USA

A Simulation Study of Two Major Events in the Heliosphere During the Present Sunspot Cycle

S.-I. AKASOFU, WEI Sun and C. FRY (Geophysical Institute, University of Alaska, Fairbanks, AK 99701)

W. FILLIUS (University of California, San Diego, La Jolla, CA 92093)

WEI SUN (On leave from Institute of Geophysics, Academia Sinica, Beijing, China)

M. DRYER (Space Environment Laboratory, NOAA, Boulder, CO 80303

The two major disturbances in the heliosphere during the present sunspot cycle, the event of June - August, 1982 and the event of April - June, 1978, are simulated by the method developed by Hakamada and Akasofu (1982). Specifically, we attempt to simulate effects of six major flares from three active regions in June - July, 1982 and April - May, 1978, respectively. A comparison of the results with the solar wind observations at Pioneer 12 (f 0.8 au), ISEE-3 (~ 1 au), Pioneer 11 (~ 7-13 au) and Pioneer 10 (~ 16-28 au) suggests that some major flares occurred behind the disk of the sun during the two periods. Our method provides qualitatively some information as to how such a series of intense solar flares can greatly disturb both the inner and outer heliospheres. A long lasting effect on cosmic rays is discussed in conjunction with the disturbed heliosphere.

The three-dimensional geometry of the heliospheric current sheet seen from fixed points in interplanetary space is also constructed for idealized (sinusoidal) magnetic neutral lines (equators), several observed magnetic equator. The development of distortion of the solar current sheet caused by a solar flare is also simulated.

A Transient, Three-Dimensional MHD Model For Numerical Simulation of Interplanetary Disturbances

by

S. M. Han[1], S. T. Wu[2] and M. Dryer[3]

1. Department of Mechanical Engineering, Tennessee Technological University, Cookeville, TN. 38501 USA

2. Department of Mechanical Engineering, University of Alabama in Huntsville, AL. 35899, USA

3. Space Environment Laboratory, NOAA, Boulder, CO. 80303, USA

ABSTRACT

Three-dimensional, time-dependent MHD wave propagations through a steady inhomogeneous MHD flow expanding with supersonic, superalfvenic speeds are examined by a MHD numerical model based on the Lax-Wendroff finite difference method.

The background steady supersonic, superalfvenic MHD flow is obtained numerically by treating the radial coordinate parabolically. In this manner, a three-dimensional steady MHD flow can be obtained by a two-dimensional time-dependent MHD formulation. Transient MHD waves are generated by introducing a perturbation at the lower radial boundary. Resulting development and propagation of three-dimensional MHD waves through the background flow are simulated by the full three-dimensional time-dependent MHD model.

Detailed discussions on the formulation of the steady and unsteady MHD models and descriptions of the numerical schemes are presented. Example computations are performed to demonstrate the validity of formulation and capabilities of the numerical models. Numerical results exhibit physically realistic propagation of MHD waves and their interactions with the background flow.

Abstract submitted to STIP Symposium on Restrospective Analyses and Future Coordinated Intervals, Les Diablerets, Switzerland, June 10-12, 1985

PRELIMINARY SUMMARY OF THE OBSERVATIONS MADE DURING STIP INTERVAL NO. XV, 12-21 FEBRUARY 1984

S. R. Kane

Space Sciences Laboratory, University of California, Berkeley, California, USA

A number of energetic solar flares occurred during STIP Interval No. XV. Perhaps the most interesting flare was the one on 16 February 1984 (∿0900 UT). Although this flare was located ∿40° behind the west limb of the sun, the X-ray and radio emissions were detectable from the earth. Also a large increase in the high energy particles was detected by the ground-based neutron monitors. The high energy X-ray source was viewed stereoscopically by instruments aboard two spacecraft, ICE and PVO. The PVO measurements show that the flare was very intense and appeared weak from the earth because most of the emission source was occulted by the photosphere. A coronal shock was also observed. Observational characteristics of this and other flares during STIP Interval No. XV will be presented, and their implications regarding the acceleration and propagation of particles and the coronal shocks will be briefly discussed.

UNUSUAL RECURRENCY OF ERUPTIVE PROMINENCES OF 20 APRIL 1984

BY

B. Rompolt
Astronomical Observatory of Wroclaw University
Poland

ABSTRACT

By means of the Large Coronograph of the Wroclaw Astronomical Observatory a sequence of limb flares and eruptive prominences has been observed in Hα at the east solar limb (SI9-E) on 20 April 1984, during the STIP Interval XVI. Uncommonness of the event lies in the fact that three recurrent eruptive prominences have been ejected from the same limb active region during the interval of 3 hours and 45 minutes only. The first eruption start at 0717 UT, the second at 0741 UT (24 minutes later!), and the third one at 1102 UT. This is the shortest time ever observed between the consecutive ejections of the recurrent eruptive prominences. This event gives the evidence that in an active region the magnetic field forming the skeleton of the eruptives can be rebuilt even in a time scale of half an hour. These three eruptive prominences should induce specific phenomenan in the outer corona and interplanetary space. The evolutionary characteristics of all observed events occurred at the east limb on 20 April 1984 are also given and discussed in the paper.

THE VARIABLE NATURE OF THE SOLAR WIND INTERACTION WITH COMET HALLEY AS IT APPROACHES THE SUN*

K.F. Flammer, D.A. Mendis and H.L.F. Houpis

EE&CS Department Mail Code C-014
University of California, San Diego
La Jolla, California 92093 USA

The different modes of interaction of the solar wind with Comet Halley, as it approaches the sun, are discussed. At large heliocentric distances the solar wind penetrates unimpeded on to the surface. This causes electrostatic charging and blow-off of fine dust from the surface; a process that is modulated by the solar wind flux. The observed irregular brightness variations of the comet between 11 and 8 AU (inbound) is explained along these lines. As the comet moves further in (closer than about 5 AU) mass loading of the solar wind by the heavy cometary ions causes it to slow down, thereby enhancing the convected IP magnetic field significantly. This magnetic enhancement is the earliest and most sensitive signature associated with solar wind mass loading. Still farther in (~ 3 AU), as the mass loading approaches a critical value, a weak ($M \approx 2$) collisionless standing shock forms, which recedes upstream of the nucleus as the comet approaches the sun. The cometary atmosphere becomes dense enough to stand off the solar wind ahead of the nucleus and form a well-defined ionopause only when the comet is fairly close to the sun (~ 2 AU). At this stage a well-developed magnetic barrier is expected to separate the ionospheric and contaminated solar wind plasmas. An "inner" shock may also then exist within the cometary ionopause, although this too is expected to be weak ($M \approx 2$) due to the photo-chemical heating of the cometary ionosphere.

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*Paper to be read at the STIP Symposium in Les Diablerets, Switzerland (10-12 June, 1985)