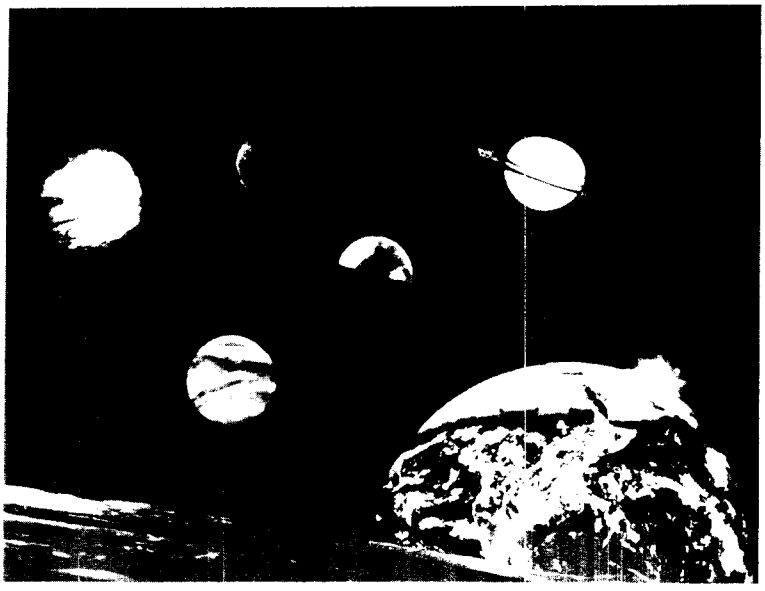
NSSDC NATIONAL SPACE SCIENCE DATA CENTER

WORLD DATA CENTER A for ROCKETS AND SATELLITES 88-07

DATA CATALOG SERIES FOR SPACE SCIENCE AND APPLICATIONS FLIGHT MISSIONS

Volume 1A

Descriptions of Planetary and Heliocentric Spacecraft and Investigations



Second Edition
March 1988

CATEGORIES OF SPACECRAFT USED IN THIS SERIES

PLANETARY AND HELIOCENTRIC

This category includes probes to the various planets of the solar system and probes designed to make measurements of the characteristics of interplanetary space. Also included are the probes that will pass out of the solar system into interstellar space.

METEOROLOGY AND TERRESTRIAL APPLICATIONS

This category includes geocentric spacecraft whose primary mission is to make remote sensing measurements of the earth and its atmosphere. Spacecraft that carry instrumentation to make geodesy and gravimetry measurements are also included. Technology, engineering, and communications spacecraft or investigations are not included because NSSDC does not archive such data.

ASTRONOMY, ASTROPHYSICS, AND SOLAR PHYSICS

This category consists of scientific satellites designed to conduct investigations of the sun, stellar objects, nonstellar sources, and interstellar phenomena. These satellites are geocentric except for the selenocentric RAE-B.

GEOSTATIONARY AND HIGH-ALTITUDE SCIENTIFIC

This category includes those satellites designed to conduct investigations of the characteristics of near-earth space from orbits with apogees near geostationary altitude and higher. Three of the spacecraft are selenocentric. Communications satellites are not included because NSSDC does not archive such data.

LOW- AND MEDIUM-ALTITUDE SCIENTIFIC

This category includes those spacecraft whose apogees are well below geostationary altitude and whose primary purpose is to conduct investigations in the near-earth environment.

NSSDC/WDC-A-R&S 88-07

DATA CATALOG SERIES FOR SPACE SCIENCE AND APPLICATIONS FLIGHT MISSIONS

Volume 1A

DESCRIPTIONS OF PLANETARY AND HELIOCENTRIC SPACECRAFT AND INVESTIGATIONS

Edited By

Winifred Sawtell Cameron
Robert W. Vostreys

Second Edition
March 1988

National Space Science Data Center (NSSDC)/
World Data Center A for Rockets and Satellites (WDC-A-R&S
National Aeronautics and Space Administration
Goddard Space Flight Center
Greenbelt, Maryland 20771

PREFACE TO THE SECOND EDITION

The decision to reprint Volume 1A of the *Data Catalog Series for Space Science and Applications Flight Missions* was made primarily because it was no longer available when its companion, Volume 1B, was completed in April 1987. Although Volume 1A was printed in September 1982, in this second edition no changes were made to the original text, since it described spacecraft and experiments as they actually were during the acquisition of the data in Volume 1B. The only significant revision made in the second edition was the addition of Appendix E, which is an index showing the pages in Volume 1A where one can find descriptions of the spacecraft and experiments corresponding to the data sets described in Volume 1B.

The organization of Appendix E is the same as that of Volume 1B. Thus, Appendix E to this second edition is ordered alphabetically by NSSDC spacecraft common name. The associated investigations, arranged alphabetically by Principal Investigator's last name, follow each spacecraft name.

Because of the organization of Volume 1A by planets and disciplines, many descriptions are repeated. For example, the description of the Voyager 2 spacecraft appears on page 68 under Jupiter, on page 83 under Saturn, and on page 94 under Interplanetary Investigations. Appendix E gives only the number of the first page on which a given description can be found. Thus, only page 68 is given for the Voyager 2 spacecraft. The index added to this edition should allow users to work smoothly from the organization of Volume 1B to that of Volume 1A.

The second edition was prepared by employees of the on-site contractor, Science Applications Research (SAR).

March 1988 John E. Jackson

PREFACE TO THE FIRST EDITION

This volume, *Brief Descriptions of Planetary and Heliocentric Spacecraft and Investigations*, part of the *Data Catalog Series for Space Science and Applications Flight Missions*, represents the work of many people. The series will describe the data sets held by NSSDC, some of the data sets held by NASA-funded investigators, and some of the data sets held by foreign investigators; and the series will serve as pointer documents for extensive data sets held and serviced by other government agencies.

We would like to thank the many spacecraft and experiment personnel who over the years provided much of the information contained in this volume. The cooperation of the investigators in supplying current status information is gratefully acknowledged. Thanks also are extended to the other NSSDC personnel, employees of the on-site contractor, M/A-COM Sigma Data, Inc., who have been involved in the information handling necessary to produce this volume. Special acknowledgment is given to Mary Elsen for her extensive editorial assistance and to the File Management group, supervised by Dorothy Rosenblatt, for their special computer processing to accommodate the format of this volume.

The Data Center is continually striving to increase the usefulness of its data holdings, supporting indexes, and documentation. Scientists are invited to submit their space science data and comments to NSSDC. Catalog recipients are urged to inform potential data users of its availability.

September 1982

Winifred Sawtell Cameron
Robert W. Vostreys

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Introduction

1.1 PURPOSE

The National Space Science Data Center (NSSDC) was established by the National Aeronautics and Space Administration (NASA) to provide data and information from space science and applications flight investigations in support of additional studies beyond those performed as the principal part of any flight mission. This volume is one of a series of eleven that will describe (1) the holdings of all spacecraft flight investigations for which NSSDC possesses data or can direct people to the data source, (2) all data sets held by NSSDC, (3) some of the data sets held and serviced by NASA-funded investigators, and (4) some of the data sets held and serviced by foreign investigators; and the series will serve as pointer documents for extensive data sets held and serviced by other government agencies, particularly the National Oceanographic and Atmospheric Administration (NOAA). There is one major omission from this series: the extensive set of data obtained from the lunar missions conducted by NASA, supplemented by a few small photographic data sets from Soviet missions. These are described in the *Catalog of Lunar Mission Data* (NSSDC/WDC-A-R&S 77-02) and will not be repeated in this series, except for a few cases. The data from IMP-E, Apollo 15 subsatellite, and Apollo 16 subsatellite are included in the series, since these data are important to disciplines other than those connected with lunar studies. Some of the experiments of the Apollo ALSEP missions also yielded useful data for magnetospheric and interplanetary physics, but these are not included in the series, since the instruments were confined to the surface of the moon. Readers should consult the *Catalog of Lunar Mission Data* if they are interested in such data sets.

The series consists of (1) five volumes that describe the spacecraft and their associated investigations (experiments) separated, mainly, into various orbit categories, (2) five corresponding volumes that describe the various orbital information and investigation data sets, and (3) a master index volume. In some cases certain data sets appear in more than one data set volume, since they are important to a discipline not normally related to most of the investigations on a given spacecraft. The five categories of spacecraft are (i) Planetary and Heliocentric, which include planetary flybys and probes, (ii) Meteorology and Terrestrial Applications, (iii) Astronomy, Astrophysics, and Solar Physics, which are all geocentric except the selenocentric RAE-B, (iv) Geostationary and High-Altitude Scientific, and (v) Low- and Medium-Altitude Scientific. It is impossible to provide an organization of categories that separates the investigations cleanly into scientific disciplines, since many missions were multidisciplinary.

Each volume is organized in a way that is believed to be most useful to the user and is described for each such volume in the Organization Section. For standard types of orbital information, i.e., predicted, refined, and definitive, the information is given in a tabular form to avoid repeating the same brief description an inordinate number of times. The standard description of a data set from an investigation is a free text brief description, since the wide variety of instruments precludes using a tabular format in most cases.

This catalog series has been prepared following a two-year survey and follow-up activity by NSSDC personnel to obtain information about the completeness of the NSSDC holdings and to solicit the description of data sets that will be serviced by individual investigators; these latter data sets are referred to as directory data sets. This survey was conducted only for NASA missions launched after December 31, 1962, but it includes the majority of NSSDC holdings. Unfortunately, of the 100 investigators surveyed, representing 346 inactive (no longer associated with an active science working team or equivalent) experiments, a small percentage failed to respond in 17 months of concerted solicitation of information. Consequently, there are now 20 investigations for which NSSDC has no data that will be dropped from this catalog series, since it would be irresponsible for NSSDC to send requesters to a possible data source that no longer has data or is non-responsive. The investigations that are being dropped from the NSSDC catalogs are identified in the appropriate volumes in the series. A small, but non-trivial, number of investigations were identified for which data no longer exist or for which the instrument failed at launch. These investigations are included in the spacecraft/investigation volumes so that users will know that it is fruitless to try to obtain such data anywhere.

The main purpose of this series is to identify the data and the contact from whom the data can be obtained within the scope previously defined. In addition, we have tried to identify the personnel involved with the investigation, so that a user will know whom to contact for an obscure or detailed piece of information relative to a given data set that NSSDC may not possess. Consequently, we have tried to provide the current affiliation of the investigators. In some cases we know that people have retired or have gone into different areas of endeavor. The latter case is treated by showing the last affiliation of such an individual and denoting that he is no longer affiliated by printing NLA after the individual's name. Since this series is oriented toward helping interested persons to obtain data from flight investigations and helping NSSDC to serve as an effective switching center, the spacecraft/mission personnel are identified at the institution where they performed their relevant duties. The term NLA is printed with the names of these personnel if they are no longer associated with the given institution.

It is hoped that this series will serve for many years as the source documents for data in the disciplines that NSSDC handles. The annual *NSSDC Data Listing* will be used to update the time intervals for which data are available and to identify in brief form the new data sets that become available in the future. The annual *Report of Active and Planned Spacecraft and Experiments* will be used to describe the new spacecraft and experiments which are placed in orbit.

1.2 ORGANIZATION

This catalog contains descriptions of the planetary and heliocentric spacecraft launched for which NSSDC has information. Described for those spacecraft are the investigations for which NSSDC has archived data.

The catalog is organized by planet, out from the sun, and then by heliocentric missions that collected interplanetary data. Included are the Pioneers 10 and 11 spacecraft which are on trajectories to take them out of the solar system. A description of missions to the moon, with descriptions of the spacecraft, experiments, and data archived is contained in the *Catalog of Lunar Missions Data* (NSSDC/WDC-A-R&S 77-02) and is not repeated here. It was not possible to obtain information from the following investigations on the availability of data and they are not included in the catalog.

Spacecraft	NSSDC ID	Investigation Name	Principal Investigator
Mariner 4	64-077A-03	Faraday Cup	H. S. Bridge
	64-077A-08	S-Band Occultation	A. J. Kliore
	64-077A-05	Cosmic Ray Protons and Electrons	J. A. Van Allen
Pioneer 7	66-075A-07	Celestial Mechanics	J. D. Anderson
Mariner 5	67-060A-01	S-Band Occultation	A. J. Kliore
	67-060A-04	Trapped Radiation Detector	J. A. Van Allen
Pioneer 8	67-123A-08	Celestial Mechanics	J. D. Anderson
Pioneer 9	68-100A-08	Celestial Mechanics	J. D. Anderson
Pioneer 10	72-012A-08	Infrared Radiometer	A. P. Ingersoll
Pioneer 11	73-019A-08	Infrared Radiometer	A. P. Ingersoll

The format for the experiments has been ordered by categories generally in order of the number of investigations. The categories discussed are (1) Imaging, (2) Particles and Fields, (3) Ultraviolet, (4) Infrared, (5) Radio Science and Celestial Mechanics, (6) Atmospheres, (7) Surface Chemistry, (8) Biology, and (9) Polarization.

Only investigations with some data either available from NSSDC or where the source of data is known are discussed. Table 1, however, lists all the experiments that were aboard the various spacecraft and indicates the status (all or partial, no data, or failed) of the data. Since NSSDC has only a few photographs from the U.S.S.R. -- Veneras 9, 10, 13, and 14 -- and no other data, only these investigations will be presented and included in Table 1; Table 2 contains planetary missions with planetary investigations listed by categories of data that are available at NSSDC. For complete coverage of the solar system, and for reference, Table 3 (from the *Catalog of Lunar Missions*), similar to Table 1, except that it covers lunar missions, is presented at the end of this catalog. Appendix A is an index to planetary missions, Appendix B is an index to missions that were primarily planetary but had investigations that only collected interplanetary data in the cruise mode, and Appendix C

contains an index to missions whose investigations were designed to collect only interplanetary data. Appendix D contains definitions for terms and acronyms that may not be readily recognized by the users of this document. In Table 1 there are many similar investigations with similar names, but they are listed separately in order to indicate status of availability of data. Under Radio Science and Celestial Mechanics, for example, there is only one investigation named Radio Occultation, yet occultation data were obtained at all the planets. These will be identified in Volume 1B, which is a companion volume describing the data sets obtained by the experiments described in this volume. It should be pointed out that many of the investigations obtained data from the interplanetary region, particularly in the particles and fields category.

1.3 NSSDC PURPOSE, FACILITIES, AND SERVICES

The National Space Science Data Center (NSSDC) was established by the National Aeronautics and Space Administration (NASA) to provide data and information from space science and applications investigations in support of additional studies beyond those performed by principal investigators. As part of that support, NSSDC has prepared this series of volumes providing descriptions of archived data, divided into five categories as presented in Section 1.1 (and see inside front cover). In addition to its main function of providing selected data and supporting information for further analysis of space science flight experiments, NSSDC produces other publications. Among these are a report on active and planned spacecraft and experiments and various users guides.

Virtually all the data available at or through NSSDC result from individual experiments carried on board individual spacecraft. The Data Center has developed an information system utilizing a spacecraft/investigation/data identification hierarchy. This catalog is based on that information system.

NSSDC provides facilities for reproduction of data and for onsite data use. Resident and visiting researchers are invited to study the data while at the Data Center. The Data Center staff will assist users with additional data searches and with the use of equipment. In addition to spacecraft data, the Data Center maintains some supporting information and other supporting data that may be related to the needs of the researchers.

The Data Center's address for information (for U.S. researchers) follows:

National Space Science Data Center
Code 601.4
Goddard Space Flight Center
Greenbelt, Maryland 20771
Telephone: (301) 344-6695
Telex No.: 89675
TWX No.: 7108289716

Researchers who reside outside the U.S. should direct requests for information to the following address:

World Data Center A for Rockets and Satellites
Code 601
Goddard Space Flight Center
Greenbelt, Maryland 20771 U.S.A.
Telephone: (301) 344-6695
Telex No.: 89675
TWX No.: 7108289716

1.4 DATA ACQUISITION

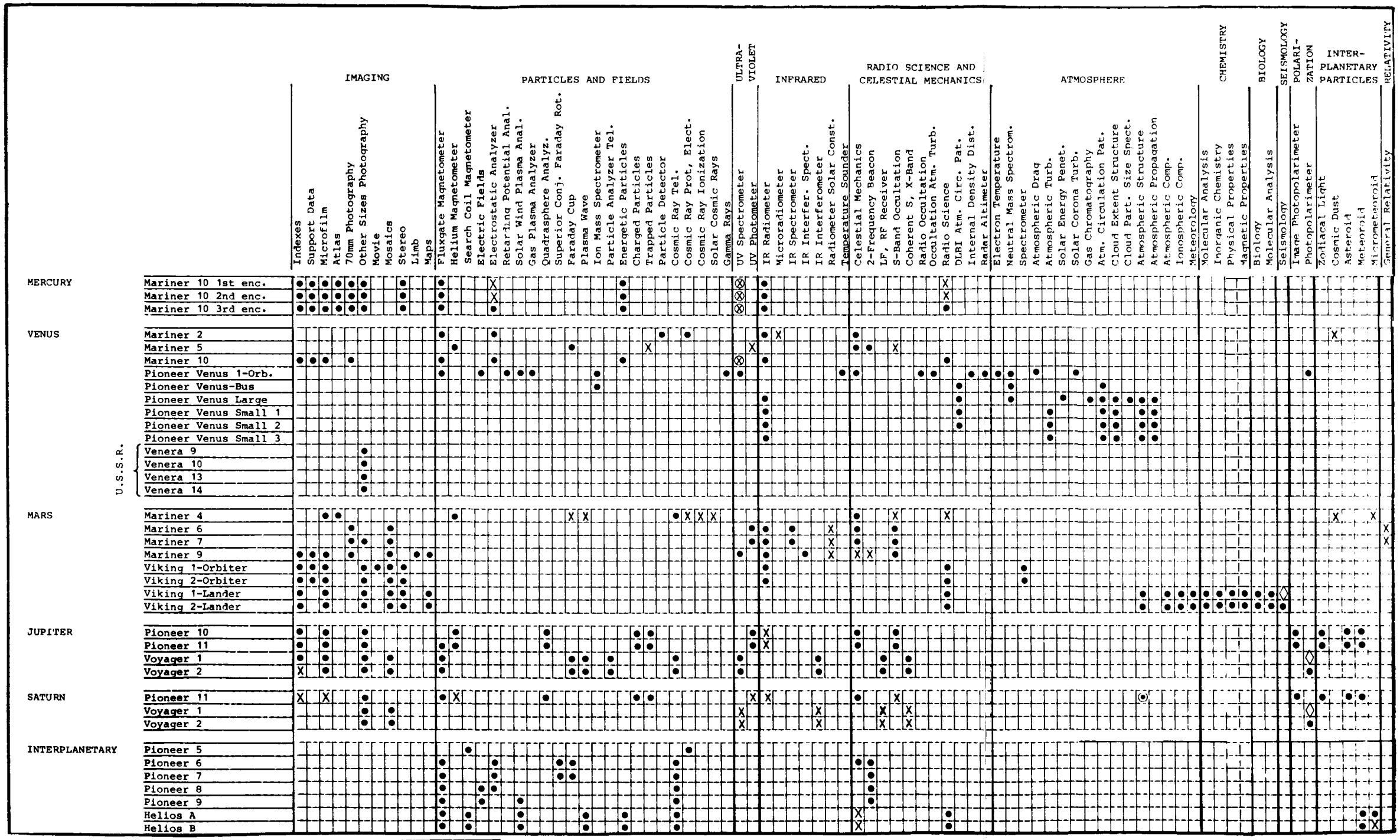
NSSDC invites members of the scientific community involved in spaceflight investigations to submit data to the Data Center or to provide information about the data sets that they prefer to handle directly. The Data Center assigns a discipline specialist to work with each investigator or science working team to determine the forms of data that are likely to be most useful to the community of users that obtain data from NSSDC. The pamphlet *Guidelines for Submitting Data to the National Space Science Data Center* can be provided on request.

FOLDOUT FRAME 1

FOLDOUT FRAME 2

Table 1. Status of Data Available from Planetary and Interplanetary Missions

(NSSDC - Named Investigations)



LEGEND

- ● Data at NSSDC
- X No data at NSSDC
- ◇ Experiment failed
- ◉ Data from another experiment
- ⊗ Data may be obtained from principal investigator

Table 2

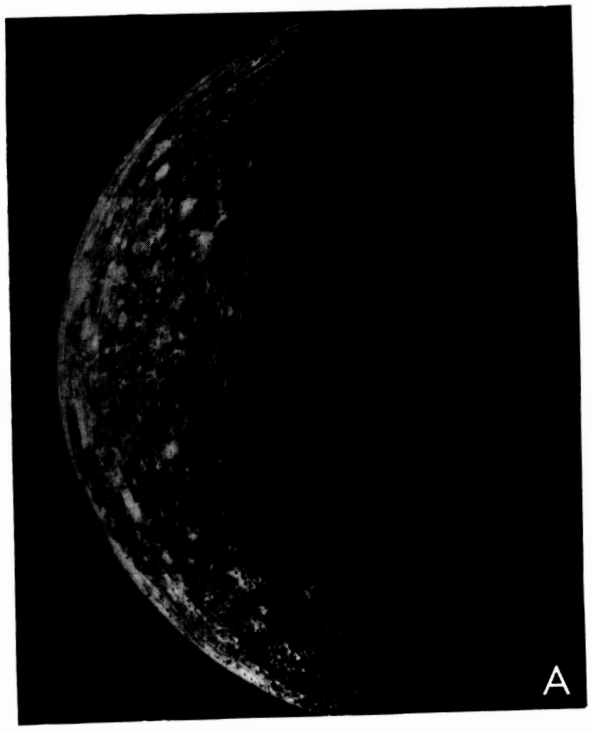
Planetary Missions, by Category of Data Available at NSSDC

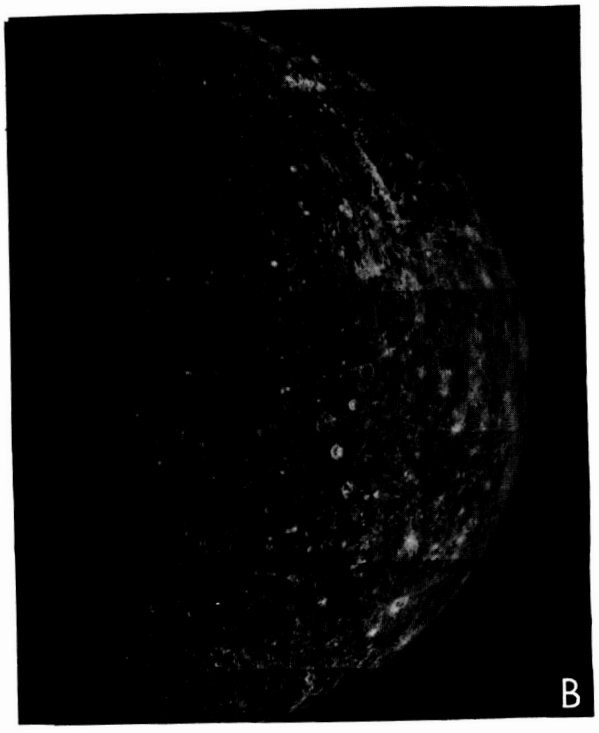
INVESTIGATION CATEGORY	PLANET	MISSIONS
IMAGING	MERCURY	MARINER 10
	VENUS	MARINER 10 PIONEER VENUS 1-ORBITER VENERA 9 VENERA 10 VENERA 13 VENERA 14
	MARS	MARINER 4 MARINER 6 MARINER 7 MARINER 9 VIKING 1-ORBITER VIKING 2-ORBITER VIKING 1-LANDER VIKING 2-LANDER
	JUPITER	PIONEER 10 PIONEER 11 VOYAGER 1 VOYAGER 2
	SATURN	PIONEER 11 VOYAGER 1 VOYAGER 2
PARTICLES & FIELDS	MERCURY	MARINER 10
	VENUS	MARINER 2 MARINER 5 MARINER 10 PIONEER VENUS 1-ORBITER PIONEER VENUS 2-BUS
	MARS	MARINER 4
	JUPITER	PIONEER 10 PIONEER 11 VOYAGER 1 VOYAGER 2
	SATURN	PIONEER 11
ULTRAVIOLET	MERCURY	MARINER 10
	VENUS	MARINER 10 PIONEER VENUS 1-ORBITER
	MARS	MARINER 6 MARINER 7 MARINER 9
	JUPITER	PIONEER 10 PIONEER 11 VOYAGER 1 VOYAGER 2
INFRARED	MERCURY	MARINER 10
	VENUS	MARINER 2 MARINER 10 PIONEER VENUS 1-ORBITER PIONEER VENUS LARGE PIONEER VENUS SMALL 1 PIONEER VENUS SMALL 2 PIONEER VENUS SMALL 3
	MARS	MARINER 6 MARINER 7 MARINER 9 VIKING 1-ORBITER VIKING 2-ORBITER
	JUPITER	VOYAGER 1 VOYAGER 2
RADIO SCIENCE & CELESTIAL MECHANICS	MERCURY	MARINER 10
	VENUS	MARINER 2 MARINER 5 MARINER 10 PIONEER VENUS 1-ORBITER PIONEER VENUS 2-BUS PIONEER VENUS-LARGE PIONEER VENUS-SMALL 1 PIONEER VENUS-SMALL 2 PIONEER VENUS-SMALL 3
	MARS	MARINER 4 MARINER 6 MARINER 7 MARINER 9 VIKING 1-ORBITER VIKING 2-ORBITER VIKING 1-LANDER VIKING 2-LANDER
	JUPITER	PIONEER 10 PIONEER 11 VOYAGER 1 VOYAGER 2
	SATURN	PIONEER 11
ATMOSPHERE	VENUS	PIONEER VENUS 1-ORBITER PIONEER VENUS 2-BUS PIONEER VENUS LARGE PIONEER VENUS-SMALL 1 PIONEER VENUS-SMALL 2 PIONEER VENUS-SMALL 3
	MARS	VIKING 1-ORBITER VIKING 2-ORBITER VIKING 1-LANDER VIKING 2-LANDER
	JUPITER	PIONEER 10 PIONEER 11 VOYAGER 2
	SATURN	PIONEER 11
SURFACE CHEMISTRY	MARS	VIKING 1-LANDER VIKING 2-LANDER
BIOLOGY	MARS	VIKING 1-LANDER VIKING 2-LANDER

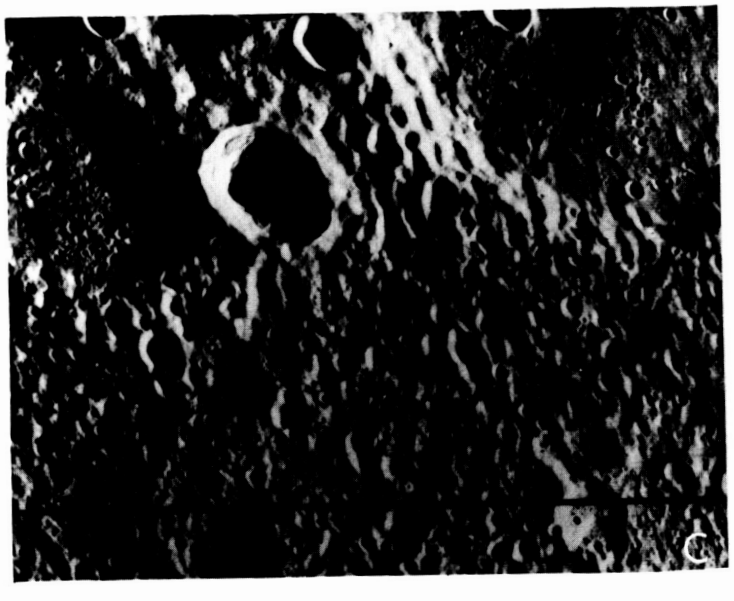
Mercury

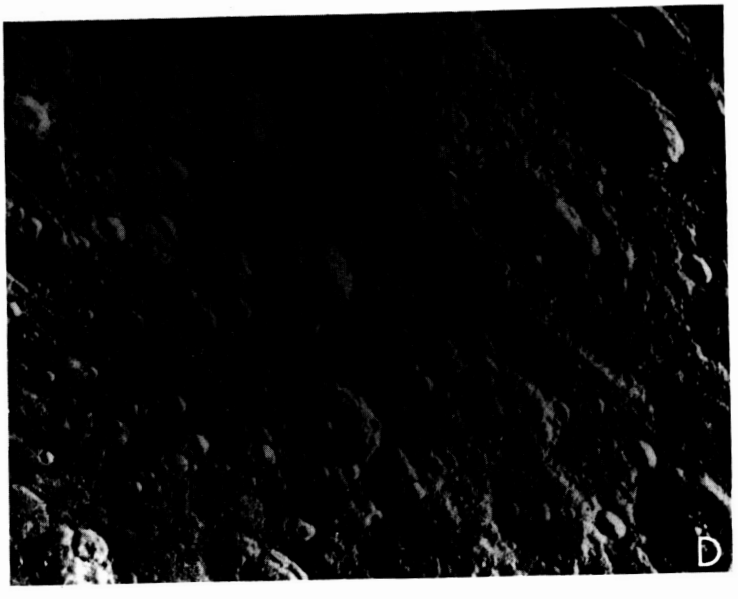
MERCURY

Plate 1. This is a collection of press release photographs of various aspects of the planet Mercury from the Mariner 10 mission, the only mission to go to Mercury. It was the first mission to use the gravitational assist from one planet (Venus) to go on to another planet (Mercury). (A) P14470 is a mosaic of medium-resolution images presenting the hemisphere of Mercury seen by the spacecraft on the incoming trajectory on the first encounter of the flyby. It shows the lunar highlands-like nature of Mercury. (B) P14580 is a mosaic of medium-resolution images of the hemisphere of Mercury seen by the spacecraft on its outgoing trajectory on the first encounter. It shows some smooth areas. The spacecraft later had two more encounters, each spaced 6 months apart. (C) P14469 is a high-resolution (about 100m) photo showing a two-level flow in a large crater. (D) P15046 is a high-resolution (about 100m) image showing some of the long ridges traversing all topography which are apparently unique to Mercury among the planets.









INTRODUCTION

It was felt that the presentation of investigations in categories and by planets would be most useful to the scientific community. In this way, a possible user of data could determine quickly and easily the data that have been gathered at each planet. This information can be obtained most quickly by consulting Table 1 for all investigations and their status in regard to data archived at NSSDC from planetary and interplanetary missions, Table 2 for general categories at each planet, and Appendix A for details.

The first planet to be covered in this catalog is Mercury. There has been only one mission to Mercury, namely Mariner 10. There were, however, three passes (encounters) past the planet. In the second part of this catalog, which contains discussions of the data sets pertaining to the investigations on Mariner 10 that covered Mercury, the data sets will be presented according to encounter. There were seven investigations for which NSSDC either has the data archived or knows the source of the archived data; these investigations fall under five categories: (1) Imaging, (2) Particles and Fields, (3) Ultraviolet, (4) Infrared, and (5) Radio Science and Celestial Mechanics, and they are presented in that order. All investigations that dealt with a category are discussed under that category.

Following the planetary investigations sections for the planets, those planetary missions that carried the interplanetary region investigations are presented. Appendix B indexes this section. This section, in turn, is followed by the interplanetary missions whose investigations collected only interplanetary data. These missions all had heliocentric orbits. Appendix C indexes this section in detail.

SPACECRAFT

********** MARINER 10**********

SPACECRAFT COMMON NAME- MARINER 10
ALTERNATE NAMES- MARINER 73, PL-732A
MARINER-J VENUS/MERCURY, MARINER VENUS/MERCURY 7
6919

NSSDC ID- 73-085A

LAUNCH DATE- 11/03/73 WEIGHT- 504. KG
LAUNCH SITE- CAPE CANAVERAL, UNITED STATES
LAUNCH VEHICLE- ATLAS

SPONSORING COUNTRY/AGENCY
UNITED STATES NASA-OSSA

INITIAL ORBIT PARAMETERS
ORBIT TYPE- MERCURY FLYBY

PERSONNEL
PM - W.E. GIBERSON NASA-JPL
PS - J.A. DUNNE NASA-JPL

BRIEF DESCRIPTION
This spacecraft was the first to use the gravitational pull of one planet (Venus) to reach another (Mercury). The spacecraft structure was an 18.15-kg (40 lb), eight-sided framework with eight electronics compartments. It measured 1.39 m diagonally and 0.457 m in depth. Two solar panels, each 2.7 m long and 0.97 m wide, were attached at the top, supporting 5.1 sq m of solar cell area. The rocket engine was liquid-fueled, with two sets of reaction jets used to stabilize the spacecraft on three axes. It carried a low-gain omnidirectional antenna, composed of a honeycomb-disk parabolic reflector, 1.37 m in diameter, with focal length 55 cm. Feeds enabled the spacecraft to transmit at S-band and X-band frequencies. The spacecraft carried a Canopus star tracker, located on the upper ring structure of the octagonal satellite, and acquisition sun sensors on the tips of the solar panels. The interior of the spacecraft was insulated with multilayer thermal blankets at top and bottom. A sunshade was deployed after launch to protect the spacecraft on the solar-oriented side. Instruments aboard the spacecraft measured the atmospheric, surface, and physical characteristics of Mercury and Venus. Experiments included television photography, magnetic field, plasma, infrared radiometry, ultraviolet spectroscopy, and radio science detectors. An experimental X-band, high-frequency transmitter was flown for the first time on this spacecraft. Mariner 10 was placed in a parking orbit after launch for approximately 25 min, then placed in orbit around the sun enroute to Venus. The orbit direction was opposite to the motion of the earth around the sun. Mid-course corrections were made. The spacecraft passed Venus on February 5, 1974, at a distance of 4200 km. It crossed the orbit of Mercury on March 29, 1974, at 2046 UT, at a distance of about 704 km from the surface. The TV and UV experiments were turned on the comet Kohoutek while the spacecraft was on the way to Venus. A second encounter with Mercury, when more photographs were taken, occurred on September 21, 1974, at an altitude of about 47,000 km. A third and last Mercury encounter at an altitude of 327 km, with additional photography of about 300 photographs and magnetic field measurements occurred on March 16, 1975. Engineering tests were continued until March 24, 1975, when the supply of attitude-control gas was depleted and the mission was terminated.

INVESTIGATIONS

IMAGING

------- MARINER 10, MURRAY----------

INVESTIGATION NAME- TELEVISION PHOTOGRAPHY

NSSDC ID- 73-085A-01 INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY ATMOSPHERES
PLANETOLOGY

PERSONNEL
PI - B.C. MURRAY CALIF INST OF TECH
OI - M.J.S.BELTON KITT PEAK NATL OBS
OI - G.P. KUIPER(DECEASED) U OF ARIZONA
OI - V.E. SUOMI U OF WISCONSIN
OI - N.J. TRASK, JR. US GEOLOGICAL SURVEY
OI - D.E. GAULT NASA-ARC
OI - B.W. HAPKE U OF PITTSBURGH
OI - M.E. DAVIES RAND CORP
OI - B.T. O'LEARY PRINCETON U

BRIEF DESCRIPTION
The objectives of this experiment were to photograph the surfaces (upper atmosphere in the case of Venus) of the planets Venus and Mercury. For Venus, the objectives were to investigate the time-dependent properties of the UV clouds, and to obtain high-resolution imagery of the main clouds. For Mercury, the objectives were to map its major physiographic provinces, determine its spin axis orientation, establish a cartographic coordinate system, and search for Mercurian satellites. The equipment consisted of two spherical (150 mm diameter) Cassegrain telescopes with eight filters, attached to GEC 1-inch vidicon tube cameras (1500 mm focal length and 0.5 deg field of view) for narrow-angle photography. An auxiliary optical system mounted on each camera provided wide-angle (62 mm focal length and 11 x 14 deg field of view) photography by moving a mirror on a filter wheel to a position in the optical path. Exposure time ranged from 3 ms to 12 s, and each camera took a picture every 42s. The TV picture consisted of 700 scan lines with 832 picture elements/line, which were digitally coded into 8-bit words for transmission. There were eight filter wheel positions: (1) wide-angle image relay mirror, (2) blue bandpass, (3) UV polarizing, (4) minus UV high pass, (5) clear, (6) UV bandpass, (7) defocusing lens (for calibration), and (8) yellow bandpass. About 7000 photographs were obtained of Venus and Mercury, with a maximum resolution of 100 m for Mercury. Three photographic passes, separated by 6-month intervals, were made for Mercury. Further details of the experiment can be obtained from NSSDC 75-18, and Icarus, v. 15, n. 2, October 1971. Science results on Mercury may be obtained from J. Geophys. Res., v. 80, p. 17, June 1975, and on Venus in Science, v. 183, p. 4131, March 1974.

PARTICLES AND FIELDS

------- MARINER 10, BRIDGE----------

INVESTIGATION NAME- MEASUREMENT OF PLASMA ENVIRONMENT

NSSDC ID- 73-085A-03 INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS

PERSONNEL
PI - H.S. BRIDGE MASS INST OF TECH
OI - J.H. BINSACK MASS INST OF TECH
OI - A.J. LAZARUS MASS INST OF TECH
OI - S. OLBERT MASS INST OF TECH
OI - S.J. BAME LOS ALAMOS SCI LAB
OI - M.D. MONTGOMERY LOS ALAMOS SCI LAB
OI - A.J. HUNDHAUSEN NATL CTR FOR ATMOS RES
OI - J.R. ASBRIDGE LOS ALAMOS SCI LAB
OI - K.W. OGILVIE NASA-GSFC
OI - L.F. BURLAGA NASA-GSFC
OI - R.E. HARTLE NASA-GSFC
OI - C.W. SNYDER NASA-JPL
OI - G.L. SISCOE U OF CALIF, LA

BRIEF DESCRIPTION
The experiment was designed to determine the mode of interaction between the planet Mercury and the solar wind, to make a comprehensive study of the plasma regime at Mercury, to verify and extend previous observations of the solar wind interaction with Venus, to clarify the role of electrons in the interactions, and to study the solar wind from 1 to 0.4 AU. Instrumentation for the experiment consisted of two sunward-facing electrostatic analyzers (SESA) and one backward facing electron spectrometer (BESA). These three detectors were mounted on a scanning platform, which could be swept at 1 deg/s through an arc of 120 deg centered on a direction in the ecliptic plane 6 deg east of the spacecraft-sun line. Both SESAs failed to return data. They were to measure positive ions from 0.08 to 8 kev and electrons from 4 to 400 eV. The BESA had a fan-shaped field of view of plus or minus 3.5 deg by plus or minus 13.5 deg. The larger angle was normal to, and symmetric about, the scan arc. An electron spectrum was obtained every 6 s, and consisted of flux measurements in 15 logarithmically spaced energy channels (with channel width delta E/E=6.6%) within the energy range 13.4 to 690 eV. Because solar wind flow past the spacecraft introduces angular distortion of the electron distribution function compared to what would be observed in the solar wind rest frame, it was possible, by taking into account this distortion and the spacecraft sheath characteristics, to derive some of the solar wind plasma parameters such as ion bulk speed, electron temperature, and electron density. The reliability of these parameters is necessarily dependent on the validity of the spacecraft sheath model employed in the analysis, and is thus affected by time changes in the ambient solar wind.

------- MARINER 10, NESS----------

INVESTIGATION NAME- FLUXGATE MAGNETOMETERS

NSSDC ID- 73-085A-04 INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS
PLANETOLOGY

PERSONNEL

PI - N.F. NESS		NASA-GSFC
OI - K.W. BEHANNON		NASA-GSFC
OI - R.P. LEPPING		NASA-GSFC
OI - Y.C. WHANG		CATHOLIC U OF AMERICA

BRIEF DESCRIPTION

This experiment consisted of two triaxial fluxgate magnetometers mounted on a common boom 2.3 m and 5.8 m from the spacecraft and designed to measure the vector magnetic field in the vicinity of Mercury and Venus and in the interplanetary medium. Outputs from the two magnetometers were simultaneously analyzed to separate ambient fields from spacecraft fields. Each sensor had dual operating ranges of minus to plus 16 nT and 128 nT, with digitization accuracies of 0.03 nT and 0.26 nT, respectively. Bias offset capability extended the operating range to minus or plus 3188 nT. During the primary phase of the mission (November 3, 1973, to March 29, 1974) and during the second and third Mercury encounters, 25 vectors per second were sampled by the primary outboard magnetometer and transmitted to Earth. At other times, a lower data rate mode was used during which five vectors per second were transmitted. The experiment functioned normally throughout the life of the spacecraft. For further details, see N. F. NESS et al., Science, v. 183, p. 1301.

------- MARINER 10, SIMPSON----------

INVESTIGATION NAME- ENERGETIC PARTICLES

NSSDC ID- 73-085A-07

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS

PERSONNEL

PI - J.A. SIMPSON		U OF CHICAGO
OI - J.E. LAMPORT		U OF CHICAGO

BRIEF DESCRIPTION

This experiment was designed to measure energetic electrons, protons, and alpha particles in the interplanetary medium and in the vicinities of Venus and Mercury. The instrumentation consisted of a main telescope and a low-energy telescope. The main telescope consisted of six colinear sensors (five silicon detectors and one CsI scintillator) surrounded by a plastic scintillator anticoincidence cup. One pulse height analysis was performed every 0.33 s, and counts accumulated in each coincidence/anticoincidence mode were measured every 0.6 s. Particles stopping in the first sensor were protons and alpha particles in the range 0.62-10.3 MeV/nucleon and electrons above approximately 170 keV. The aperture half angle for this mode was 47 deg, and the geometric factors were 14 sq cm ster for electrons and 7.4 sq cm ster for protons and alpha particles. The telescope aperture half angle decreased to 32 deg for coincident counts in the first and third sensors. The low-energy telescope, a two-element (plus anticoincidence) detector with a 38-deg half angle aperture and a 0.49 sq cm ster geometrical factor, was designed to measure 0.53-1.9 and 1.9-8.9 MeV protons without responding to electrons over a wide range of electron energies and intensities. See J. Geophys. Res., v. 80, p. 4018 and references therein for further details.

ULTRAVIOLET

------- MARINER 10, BROADFOOT----------

INVESTIGATION NAME- EUV SPECTROSCOPY

NSSDC ID- 73-085A-05

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY ATMOSPHERES

PERSONNEL

PI - A.L. BROADFOOT		U OF SOUTHERN CALIF
OI - M.B. MCELROY		HARVARD U
OI - M.J.S.BELTON		KITT PEAK NATL OBS

BRIEF DESCRIPTION

Two instruments were flown: an occultation spectrometer that was body-fixed to the spacecraft and an airglow spectrometer that was mounted on the scan platform. When the sun was obscured by the limbs of the planet, the occultation spectrometer measured the extinction properties of the atmosphere. The occultation spectrometer had a plane grating which operated at grazing incidence. The fluxes were measured at 470, 740, 810, and 890 A using channel electron multipliers. Pinholes defined the effective field of view of the instrument which was 0.15 deg full width at half maximum (FWHM). Isolated spectral bands at approximately 75 A (FWHM) were also measured. The objective grating airglow spectrometer was flown to measure airglow radiation from Venus and Mercury in the spectral range from 200 to 1700 A. With a spectral resolution of 20 A, the instrument measured radiation at the following wavelengths: 304, 430, 584, 740, 869, 1048, 1216, 1304, 1480, and 1657 A. In addition, to provide a check on the total incident extreme UV flux to the spectrometer, two zero-order channels were flown. The effective field of view of the instrument was 0.13 deg by 3.6 deg. More experiment details and some measurements are contained in two papers: (1) "Ultraviolet Observations of Venus from Mariner 10 -- Preliminary Results," A. L. Broadfoot, et al., Science, v. 183, March 29, 1974, and (2) "Mercury's Atmosphere from Mariner 10 -Preliminary Results," A. L. Broadfoot, et al., Science, v. 185, July 12, 1974. A description of the instrumentation is given in two later papers: (1) "Mariner 10 Ultraviolet Spectrometer: Airglow Experiment," A. L. Broadfoot, S. S. Clapp and F. E. Stuart, Space Sci. Instr. v. 3, 199 (1977); (2) "Mariner 10 Ultraviolet Spectrometer: Occultation Experiment," A. L. Broadfoot, S. S. Clapp and F. E. Stuart, Space Sci. Instr. v. 3, p. 209 (1977). Data also include the interplanetary region.

INFRARED

------- MARINER 10, CHASE, JR.----------

INVESTIGATION NAME- TWO-CHANNEL IR RADIOMETER

NSSDC ID- 73-085A-06

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY ATMOSPHERES
PLANETOLOGY

PERSONNEL

PI - S.C. CHASE, JR.		SANTA BARBARA RES CTR
OI - E.D. MINER		NASA-JPL
OI - D. MORRISON		U OF HAWAII
OI - G. MUNCH		MPI-HEIDELBERG
OI - G. NEUGEBAUER		CALIF INST OF TECH
OI - J.M. SAARI(DECEASED)		BOEING SCI RES LAB

BRIEF DESCRIPTION

An infrared radiometer having two channels, 22 to 39 micrometers (80 K to 500 K) and 10 to 17 micrometers (200 K to 650 K), was used to observe the thermal emission from Venus and Mercury in two broad spectral bands. The IR thermal emission from the surface of Mercury between late afternoon and early morning (local time) and deviations from the average thermal behavior of the surface were measured. Measurements were also made of the brightness temperatures of Venusian cloud tops and limb darkening phenomena. Attempts were made to correlate unusual temperature variations with photographs and measurements by other instruments to identify mountains, valleys, volcanoes, and unusual surface materials.

RADIO SCIENCE AND CELESTIAL MECHANICS

------- MARINER 10, HOWARD----------

INVESTIGATION NAME- S- AND X-BAND RADIO PROPAGATION

NSSDC ID- 73-085A-02

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
IONOSPHERES AND RADIO PHYSICS
PARTICLES AND FIELDS
PLANETARY ATMOSPHERES

PERSONNEL

PI - H.T. HOWARD		STANFORD U
OI - G.S. LEVY		NASA-JPL
OI - I.I. SHAPIRO		MASS INST OF TECH
OI - G. FJELDBO(NLA)		NASA-JPL
OI - A.J. KLIORE		NASA-JPL
OI - J.D. ANDERSON		NASA-JPL

BRIEF DESCRIPTION

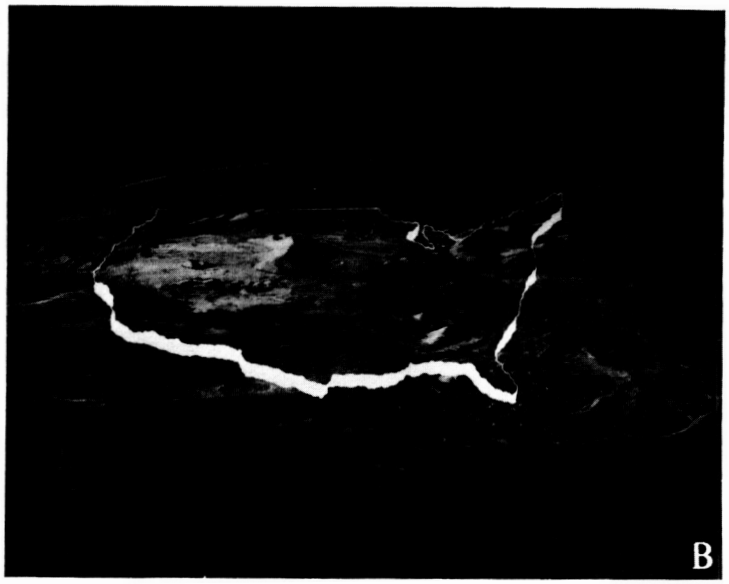
This experiment used X- (8400 MHz) and S- (2113 MHz) band, on-board radio systems for whatever scientific purposes could be devised. Two primary approaches were made, one utilizing tracking information, the other taking advantage of radio trajectory variations associated with occultation of the earth-spacecraft signal. Tracking information was analyzed to determine mass and gravitational characteristics (including planetary internal composition and density estimates) of both Venus and Mercury. From anomalous characteristics observed in the X- and S-band signals during spacecraft passage through the planetary atmospheres just prior to, and subsequent to, occultation, temperature and pressure profiles were calculated. These profiles were useful to adjust atmospheric composition models. Signal cutoff provided useful information for determination of planetary radius.

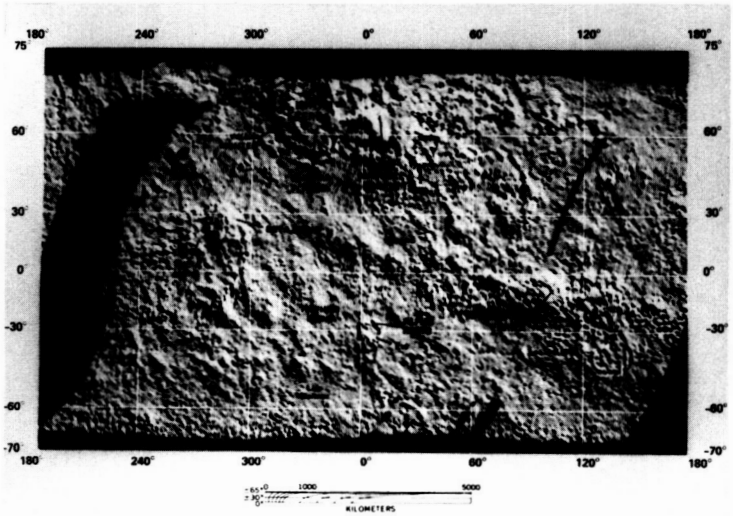
Venus

VENUS

Plate 2. This is a composite of press release illustrations of features on the surface of Venus. (A) P80-25 is an artist's rendition of the continent-sized structures and most of the planet's surface derived from the results from the Radar Altimeter investigation on the Pioneer Venus 1 - Orbiter spacecraft. (B) P80-13A is an artist's rendition of the continent-sized mass, Aphrodite, with the outline of the United States on it for comparison. This was also derived from the Pioneer Venus 1 - Orbiter Radar Altimeter. (C) P80-17 is an air brush map of the surface of Venus as revealed by the Pioneer Venus 1 - Orbiter Radar Altimeter measurements. (D) YI-000811 is a reproduction of the photos of the surface of Venus surrounding each Descent Craft landing area of Veneras 9 and 10 launched by the U.S.S.R. Note the different appearance of the rocks at the two sites which are separated by several thousand kilometers. (E) YG-06848 is a photograph of the surface surrounding the USSR's Venera 14 Descent Craft at its landing site. Note the still different structure of the platy, rocky outcrops compared with those of Veneras 9 and 10. Venera 14 landed in still another part of Venus, near the Phoebe Regio part of Venus.


A

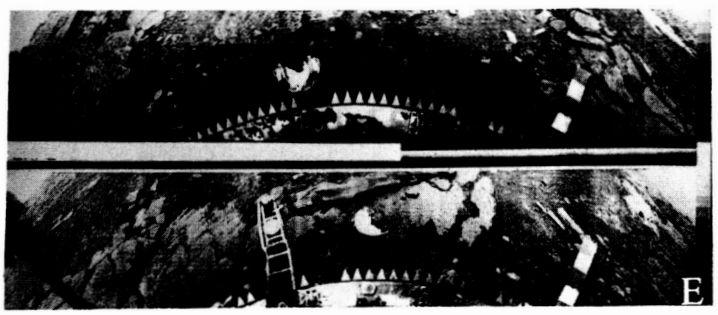

B



PRELIMINARY TOPOGRAPHIC MAP OF VENUS
CONTOUR INTERVAL 1 km ALL ELEV REFER TO A RADIUS OF 6045 kilometers

C

D


E

INTRODUCTION

The next planet out from the sun is Venus. There were four U.S. missions and four U.S.S.R. missions (for which data are available) that either flew by, orbited, or entered the atmosphere and landed on the surface of Venus. The last U.S. mission, Pioneer Venus was composed of six separate spacecraft: (1) Pioneer Venus 1 - Orbiter, (2) Pioneer Venus 2 - Bus, (3) Pioneer Venus - Large Probe, (4) Pioneer Venus - Small Probe 1, (5) Pioneer Venus - Small Probe 2, and (6) Pioneer Venus - Small Probe 3. All of the probes and the bus traveled together as one unit, Pioneer Venus 2, from the earth to Venus. The Large Probe and Small Probe 3 entered on the day side of Venus, and the Small Probes 1 and 2 entered on the night side. Two of the Small Probes actually survived and transmitted data for a short time, while the other two may have survived but were oriented wrong to transmit their data to the Orbiter. There were 65 separate investigations when each spacecraft on the Pioneer Venus mission is treated separately. These cover seven categories which are (1) Imaging, (2) Particles and Fields, (3) Ultraviolet, (4) Infrared, (5) Radio Science and Celestial Mechanics, (6) Atmosphere, and (7) Polarization. See Tables 1 and 2 and Appendix A for more details. The U.S.S.R. has sent many missions to Venus, many of which were successful. NSSDC, however, has data archived from only four missions -- namely Veneras 9, 10, 13 and 14 -- from which imaging was obtained. Only these are presented in this catalog.

********** MARINER 2**********

SPACECRAFT COMMON NAME- MARINER 2
ALTERNATE NAMES- 1962 ALPHA RHO 1, P 38
MARINER R-2, 00374

NSSDC ID- 62-041A

LAUNCH DATE- 08/27/62 WEIGHT- 203. KG
LAUNCH SITE- CAPE CANAVERAL, UNITED STATES
LAUNCH VEHICLE- ATLAS

SPONSORING COUNTRY/AGENCY
UNITED STATES NASA-OSSA

INITIAL ORBIT PARAMETERS
ORBIT TYPE- VENUS FLYBY

PERSONNEL
PM - J.S. MARTIN(NLA) NASA-JPL
PS - R.C. WYCKOFF(NLA) NASA-JPL

BRIEF DESCRIPTION
The Mariner 2 spacecraft was the second of a series of spacecraft used for planetary exploration in the flyby, or nonlanding, mode. Mariner 2 was a backup for the Mariner 1 mission which failed shortly after launch to Venus. The spacecraft was attitude-stabilized using the sun and earth as references. It was solar powered and capable of continuous telemetry operation. The spacecraft obtained data on the interplanetary medium during the flight to Venus and beyond, and it obtained planetary data during the encounter of Venus. The spacecraft passed Venus at a distance of 41,000 km on December 14, 1962.

********** MARINER 5**********

SPACECRAFT COMMON NAME- MARINER 5
ALTERNATE NAMES- MARINER VENUS 67, 02845
VENUS-67

NSSDC ID- 67-060A

LAUNCH DATE- 06/14/67 WEIGHT- 245. KG
LAUNCH SITE- CAPE CANAVERAL, UNITED STATES
LAUNCH VEHICLE- ATLAS

SPONSORING COUNTRY/AGENCY
UNITED STATES NASA-OSSA

PERSONNEL
PM - D. SCHNEIDERMAN NASA-JPL
PM - T.H. PARKER(NLA) NASA-JPL
PM - G.A. REIFF(NLA) NASA HEADQUARTERS
PS - C.W. SNYDER NASA-JPL

BRIEF DESCRIPTION
The Mariner 5 spacecraft was the fifth in a series of spacecraft used for planetary exploration in the flyby mode. Mariner 5 was a refurbished backup spacecraft for the Mariner 4 mission and was converted from a Mars mission to a Venus mission. The spacecraft was fully attitude stabilized, using the sun and Canopus as references. A central computer and sequencer subsystem supplied timing sequences and computing services for other spacecraft subsystems. The spacecraft passed 4,000 km from Venus on October 19, 1967. The spacecraft instruments measured both interplanetary and Venusian magnetic fields, charged particles, and plasmas, as well as the radio refractivity and UV emissions of the Venusian atmosphere. The mission was termed a success.

********** MARINER 10**********

SPACECRAFT COMMON NAME- MARINER 10
ALTERNATE NAMES- MARINER 73, PL-732A
MARINER-J VENUS/MERCURY, MARINER VENUS/MERCURY 7
6919

NSSDC ID- 73-085A

LAUNCH DATE- 11/03/73 WEIGHT- 504. KG
LAUNCH SITE- CAPE CANAVERAL, UNITED STATES
LAUNCH VEHICLE- ATLAS

SPONSORING COUNTRY/AGENCY
UNITED STATES NASA-OSSA

INITIAL ORBIT PARAMETERS
ORBIT TYPE- MERCURY FLYBY

PERSONNEL
PM - W.E. GIBERSON NASA-JPL
PS - J.A. DUNNE NASA-JPL

BRIEF DESCRIPTION
This spacecraft was the first to use the gravitational pull of one planet (Venus) to reach another (Mercury). The spacecraft structure was an 18.15-kg (40 lb), eight-sided framework with eight electronics compartments. It measured 1.39 m diagonally and 0.457 m in depth. Two solar panels, each 2.7 m long and 0.97 m wide, were attached at the top, supporting 5.1 sq m of solar cell area. The rocket engine was liquid-fueled, with two sets of reaction jets used to stabilize the spacecraft on three axes. It carried a low-gain omnidirectional antenna, composed of a honeycomb-disk parabolic reflector, 1.37 m in diameter, with focal length 55 cm. Feeds enabled the spacecraft to transmit at S-band and X-band frequencies. The spacecraft carried a Canopus star tracker, located on the upper ring structure of the octagonal satellite, and acquisition sun sensors on the tips of the solar panels. The interior of the spacecraft was insulated with multilayer thermal blankets at top and bottom. A sunshade was deployed after launch to protect the spacecraft on the solar-oriented side. Instruments aboard the spacecraft measured the atmospheric, surface, and physical characteristics of Mercury and Venus. Experiments included television photography, magnetic field, plasma, infrared radiometry, ultraviolet spectroscopy, and radio science detectors. An experimental X-band, high-frequency transmitter was flown for the first time on this spacecraft. Mariner 10 was placed in a parking orbit after launch for approximately 25 min, then placed in orbit around the sun enroute to Venus. The orbit direction was opposite to the motion of the earth around the sun. Mid-course corrections were made. The spacecraft passed Venus on February 5, 1974, at a distance of 4200 km. It crossed the orbit of Mercury on March 29, 1974, at 2046 UT, at a distance of about 704 km from the surface. The TV and UV experiments were turned on the comet Kohoutek while the spacecraft was on the way to Venus. A second encounter with Mercury, when more photographs were taken, occurred on September 21, 1974, at an altitude of about 47,000 km. A third and last Mercury encounter at an altitude of 327 km, with additional photography of about 300 photographs and magnetic field measurements occurred on March 16, 1975. Engineering tests were continued until March 24, 1975, when the supply of attitude-control gas was depleted and the mission was terminated.

********** PIONEER VENUS 1**********

SPACECRAFT COMMON NAME- PIONEER VENUS 1
ALTERNATE NAMES- PIONEER VENUS 1978 ORBIT, 10911
PIONEER VENUS ORBITER

NSSDC ID- 78-051A

LAUNCH DATE- 05/20/78 WEIGHT- 517. KG
LAUNCH SITE- CAPE CANAVERAL, UNITED STATES
LAUNCH VEHICLE- ATLAS-CENT

SPONSORING COUNTRY/AGENCY
UNITED STATES NASA-OSSA

INITIAL ORBIT PARAMETERS
ORBIT TYPE- VENUS ORBITER EPOCH DATE- 12/04/78
ORBIT PERIOD- 1440. MIN INCLINATION- 105. DEG
PERIAPSIS- 200. KM ALT APOAPSIS- 66614. KM ALT

PERSONNEL
PM - C.F. HALL(NLA) NASA-ARC
PS - L. COLIN NASA-ARC

BRIEF DESCRIPTION
Pioneer Venus 1 was the first of two missions designed to conduct a comprehensive investigation of the atmosphere of Venus. The spacecraft was a solar-powered cylinder about 250 cm in diameter with its spin axis spin-stabilized perpendicular to the ecliptic plane. A high-gain antenna was mechanically despun to remain focused on the earth. The instruments were mounted on a shelf within the spacecraft except for a magnetometer mounted at the end of a boom to ensure against magnetic interference from the spacecraft. Pioneer Venus 1 measured the detailed structure of the upper atmosphere and ionosphere of Venus, investigated the interaction of the solar wind with the ionosphere and the magnetic field in the vicinity of Venus, determined the characteristics of the atmosphere and surface of Venus on a planetary scale, determined the planet's gravitational field harmonics from perturbations of the spacecraft orbit, and detected gamma-ray bursts.

********** PIONEER VENUS 2**********

SPACECRAFT COMMON NAME- PIONEER VENUS 2
ALTERNATE NAMES- PIONEER VENUS 1978

NSSDC ID- 78-078A

LAUNCH DATE- 08/08/78 WEIGHT- 380. KG
LAUNCH SITE- CAPE CANAVERAL, UNITED STATES
LAUNCH VEHICLE- ATLAS

SPONSORING COUNTRY/AGENCY
UNITED STATES NASA-OSSA

INITIAL ORBIT PARAMETERS
ORBIT TYPE- VENUS PROBE

PERSONNEL
PM - C.F. HALL(NLA) NASA-ARC
PS - L. COLIN NASA-ARC

BRIEF DESCRIPTION
The spacecraft was the Bus portion of the Pioneer Venus Multiprobe mission. On this mission four instrumented atmospheric entry Probes were carried by this Bus to the vicinity of Venus and released for descent through the atmosphere to the planetary surface. Two Small Probes entered on the nightside, and one Small Probe and the Large Probe entered on the dayside of the planet. The spacecraft was spin-stabilized. The trip to Venus took 123 days. The four Probes separated from the Bus about 10 to 20 days before entry. The Large Probe took 1-1/2 h to descend through the atmosphere, while the three smaller probes reached the surface of the planet 75 min after entry. The Bus portion of the spacecraft was targeted to enter the Venusian atmosphere at a shallow entry angle and transmit data to earth until the Bus was destroyed by the heat of atmospheric friction during its descent. Investigators emphasized the study of the structure and composition of the atmosphere down to the surface, the nature and composition of the clouds, the radiation field and energy exchange in the lower atmosphere, and local information on the atmospheric circulation pattern. A sister mission, Pioneer Venus Orbiter, placed an orbiting spacecraft around Venus two weeks before the Probes were released. Simultaneous measurements by the probes and orbiter permitted relating specific local measurements to the general state of the planet and its environment as observed from orbit. The Probes stopped transmitting temperature data about 15 km above the surface of Venus, but two Probes survived on the surface and transmitted other data for a matter of seconds to minutes. The Bus ceased transmitting data at an altitude of about 165 km.

********** PIONEER VENUS PROBE LRG**********

SPACECRAFT COMMON NAME- PIONEER VENUS PROBE LRG
ALTERNATE NAMES- PIONEER VENUS 1978

NSSDC ID- 78-078D

LAUNCH DATE- 08/08/78 WEIGHT- 300. KG
LAUNCH SITE- CAPE CANAVERAL, UNITED STATES
LAUNCH VEHICLE- ATLAS

SPONSORING COUNTRY/AGENCY
UNITED STATES NASA-OSSA

INITIAL ORBIT PARAMETERS
ORBIT TYPE- VENUS PROBE

PERSONNEL
PM - C.F. HALL(NLA) NASA-ARC
PS - L. COLIN NASA-ARC

BRIEF DESCRIPTION
This spacecraft was the Large Probe portion of the Pioneer Venus Multiprobe mission. On this mission four instrumented atmospheric entry probes were carried by a spacecraft bus to the vicinity of Venus and released for descent through the atmosphere to the planetary surface. Two Small Probes entered on the nightside and a Small Probe and this Large Probe entered on the dayside of the planet. The spacecraft Bus entered the atmosphere and obtained atmospheric composition data until burnup. Investigations emphasized the study of the structure and composition of the atmosphere down to the surface, the nature and composition of the clouds, the radiation field and energy exchange in the lower atmosphere, and local information on the atmospheric circulation pattern. A sister mission, Pioneer Venus Orbiter, placed an orbiting spacecraft around Venus two weeks before the Probes were released. Simultaneous measurements by the Probes and Orbiter permitted relating specific local measurements to the general state of the planet and its environment as observed from orbit.

********** PIONEER VENUS PROBE SM1**********

SPACECRAFT COMMON NAME- PIONEER VENUS PROBE SM1
ALTERNATE NAMES- PIONEER VENUS 1978

NSSDC ID- 78-078E

LAUNCH DATE- 08/08/78 WEIGHT- 75. KG
LAUNCH SITE- CAPE CANAVERAL, UNITED STATES
LAUNCH VEHICLE- ATLAS

SPONSORING COUNTRY/AGENCY
UNITED STATES NASA-OSSA

INITIAL ORBIT PARAMETERS
ORBIT TYPE- VENUS PROBE

PERSONNEL
PM - C.F. HALL(NLA) NASA-ARC
PS - L. COLIN NASA-ARC

BRIEF DESCRIPTION
This spacecraft was the first Small Probe of the Pioneer Venus Multiprobe mission. On this mission four instrumented atmospheric entry probes were carried by a spacecraft Bus to the vicinity of Venus for descent through the atmosphere to the planetary surface. Two Small Probes entered on the nightside, and one Small Probe and one Large Probe entered on the dayside of the planet. The spacecraft Bus entered the atmosphere and obtained atmospheric composition data until burnup. Investigations emphasized the study of the structure composition and nature of the atmosphere down to the surface, and of the clouds, the radiation field and energy exchange in the lower atmosphere, and local information on the atmospheric circulation pattern. A sister mission, Pioneer Venus Orbiter, placed an orbiting spacecraft around Venus two weeks before the probes were released. Simultaneous measurements by the Probes and Orbiter permitted relating specific local measurements to the general state of the planet and its environment as observed from orbit.

********** PIONEER VENUS PROBE SM2**********

SPACECRAFT COMMON NAME- PIONEER VENUS PROBE SM2
ALTERNATE NAMES- PIONEER VENUS 1978

NSSDC ID- 78-078F

LAUNCH DATE- 08/08/78 WEIGHT- 75. KG
LAUNCH SITE- CAPE CANAVERAL, UNITED STATES
LAUNCH VEHICLE- ATLAS

SPONSORING COUNTRY/AGENCY
UNITED STATES NASA-OSSA

INITIAL ORBIT PARAMETERS
ORBIT TYPE- VENUS PROBE

PERSONNEL
PM - C.F. HALL(NLA) NASA-ARC
PS - L. COLIN NASA-ARC

BRIEF DESCRIPTION
This spacecraft was the second Small Probe of the Pioneer Venus Multiprobe mission. On this mission four instrumented atmospheric entry probes were carried by a spacecraft Bus to the vicinity of Venus for descent through the atmosphere to the planetary surface. Two Small Probes entered on the nightside, and one Small Probe and one Large Probe entered on the dayside of the planet. The spacecraft Bus entered the atmosphere and obtained atmospheric composition data until burnup. Investigations emphasized the study of the structure composition and nature of the atmosphere down to the surface, and of the clouds, the radiation field and energy exchange in the lower atmosphere, and local information on the atmospheric circulation pattern. A sister mission, Pioneer Venus Orbiter, placed an orbiting spacecraft around Venus two weeks before the Probes were released. Simultaneous measurements by the Probes and Orbiter permitted relating specific local measurements to the general state of the planet and its environment as observed from orbit.

********** PIONEER VENUS PROBE SM3**********

SPACECRAFT COMMON NAME- PIONEER VENUS PROBE SM3
ALTERNATE NAMES- PIONEER VENUS 1978

NSSDC ID- 78-078G

LAUNCH DATE- 08/08/78 WEIGHT- 75. KG
LAUNCH SITE- CAPE CANAVERAL, UNITED STATES
LAUNCH VEHICLE- ATLAS

SPONSORING COUNTRY/AGENCY
UNITED STATES NASA-OSSA

INITIAL ORBIT PARAMETERS
ORBIT TYPE- VENUS PROBE

PERSONNEL
PM - C.F. HALL(NLA) NASA-ARC
PS - L. COLIN NASA-ARC

BRIEF DESCRIPTION
This spacecraft was the third Small Probe of the Pioneer Venus Multiprobe mission. On this mission four instrumented atmospheric entry Probes were carried by a spacecraft Bus to the vicinity of Venus for descent through the atmosphere to the planetary surface. Two Small Probes entered on the nightside, and one Small Probe and one Large Probe entered on the dayside of the planet. The spacecraft Bus entered the atmosphere and obtained atmospheric composition data until burnup. Investigations emphasize the study of the structural composition and nature of the atmosphere down to the surface, and of the clouds, the radiation field and energy exchange in the lower atmosphere; and local information on the atmospheric

circulation patterr. A sister missicn, Pioneer Venus Orbiter, placed an orbiting spacecraft around Venus two weeks before the Probes were released. Simultaneous measurements by the Probes and the Orbiter permitted relating specific local measurements to the general state of the planet and its environment as observed from orbit.

********** VENERA 9 DESCENT CRAFT**********

SPACECRAFT COMMON NAME- VENERA 9 DESCENT CRAFT
ALTERNATE NAMES-

NSSDC ID- 75-050D

LAUNCH DATE- 06/08/75 WEIGHT- KG
LAUNCH SITE- TYURATAM (BAIKONUR COSMODROME), U.S.S.R.
LAUNCH VEHICLE- D-1-E

SPONSORING COUNTRY/AGENCY
U.S.S.R. SAS

INITIAL ORBIT PARAMETERS
ORBIT TYPE- VENUS LANDER

PERSONNEL
PM - UNKNOWN
PS - UNKNOWN

BRIEF DESCRIPTION
On October 20, 1975, this spacecraft was separated from the Orbiter, and landing was made with the sun near zenith at 0513 UT on October 22. A system of circulating fluid was used to distribute the heat load. This system, plus precooling prior to entry, permitted operation of the spacecraft for 53 min after landing. During descent, heat dissipation and deceleration were accomplished secuentially by protective hemispheric shells, three parachutes, a disk-shaped drag brake, and a compressible, metal, doughnut-shaped, landing cushion. The landing was about 2,200 km from the Venera 10 landing site. Preliminary results indicated: (A) clouds 30-40 km thick with bases at 30-35 km altitude, (B) atmospheric constituents including HCl, HF, Br, and I, (C) surface pressure about 90 (earth) atmospheres, (D) surface temperature 485 deg C, (E) light levels comparable to those at earth midlatitudes or a cloudy summer day, and (F) successful TV photography showing shadows, no apparent dust in the air, and a variety of 30-40 cm rocks which were rot eroded.

********** VENERA 10 DESCENT CRAFT**********

SPACECRAFT COMMON NAME- VENERA 10 DESCENT CRAFT
ALTERNATE NAMES-

NSSDC ID- 75-054D

LAUNCH DATE- 06/14/75 WEIGHT- KG
LAUNCH SITE- TYURATAM (BAIKONUR COSMODROME), U.S.S.R.
LAUNCH VEHICLE- D-1-E

SPONSORING COUNTRY/AGENCY
U.S.S.R. SAS

INITIAL ORBIT PARAMETERS
ORBIT TYPE- VENUS LANDER

PERSONNEL
PM - UNKNOWN
PS - UNKNOWN

BRIEF DESCRIPTION
On October 23, 1975, this spacecraft was separated from the Orbiter, ard lancing was made with the sun near zenith, at 0517 UT, on October 25. A system of circulating fluid was used to distribute the heat load. This system, plus precooling prior to entry, permitted operation of the spacecraft for 65 min after landing. During descent, heat dissipation and deceleration were accomplished sequentially by protective hemispheric shells, three parachutes, a disk-shaped drag brake, and a compressible, metal, doughnut-shaped, landing cushicr. The landing was about 2,200 km distant from Venera 9. Preliminary results provided: (A) profile of altitude (km)/pressure (earth atmospheres)/temperature (deg C) of 42/3.3/158, 15/37/363, and 0/92/465, (B) successful TV photography showing large pancake rocks with lava or other weathered rocks in between, and (C) surface wind speed of 3.5 m/s.

********** VENERA 13 DESCENT CRAFT**********

SPACECRAFT COMMON NAME- VENERA 13 DESCENT CRAFT
ALTERNATE NAMES-

NSSDC ID- 81-106D

LAUNCH DATE- 10/30/81 WEIGHT- KG
LAUNCH SITE- TYURATAM (BAIKONUR COSMODROME), U.S.S.R.
LAUNCH VEHICLE- D-1-E

SPONSORING COUNTRY/AGENCY
U.S.S.R. SAS

INITIAL ORBIT PARAMETERS
ORBIT TYPE- VENUS LANDER

PERSONNEL
PM - UNKNOWN
PS - UNKNOWN

BRIEF DESCRIPTION
Venera 13 landed at 7 deg 30 min S by 303 deg, just east of the eastern extension of an elevated region known as Phoebe Regio. It survived for 2 h 7 min in an environment with a temperature of 457 deg C and a pressure of 89 earth atmospheres. Venera 13 carried instruments to take chemical and isotopic measurements, monitored the spectrum of scattered sunlight, and recorded electric discharges during its descent phase through the Venusian atmosphere. The spacecraft utilized a camera system, an X-ray fluorescence spectrometer, and a seismometer tc conduct investigations on the surface.

********** VENERA 14 DESCENT CRAFT**********

SPACECRAFT COMMON NAME- VENERA 14 DESCENT CRAFT
ALTERNATE NAMES-

NSSDC ID- 81-110D

LAUNCH DATE- 11/04/81 WEIGHT- KG
LAUNCH SITE- TYURATAM (BAIKONUR COSMODROME), U.S.S.R.
LAUNCH VEHICLE- D-1-E

SPONSORING COUNTRY/AGENCY
U.S.S.R. SAS

INITIAL ORBIT PARAMETERS
ORBIT TYPE- VENUS LANDER

PERSONNEL
PM - UNKNOWN
PS - UNKNOWN

BRIEF DESCRIPTION
Venera 14 landed at 13 deg 15 min S by 310 deg, about 950 km southwest of Venera 13. Surface temperature was 465 deg C and pressure was 94 earth atmospheres. Venera 14 carried instruments to take chemical and isotopic measurements, monitored the spectrum of scattered sunlight, and recorded electric discharges during its descent phase through the Venusian atmosphere. The spacecraft utilized a camera system, an X-ray fluorescence spectrometer, and a seismometer to conduct investigations on the surface.

INVESTIGATIONS

IMAGING

------- MARINER 10, MURRAY-------

INVESTIGATION NAME- TELEVISION PHOTOGRAPHY

NSSDC ID- 73-085A-01 INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY ATMOSPHERES
PLANETOLOGY

PERSONNEL

PI - B.C. MURRAY		CALIF INST OF TECH
OI - M.J.S.BELTON		KITT PEAK NATL OBS
OI - G.P. KUIPER(DECEASED)		U OF ARIZONA
OI - V.E. SUOMI		U OF WISCONSIN
OI - N.J. TRASK, JR.		US GEOLOGICAL SURVEY
OI - D.E. GAULT		NASA-ARC
OI - B.W. HAPKE		U OF PITTSBURGH
OI - M.E. DAVIES		RAND CORP
OI - B.T. O'LEARY		PRINCETON U

BRIEF DESCRIPTION
The objectives of this experiment were to photograph the surfaces (upper atmosphere in the case of Venus) of the planets Venus and Mercury. For Venus, the objectives were to investigate the time-dependent properties of the UV clouds, and to obtain high-resolution imagery of the main clouds. For Mercury, the objectives were to map its major physiographic provinces, determine its spin axis orientation, establish a cartographic coordinate system, and search for Mercurian satellites. The equipment consisted of two spherical (150 mm diameter) Cassegrain telescopes with eight filters, attached to GEC 1-inch vidicon tube cameras (1500 mm focal length and 0.5 deg field of view) for narrow-angle photography. An auxiliary optical system mounted on each camera provided wide-angle (62 mm focal length and 11 x 14 deg field of view) photography by moving a mirror on a filter wheel to a position in the optical path. Exposure time ranged from 3 ms to 12 s, and each camera took a picture every 42s. The TV picture consisted of 700 scan lines with 832 picture elements/line, which were digitally coded into 8-bit words for transmission. There were eight filter wheel positions: (1) wide-angle image relay mirror, (2)

blue bandpass, (3) UV polarizing, (4) minus UV high pass, (5) clear, (6) UV bandpass, (7) defocusing lens (for calibration), and (8) yellow bandpass. About 7000 photographs were obtained of Venus and Mercury, with a maximum resolution of 100 m for Mercury. Three photographic passes, separated by 6-month intervals, were made for Mercury. Further details of the experiment can be obtained from NSSDC 75-18, and Icarus, v. 15, n. 2, October 1971. Science results on Mercury may be obtained from J. Geophys. Res., v. 80, p. 17, June 1975, and on Venus in Science, v. 183, p. 4131, March 1974.

------- PIONEER VENUS 1, HANSEN----------

INVESTIGATION NAME- CLOUD PHOTOPOLARIMETER

NSSDC ID- 78-051A-06
INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY ATMOSPHERES

PERSONNEL

PI - J.E.	HANSEN	NASA-GISS
OI - P.H.	STONE	MASS INST OF TECH
OI - A.A.	LACIS	NASA-GISS
OI - D.L.	COFFEEN	NASA-GISS
OI - L.D.	TRAVIS	NASA-GISS

BRIEF DESCRIPTION
This experiment used a simplified version of the Imaging Photopolarimeter (IPP) flown on Pioneers 10 and 11 to provide low-resolution, four-color maps of the Venusian cloud cover with a high-resolution imaging capability near apocenter. The principal objective of this investigation was to determine the properties of the clouds and haze, including the vertical and horizontal distribution of the particles, cloud particle size and refractive index, the cloud-top height, and the number density of particles.

------- VENERA 9 DESCENT CRAFT, UNKNOWN----------

INVESTIGATION NAME- PANORAMIC TELEPHOTOMETER FOR SURFACE IMAGERY

NSSDC ID- 75-050D-01
INVESTIGATIVE PROGRAM
LUNAR AND PLANETARY

INVESTIGATION DISCIPLINE(S)
PLANETOLOGY

PERSONNEL
PI - UNKNOWN

BRIEF DESCRIPTION
This experiment used a television camera to photograph the surface of Venus. One successful image was obtained.

------- VENERA 10 DESCENT CRAFT, UNKNOWN----------

INVESTIGATION NAME- PANORAMIC TELEPHOTOMETER FOR SURFACE IMAGERY

NSSDC ID- 75-054D-01
INVESTIGATIVE PROGRAM
LUNAR AND PLANETARY

INVESTIGATION DISCIPLINE(S)
PLANETOLOGY

PERSONNEL
PI - UNKNOWN

BRIEF DESCRIPTION
This experiment used a television camera to photograph the surface of Venus. One successful image was obtained.

------- VENERA 13 DESCENT CRAFT, UNKNOWN----------

INVESTIGATION NAME- PANORAMIC TELEPHOTOMETER FOR SURFACE IMAGERY

NSSDC ID- 81-106D-01
INVESTIGATIVE PROGRAM
LUNAR AND PLANETARY

INVESTIGATION DISCIPLINE(S)
PLANETOLOGY

PERSONNEL
PI - UNKNOWN

BRIEF DESCRIPTION
The camera system carried on Venera 13 was an improvement on the ones carried on Veneras 9 and 10. Eight photographs were obtained, some of which were taken through multiple filters to provide color. Resolution was good enough to show details as small as 4 to 5 mm across at a distance of 1.5 m.

------- VENERA 14 DESCENT CRAFT, UNKNOWN----------

INVESTIGATION NAME- PANORAMIC TELEPHOTOMETER FOR SURFACE IMAGERY

NSSDC ID- 81-110D-01
INVESTIGATIVE PROGRAM
LUNAR AND PLANETARY

INVESTIGATION DISCIPLINE(S)
PLANETOLOGY

PERSONNEL
PI - UNKNOWN

BRIEF DESCRIPTION
The camera system carried on Venera 14 was an improvement on the ones carried on Veneras 9 and 10. Four images were obtained of the surface of Venus.

PARTICLES AND FIELDS

------- MARINER 2, NEUGEBAUER----------

INVESTIGATION NAME- SOLAR PLASMA ANALYZER

NSSDC ID- 62-041A-06
INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
SOLAR PHYSICS

PERSONNEL

PI - M.M.	NEUGEBAUER	NASA-JPL
OI - C.W.	SNYDER	NASA-JPL

BRIEF DESCRIPTION
This experiment was designed to study the flux and energy spectrum of the positive ion component of the solar wind plasma. The experiment consisted of a cylindrical electrostatic analyzer with a faraday cup detector. This system separated positively-charged ions according to their energy per unit charge. The entrance aperture was 5 sq cm and rectangular. The aperture pointed to within 0.1 deg of the sun throughout the flight. The voltage on the analyzer plates was changed at intervals of about 18 s in an ascending sequence of 10 values from 231 V to 8824 V. A zero current reading and a calibration reading were then taken. The complete sequence of 12 measurements was repeated every 3.696 min (every 2.016 min near Venus). The instrument functioned normally over the entire flight and provided data almost continuously until December 30, 1962.

------- MARINER 10, BRIDGE----------

INVESTIGATION NAME- MEASUREMENT OF PLASMA ENVIRONMENT

NSSDC ID- 73-085A-03
INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS

PERSONNEL

PI - H.S.	BRIDGE	MASS INST OF TECH
OI - J.H.	BINSACK	MASS INST OF TECH
OI - A.J.	LAZARUS	MASS INST OF TECH
OI - S.	OLBERT	MASS INST OF TECH
OI - S.J.	BAME	LOS ALAMOS SCI LAB
OI - M.D.	MONTGOMERY	LOS ALAMOS SCI LAB
OI - A.J.	HUNDHAUSEN	NATL CTR FOR ATMOS RES
OI - J.R.	ASBRIDGE	LOS ALAMOS SCI LAB
OI - K.W.	OGILVIE	NASA-GSFC
OI - L.F.	BURLAGA	NASA-GSFC
OI - R.E.	HARTLE	NASA-GSFC
OI - C.W.	SNYDER	NASA-JPL
OI - G.L.	SISCOE	U OF CALIF, LA

BRIEF DESCRIPTION
The experiment was designed to determine the mode of interaction between the planet Mercury and the solar wind, to make a comprehensive study of the plasma regime at Mercury, to verify and extend previous observations of the solar wind interaction with Venus, to clarify the role of electrons in the interactions, and to study the solar wind from 1 to 0.4 AU. Instrumentation for the experiment consisted of two sunward-facing electrostatic analyzers (SESA) and one backward facing electron spectrometer (BESA). These three detectors were mounted on a scanning platform, which could be swept at 1 deg/s through an arc of 120 deg centered on a direction in the ecliptic plane 6 deg east of the spacecraft-sun line. Both SESAs failed to return data. They were to measure positive ions from 0.08 to 8 kev and electrons from 4 to 400 eV. The BESA had a fan-shaped field of view of plus or minus 3.5 deg by plus or minus 13.5 deg. The larger angle was normal to, and symmetric about, the scan arc. An electron spectrum was obtained every 6 s, and consisted of flux measurements in 15 logarithmically spaced energy channels (with channel width delta E/E=6.6%) within the energy range 13.4 to 690 eV. Because solar wind flow past the spacecraft introduces angular distortion of the electron distribution function compared to what would be observed in the solar wind rest frame, it was possible, by taking into account this distortion and the spacecraft sheath characteristics, to derive some of the solar wind plasma parameters such as ion bulk speed, electron temperature, and electron density. The reliability of these

parameters is necessarily dependent on the validity of the spacecraft sheath model employed in the analysis, and is thus affected by time changes in the ambient solar wind.

------- PIONEER VENUS 1, SCARF----------

INVESTIGATION NAME- ELECTRIC FIELD DETECTOR

NSSDC ID- 78-051A-13

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS
SPACE PLASMAS

PERSONNEL

PI - F.L.	SCARF	TRW SYSTEMS GROUP
OI - I.M.	GREEN	TRW SYSTEMS GROUP

BRIEF DESCRIPTION

This experiment consisted of a modified version of the Pioneer 8 and Pioneer 9 experiments to measure the electric-field components in four 30%, narrow-band channels centered at 100, 730, 7350, and 30,000 Hz. The aims of the investigation were to perform the first analysis of VLF electric fields at Venus to elucidate the plasma interactions between the solar wind and the ionospheric or exospheric plasma. The role of plasma instabilities in modifying the heat flux from the solar wind and in thermalizing newly-born ions from Venus was also studied. A self-contained balanced V-type antenna with a differential preamplifier was employed to make the measurements. At the 512-bps satellite mode, one frequency scan per second was obtained.

------- PIONEER VENUS 1, KNUDSEN----------

INVESTIGATION NAME- RETARDING POTENTIAL ANALYZER

NSSDC ID- 78-051A-07

INVESTIGATIVE PROGRAM
CODE EL-4/CO-OP, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY ATMOSPHERES
PLANETARY IONOSPHERES

PERSONNEL

PI - W.C.	KNUDSEN	LOCKHEED PALO ALTO
OI - K.	SPENNER	INST FUR PHYS WELTRAUM
OI - R.C.	WHITTEN	NASA-ARC

BRIEF DESCRIPTION

This investigation used a Langmuir-probe retarding-potential analyzer designed to measure electron concentration and temperature, major ion concentrations and temperatures, ion drift velocities, and the energy distribution function of ambient photoelectrons. It was an adaptation of the instrument flown on the German Aeros satellite in 1972. Either one of two sensor heads could be used, each consisting of a multigrid cup and electrometer, which could operate in electron, ion, or photoelectron modes, initiated by spacecraft roll pulses. The measurements taken when the sensor axis was closest to the plasma flow velocity vector were transmitted. The aims of the investigation were to improve knowledge of the important ionic reactions in the Venusian ionosphere, to study the plasma transport processes to determine if Venus has a polar wind, to study the processes at the solar wind-ionosphere boundary, and to study similar aims concerning the ambient electron population.

------- PIONEER VENUS 1, WOLFE----------

INVESTIGATION NAME- PLASMA ANALYZER (OPA)

NSSDC ID- 78-051A-18

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
SPACE PLASMAS
PARTICLES AND FIELDS

PERSONNEL

PI - J.H.	WOLFE	NASA-ARC
OI - A.	BARNES	NASA-ARC
OI - H.R.	COLLARD	NASA-ARC
OI - D.D.	MCKIBBIN	NASA-ARC
OI - J.D.	MIHALOV	NASA-ARC
OI - R.C.	WHITTEN	NASA-ARC
OI - D.S.	INTRILIGATOR	CARMEL RES CENTER

BRIEF DESCRIPTION

The instrument for this experiment was a quadrispherical electrostatic analyzer (detector B of plasma instrument on Pioneers 10 and 11), with five current collectors and electrometers. The energy/charge range was 50-8000 (ions) in 32 steps and 1-500 (electrons) in 16 steps. The angular range covered was plus or minus 85 deg elevation by 360 deg azimuth, and the detector field of view was 15 deg times 25 deg or 15 deg times 45 deg, depending on position. The logic design was essentially that used on Pioneers 8 and 9. The objectives were to measure solar wind conditions outside the Venusian bow shock, inside the magnetosheath flow field, and to study the ionopausal structure. Solar-wind measurements were made during the transit to Venus, particularly to study macroscale problems and to determine average gradients. The near-planet wake region was also available for study.

------- MARINER 5, BRIDGE----------

INVESTIGATION NAME- INTERPLANETARY ION PLASMA PROBE FOR E/Q OF 40 TO 9400 VOLTS

NSSDC ID- 67-060A-03

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS
INTERPLANETARY PHYSICS

PERSONNEL

PI - H.S.	BRIDGE	MASS INST OF TECH
OI - C.W.	SYNDER	NASA-JPL

BRIEF DESCRIPTION

This three-sectional-collector modulated-grid Faraday cup measured positive ions from 40 to 9400 eV/Q in eight approximately logarithmically equispaced energy windows. As the instrument always pointed toward the sun, vector data were obtained by comparing the relative signals from the three 120-deg pie-shaped collector sections. During each telemetry sequence, the instrument was stepped forward and backward through the eight windows to measure the sum of the currents from the three plates. Then it was stepped forward and backward to measure, for each voltage setting, the currents to the three plates in succession. The entire 32 steps in voltage window per telemetry sequence produced 64 current measurements. These measurements were repeated every 5 min. The instrument operated nominally throughout its mission.

------- MARINER 2, COLEMAN, JR.----------

INVESTIGATION NAME- FLUXGATE MAGNETOMETER

NSSDC ID- 62-041A-03

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
INTERPLANETARY PHYSICS
PLANETARY MAGNETIC FIELD

PERSONNEL

PI - P.J.	COLEMAN, JR.	U OF CALIF, LA

BRIEF DESCRIPTION

This experiment was designed to measure the magnitude and direction of the interplanetary and Venusian magnetic fields. It consisted of three orthogonal fluxgate magnetometers mounted on top of a 152.4-m tower. One magnetometer axis was parallel to the spacecraft roll axis. In the high-sensitivity mode, each magnetometer had a dynamic range of -64 to +64 nT with an accuracy of + or -0.5 nT. In the low-sensitivity mode, this range was -320 to +320 nT with an accuracy of + or -2.5 nT. All three magnetometers were sampled within 8.64 s, and this sequence of sampling was repeated every 36.96 s (or every 20.16 s during the Venus encounter on December 14, 1962). An inflight calibration system was designed to check the sensitivity of the three magnetometers once during each 15.77-h period. Due to a failure in the control circuit, inflight calibrations were performed more often and in a random fashion. Other than the failure in the inflight calibration system, the experiment performed normally until January 3, 1963, when contact with Mariner 2 was lost.

------- MARINER 10, NESS----------

INVESTIGATION NAME- FLUXGATE MAGNETOMETERS

NSSDC ID- 73-085A-04

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS
PLANETOLOGY

PERSONNEL

PI - N.F.	NESS	NASA-GSFC
OI - K.W.	BEHANNON	NASA-GSFC
OI - R.P.	LEPPING	NASA-GSFC
OI - Y.C.	WHANG	CATHOLIC U OF AMERICA

BRIEF DESCRIPTION

This experiment consisted of two triaxial fluxgate magnetometers mounted on a common boom 2.3 m and 5.8 m from the spacecraft and designed to measure the vector magnetic field in the vicinity of Mercury and Venus and in the interplanetary medium. Outputs from the two magnetometers were simultaneously analyzed to separate ambient fields from spacecraft fields. Each sensor had dual operating ranges of minus to plus 16 nT and 128 nT, with digitization accuracies of 0.03 nT and 0.26 nT, respectively. Bias offset capability extended the operating range to minus or plus 3188 nT. During the primary phase of the mission (November 3, 1973, to March 29, 1974) and during the second and third Mercury encounters, 25 vectors per second were sampled by the primary outboard magnetometer and transmitted to Earth. At other times, a lower data rate mode was used during which five vectors per second were transmitted. The experiment functioned normally throughout the life of the spacecraft. For further details, see N. F. NESS et al., Science, v. 183, p. 1301.

------- PIONEER VENUS 1, RUSSELL----------

INVESTIGATION NAME- MAGNETOMETER (OMAG)

NSSDC ID- 78-051A-12

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
MAGNETOSPHERIC PHYSICS
PARTICLES AND FIELDS
ATMOSFHERIC PHYSICS

PERSONNEL

PI - C.T.	RUSSELL	U OF CALIF, LA
OI - P.J.	COLEMAN, JR.	U OF CALIF, LA
OI - F.V.	CORONITI	U OF CALIF, LA
OI - C.F.	KENNEL	U OF CALIF, LA
OI - R.L.	MCPHERRON	U OF CALIF, LA
OI - G.L.	SISCOE	U OF CALIF, LA

BRIEF DESCRIPTION

This experiment used a triaxial fluxgate magnetometer with two ring-core sensors at the end of a magnetometer boom and one ring-core sensor, at 45 deg to the spin axis, halfway down the boom. The drive and electronics design had been used on the Apollo 15 and 16 subsatellites. The objectives were to determine any planetary and remanent magnetic fields, to deduce the location and strength of the ionospheric current system, to determine the energy and mass balance in the upper atmosphere of Venus, to determine the nature of the solar wind interaction with Venus, and to study the near-wake region of Venus and the structure of the Venusian bow shock. Interplanetary objectives were to determine the perturbation of the near-planet region by Venus and to compare the properties of the average field at 0.7 and 1.0 AU. The instrument was intended to, in the worst case of low-bit and low-sample rates, measure one vector per 32 s. While in Venus orbit, when the spacecraft was coasting through the interplanetary region in the apoapsis mode, the sample rate was one vector per 8 s. While the spacecraft was passing through the Venusian ionosphere in the periapsis mode, the sample rate was four vectors per s.

------- MARINER 5, SMITH----------

INVESTIGATION NAME- TRIAXIAL LOW FIELD HELIUM MAGNETOMETER

NSSDC ID- 67-060A-05

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS
PLANETARY MAGNETIC FIELD

PERSONNEL

PI - E.J.	SMITH	NASA-JPL

BRIEF DESCRIPTION

For this experiment a low-field helium magnetometer was used to obtain triaxial measurements of interplanetary and Venusian magnetic fields. Its operation depended on the variation in absorptivity of excited helium to circularly polarized infrared light with applied field. Swept Helmholtz coils nulled the ambient field by use of feedback circuits. Mounted on a 1.5-m boom, the instrument's dynamic range was plus or minus 204 nT per axis, with a measurement precision determined by telemetry constraints of plus or minus 0.2 nT. Offset fields were correctable to within 0.25 nT per component. The experiment operated in a high (low) bit-rate mode of 3 vector samples spaced 1/7, 2/7, and 4/7 of the sequence every 12.6 (50.4) s; thus the Nyquist frequencies were about 0.12 and 0.03 Hz respectively. High-rate data were obtained from June 14 to July 24, 1967, and for 4 hours on October 25, 1967. Low bit-rate data were obtained for the remainder of the experiment's useful lifetime. Quality of data was high except during September 23 to October 1, 1967, when telemetered data were of uncertain quality. NSSDC has all the data from this experiment.

------- MARINER 2, VAN ALLEN----------

INVESTIGATION NAME- PARTICLE DETECTOR

NSSDC ID- 62-041A-07

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS
PLANETARY PHYSICS

PERSONNEL

PI - J.A.	VAN ALLEN	U OF IOWA

BRIEF DESCRIPTION

A collimated, directional, Anton type 213 Geiger-Mueller tube (with energy thresholds of 40 keV for electrons and 500 keV for protons) was used to search for charged particles magnetically trapped in the vicinity of the planet Venus and, if such particles were found, to obtain preliminary measurements of their spatial distribution and intensity. Throughout the flight, including the planetary flyby, the axis of the detector's ecrical field of view (90 deg full angle) was directed at 70 deg plus or minus 1 deg to the spacecraft-sun line. This axis lay in the plane containing the sun, earth, and spacecraft and was on the earthward side of the spacecraft. During the 3.5 month interplanetary mode of operation, the radiation equipment was used to monitor the intensity of low-energy particles. The accumulated number of counts from the detector during a 9.60-s interval was read out once each 887 s. During the encounter mode, the accumulated number of counts during a 9.60-s interval was read out once each 484 s. There was an absence of any discernible increase in counting rate during passage by Venus at radial distances as small as 41,000 km on the sunward side of the planet.

------- MARINER 10, SIMPSON----------

INVESTIGATION NAME- ENERGETIC PARTICLES

NSSDC ID- 73-085A-07

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS

PERSONNEL

PI - J.A.	SIMPSON	U OF CHICAGO
OI - J.E.	LAMPORT	U OF CHICAGO

BRIEF DESCRIPTION

This experiment was designed to measure energetic electrons, protons, and alpha particles in the interplanetary medium and in the vicinities of Venus and Mercury. The instrumentation consisted of a main telescope and a low-energy telescope. The main telescope consisted of six colinear sensors (five silicon detectors and one CsI scintillator) surrounded by a plastic scintillator anticoincidence cup. One pulse height analysis was performed every 0.33 s, and counts accumulated in each coincidence/anticoincidence mode were measured every 0.6 s. Particles stopping in the first sensor were protons and alpha particles in the range 0.62-10.3 MeV/nucleon and electrons above approximately 170 keV. The aperture half angle for this mode was 47 deg, and the geometric factors were 14 sq cm ster for electrons and 7.4 sq cm ster for protons and alpha particles. The telescope aperture half angle decreased to 32 deg for coincident counts in the first and third sensors. The low-energy telescope, a two-element (plus anticoincidence) detector with a 38-deg half angle aperture and a 0.49 sq cm ster geometrical factor, was designed to measure 0.53-1.9 and 1.9-8.9 MeV protons without responding to electrons over a wide range of electron energies and intensities. See J. Geophys. Res., v. 80, p. 4018 and references therein for further details.

------- PIONEER VENUS 1, TAYLOR, JR.----------

INVESTIGATION NAME- ION MASS SPECTROMETER

NSSDC ID- 78-051A-17

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY IONOSPHERES
PLANETARY ATMOSPHERES

PERSONNEL

PI - H.A.	TAYLOR, JR.	NASA-GSFC
OI - S.J.	BAUER	GRAZ U
OI - R.E.	HARTLE	NASA-GSFC
OI - H.C.	BRINTON	NASA-GSFC
OI - J.R.	HERMAN	NASA-GSFC
OI - T.M.	DONAHUE	U OF MICHIGAN
OI - P.A.	CLOUTIER	RICE U
OI - F.C.	MICHEL	RICE U

BRIEF DESCRIPTION

The composition and concentration of thermal positive ions in the ionosphere of Venus were determined and interpreted in terms of vertical and horizontal components. The instrument used was a Bennett radio-frequency mass spectrometer based on the design of those flown on OGO and Atmospheric Explorer satellites. A mass range of 1 to 60 u was covered with a variety of automatic scan-search modes available.

------- PIONEER VENUS 2, TAYLOR, JR.----------

INVESTIGATION NAME- ION-MASS SPECTROMETER

NSSDC ID- 78-078A-02

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY ATMOSPHERES
PLANETARY IONOSPHERES
AERONOMY

PERSONNEL

PI - H.A.	TAYLOR, JR.	NASA-GSFC
OI - S.J.	BAUER	GRAZ U
OI - T.M.	DONAHUE	U OF MICHIGAN
OI - P.A.	CLOUTIER	RICE U
OI - R.E.	HARTLE	NASA-GSFC
OI - H.C.	BRINTON	NASA-GSFC
OI - F.C.	MICHEL	RICE U

BRIEF DESCRIPTION
This ion mass spectrometer experiment obtained measurements which provided information on the solar wind interaction with Venus, upper atmosphere photochemistry, and the mass and heat transport characteristics of the atmosphere. A Bennett ion spectrometer, similar to units flown on many earth satellites are rockets, measured Venus' upper atmosphere ion concentrations in the mass range from 1 to 60 atomic mass units (u) from the time of crossing Venus' bowshock to bus burnup.

------- PIONEER VENUS 1, EVANS----------

INVESTIGATION NAME- GAMMA-RAY BURST DETECTOR

NSSDC ID- 78-051A-05 INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
GAMMA-RAY ASTRONOMY

PERSONNEL

PI - W.D.	EVANS	LOS ALAMOS NAT LAB
OI - J.P.	CONNER	LOS ALAMOS NAT LAB
OI - P.R.	HIGBIE	LOS ALAMOS NAT LAB
OI - R.W.	KLEBESADEL	LOS ALAMOS NAT LAB
OI - R.A.	OLSON	LOS ALAMOS NAT LAB
OI - I.B.	STRONG	LOS ALAMOS NAT LAB
OI - R.E.	SPALDING	SANDIA LABORATORIES

BRIEF DESCRIPTION
An omnidirectional gamma-ray detector employing two Phoswich scintillation spectrometers sensitive to protons from 0.2 to 2.0 MeV was used with logic circuitry to detect the beginning of a gamma event and to initiate a period of rapid data collection. Data were stored in a memory unit for subsequent transmission to earth. Confirmation that a true gamma event had occurred was obtained by comparison with results from other experiments in earth satellites. This experiment provided the long-baseline time correlations necessary for calculating accurate source locations.

------- MARINER 2, ANDERSON----------

INVESTIGATION NAME- COSMIC-RAY IONIZATION

NSSDC ID- 62-041A-04 INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
COSMIC RAYS

PERSONNEL

PI - H.R.	ANDERSON	SCIENCE APPL, INC
OI - J.A.	VAN ALLEN	U OF IOWA
OI - V.H.	NEHER	CALIF INST OF TECH

BRIEF DESCRIPTION
The particle experiment was designed to investigate (1) the dependence of the intensity of ionizing particles in space upon distance from the sun; (2) temporal variations of the particles and their correlation with variations of the magnetic field and plasma flux at the location of the spacecraft and with solar-terrestrial disturbances; and (3) the intensity and extent of magnetically trapped particles, if any, around Venus. The instrumentation consisted of three detectors: (1) a gas-filled, integrating, ionization chamber with a wall of stainless steel; (2) an omnidirectional thin-walled cylindrical glass GM tube shielded with stainless steel; and (3) an identical glass GM tube shielded with beryllium. The two GM tubes differed in the efficiency with which they detected nonpenetrating electrons by the bremsstrahlung process. All three detectors were sensitive to electrons of energies greater than 500 keV and protons of energies greater than 10 MeV. The ionization chamber was sampled for 221.76 s once every 443.52 s. The count accumulation of the GM tube shielded with stainless steel was sampled once for 0.828 s and once for 9.6 s every 443.52 s, and the count accumulation of the beryllium-shielded GM tube was sampled once for 0.828 s and once for 9.6 s every 887.04 s. The detectors were mounted close together with the axes of the GM tubes perpendicular to the roll axis of the spacecraft and hence to the radius vector from the sun. The GM tubes shielded with stainless steel and beryllium had omnidirectional geometric factors of 6.97 and 6.91 sq cm, respectively. The experiment operated normally throughout the mission.

ULTRAVIOLET

------- MARINER 10, BROADFOOT----------

INVESTIGATION NAME- EUV SPECTROSCOPY

NSSDC ID- 73-085A-05 INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY ATMOSPHERES

PERSONNEL

PI - A.L.	BROADFOOT	U OF SOUTHERN CALIF
OI - M.B.	MCELROY	HARVARD U
OI - M.J.S.	BELTON	KITT PEAK NATL OBS

BRIEF DESCRIPTION
Two instruments were flown: an occultation spectrometer that was body-fixed to the spacecraft and an airglow spectrometer that was mounted on the scan platform. When the sun was obscured by the limbs of the planet, the occultation spectrometer measured the extinction properties of the atmosphere. The occultation spectrometer had a plane grating which operated at grazing incidence. The fluxes were measured at 470, 740, 810, and 890 A using channel electron multipliers. Pinholes defined the effective field of view of the instrument which was 0.15 deg full width at half maximum (FWHM). Isolated spectral bands at approximately 75 A (FWHM) were also measured. The objective grating airglow spectrometer was flown to measure airglow radiation from Venus and Mercury in the spectral range from 200 to 1700 A. With a spectral resolution of 20 A, the instrument measured radiation at the following wavelengths: 304, 430, 584, 740, 869, 1048, 1216, 1304, 1480, and 1657 A. In addition, to provide a check on the total incident extreme UV flux to the spectrometer, two zero-order channels were flown. The effective field of view of the instrument was 0.13 deg by 3.6 deg. More experiment details and some measurements are contained in two papers: (1) "Ultraviolet Observations of Venus from Mariner 10 -- Preliminary Results," A. L. Broadfoot, et al., Science, v. 183, March 29, 1974, and (2) "Mercury's Atmosphere from Mariner 10 -Preliminary Results," A. L. Broadfoot, et al., Science, v. 185, July 12, 1974. A description of the instrumentation is given in two later papers: (1) "Mariner 10 Ultraviolet Spectrometer: Airglow Experiment," A. L. Broadfoot, S. S. Clapp and F. E. Stuart, Space Sci. Instr. v. 3, 199 (1977); (2) "Mariner 10 Ultraviolet Spectrometer: Occultation Experiment," A. L. Broadfoot, S. S. Clapp and F. E. Stuart, Space Sci. Instr. v. 3, p. 209 (1977). Data also include the interplanetary region.

------- PIONEER VENUS 1, STEWART----------

INVESTIGATION NAME- PROGRAMMABLE ULTRAVIOLET SPECTROMETER

NSSDC ID- 78-051A-15 INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY ATMOSPHERES
AERONOMY
IONOSPHERES

PERSONNEL

PI - A.I.	STEWART	U OF COLORADO
OI - C.A.	BARTH	U OF COLORADO
OI - C.W.	HORD	U OF COLORADO
OI - G.E.	THOMAS	U OF COLORADO
OI - D.	ANDERSON	NOAA-SEL

BRIEF DESCRIPTION
This investigation used a 125-mm Cassegrain telescope on a 125-mm Ebert-Fastie spectrometer with a programmable grating drive. Airglow, scattered sunlight, and hydrogen Lyman-alpha emissions were detected in the thermosphere, mesosphere, and exosphere of Venus. These measurements were used to establish and map the composition, temperature, and photochemistry of the thermosphere and ionosphere, to determine the pressure at and above the visible cloud tops, and to establish the distribution and escape rate of atomic hydrogen. The instrument operated in the 1100-3400 A region.

INFRARED

------- MARINER 2, NEUGEBAUER----------

INVESTIGATION NAME- INFRARED RADIOMETER

NSSDC ID- 62-041A-02 INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETOLOGY
PLANETARY ATMOSPHERES

PERSONNEL

PI - G.	NEUGEBAUER	CALIF INST OF TECH

BRIEF DESCRIPTION
The infrared radiometer on Mariner 2 was designed to measure the radiation temperatures of small areas of Venus in the 8.4- and 10.4-micrometer bands. Optically, the radiometer consisted of two similar lens systems whose axes were separated by 45 deg. One system, establishing the chopping reference, viewed dark space, and the other viewed the planet. The energy through the two systems was combined into a single chopped beam

that was in turn split by a dichroic filter into two perpendicular beams that were incident on two thermistor bolometer detectors. Three successful scans were accomplished during planetary flyby on December 14, 1962. The accuracy of the radiation temperatures obtained varied from 2 deg for source temperatures near 200 deg K to 10 deg for source temperatures near 500 deg K. A complete description and performance summary for the Mariner 2 radiometer is given in "Mariner-Venus 1962, Final Project Report," NASA SP-59, 1965.

------- MARINER 10, CHASE, JR.----------

INVESTIGATION NAME- TWO-CHANNEL IR RADIOMETER

NSSDC ID- 73-085A-06

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY ATMOSPHERES
PLANETOLOGY

PERSONNEL

PI - S.C.	CHASE, JR.	SANTA BARBARA RES CTR
OI - E.D.	MINER	NASA-JPL
OI - D.	MORRISON	U OF HAWAII
OI - G.	MUNCH	MPI-HEIDELBERG
OI - G.	NEUGEBAUER	CALIF INST OF TECH
OI - J.M.	SAARI(DECEASED)	BOEING SCI RES LAB

BRIEF DESCRIPTION
An infrared radiometer having two channels, 22 to 39 micrometers (80 K to 500 K) and 10 to 17 micrometers (208 K to 650 K), was used to observe the thermal emission from Venus and Mercury in two broad spectral bands. The IR thermal emission from the surface of Mercury between late afternoon and early morning (local time) and deviations from the average thermal behavior of the surface were measured. Measurements were also made of the brightness temperatures of Venusian cloud tops and limb darkening phenomena. Attempts were made to correlate unusual temperature variations with photographs and measurements by other instruments to identify mountains, valleys, volcanoes, and unusual surface materials.

------- PIONEER VENUS 1, TAYLOR----------

INVESTIGATION NAME- INFRARED RADIOMETER (OIR)

NSSDC ID- 78-051A-16

INVESTIGATIVE PROGRAM
CODE EL-4/CO-OP, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY ATMOSPHERES
AERONOMY

PERSONNEL

PI - F.	TAYLOR(NLA)	NASA-JPL
OI - H.H.	AUMANN	NASA-JPL
OI - M.T.	CHAHINE	NASA-JPL
OI - C.B.	FARMER	NASA-JPL
OI - J.V.	MARTONCHIK	NASA-JPL
OI - A.P.	INGERSOLL	CALIF INST OF TECH
OI - J.T.	HOUGHTON	OXFORD U
OI - G.D.	PESKETT	CLARENDON LAB
OI - C.D.	RODGERS	OXFORD U
OI - E.J.	WILLIAMSON	CLARENDON LAB
OI - R.E.	DICKINSON	NATL CTR FOR ATMOS RES
OI - J.C.	GILLE	NATL CTR FOR ATMOS RES

BRIEF DESCRIPTION
This investigation used an 8-channel radiometer for vertical temperature sounding of the atmosphere from the cloud tops (60 km) to 150 km and for investigations of cloud morphology, including the identification of possible multiple layers and water vapor mapping. The instrument was based on the selective chopper radiometer and the pressure modulator radiometer designs flown on Nimbus satellites.

------- PIONEER VENUS PROBE LRG, BOESE----------

INVESTIGATION NAME- INFRARED RADIOMETER (LIR)

NSSDC ID- 78-078D-05

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY ATMOSPHERES
AERONOMY

PERSONNEL

PI - R.W.	BOESE	NASA-ARC
OI - J.B.	POLLACK	NASA-ARC
OI - J.H.	MILLER	NASA-ARC
OI - L.P.	GIVER	NASA-ARC

BRIEF DESCRIPTION
The objectives of this experiment were to measure the atmosphere thermal flux profile, detect cloud layers and infer their composition, and estimate the atmospheric water vapor content. This experiment used a 4-channel infrared radiometer looking down from the probe. Two internal blackbodies were used to allow absolute measurements of the flux in each channel. The instrument weighed about 2 kg and used about 3 W of power.

------- PIONEER VENUS PROBE SM1, SUOMI----------

INVESTIGATION NAME- NET FLUX RADIOMETER (SNFR)

NSSDC ID- 78-078E-04

INVESTIGATIVE PROGRAM
CODE EL-4/CO-OP, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY ATMOSPHERES
AERONOMY

PERSONNEL

PI - V.E.	SUOMI	U OF WISCONSIN
OI - J.	LENOBLE	U OF LILLE
OI - L.A.	SROMOVSKY	U OF WISCONSIN
OI - A.	FYMAT	NASA-JPL
OI - G.E.	DANIELSON	CALIF INST OF TECH
OI - M.	HERMAN	U OF LILLE

BRIEF DESCRIPTION
The objectives were to locate regions of radiative convergence and divergence as a function of altitude and to indicate the height at which solar energy is absorbed by the atmosphere. This experiment used a small net flux radiometer on the Probe targeted to the dayside of Venus to measure the net solar flux in the 0.2- to 4-micrometer region. The two Probes targeted to the nightside of the planet carried net infrared flux sensors covering the 1- to 25-micrometer region. The instrument weighed about 0.4 kg and used 2.2 W of power.

------- PIONEER VENUS PROBE SM2, SUOMI----------

INVESTIGATION NAME- NET FLUX RADIOMETER (SNFR)

NSSDC ID- 78-078F-04

INVESTIGATIVE PROGRAM
CODE EL-4/CO-OP, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY ATMOSPHERES
AERONOMY

PERSONNEL

PI - V.E.	SUOMI	U OF WISCONSIN
OI - J.	LENOBLE	U OF LILLE
OI - L.A.	SROMOVSKY	U OF WISCONSIN
OI - A.L.	FYMAT	NASA-JPL
OI - G.E.	DANIELSON	CALIF INST OF TECH
OI - M.	HERMAN	U OF LILLE

BRIEF DESCRIPTION
The objectives were to locate regions of radiative convergence and divergence as a function of altitude and to indicate the height at which solar energy is absorbed by the atmosphere. This experiment used a small net flux radiometer on the Probe targeted to the dayside of Venus to measure the net solar flux in the 0.2 to 4 micrometer region. The two Probes targeted to the nightside of the planet carried net infrared flux sensors covering the 1 to 25 micrometer region. The instrument weighed about 0.4 kg and used 2.2 W of power.

------- PIONEER VENUS PROBE SM3, SUOMI----------

INVESTIGATION NAME- NET FLUX RADIOMETER (SNFR)

NSSDC ID- 78-078G-04

INVESTIGATIVE PROGRAM
CODE EL-4/CO-OP, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY ATMOSPHERES
AERONOMY

PERSONNEL

PI - V.E.	SUOMI	U OF WISCONSIN
OI - J.	LENOBLE	U OF LILLE
OI - A.	FYMAT	NASA-JPL
OI - L.A.	SROMOVSKY	U OF WISCONSIN
OI - G.E.	DANIELSON	CALIF INST OF TECH
OI - M.	HERMAN	U OF LILLE

BRIEF DESCRIPTION
The objectives were to locate regions of radiative convergence and divergence as a function of altitude and to indicate the height at which solar energy is absorbed by the atmosphere. This experiment used a small net flux radiometer on the Probe targeted to the dayside of Venus to measure the net solar flux in the 0.2- to 4-micrometer region. The two Probes targeted to the nightside of the planet carry net infrared flux sensors covering the 1- to 25 micrometer region. The instrument weighed about 0.4 kg and used 2.2 W of power.

RADIO SCIENCE AND CELESTIAL MECHANICS

------- MARINER 2, ANDERSON----------

INVESTIGATION NAME- CELESTIAL MECHANICS

NSSDC ID- 62-041A-08 INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
CELESTIAL MECHANICS

PERSONNEL
PI - J.D. ANDERSON NASA-JPL

BRIEF DESCRIPTION
Deep Space Network tracking data from Mariner 2 were used to obtain improved measurements of the masses of Venus and the moon, the astronomical unit, and improved ephemerides of the earth and Venus. The experiment used the onboard receiver and transmitter equipment in conjunction with the Deep Space Station equipment tc obtain Doppler measurements. Data were obtained at 12-h intervals from September 5 to December 14, 1962, at 1-h intervals until December 16, and then again at 12-h intervals until January 4, 1963.

------- PIONEER VENUS 1, SHAPIRO----------

INVESTIGATION NAME- CELESTIAL MECHANICS (OCM)

NSSDC ID- 78-051A-21 INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY ATMOSPHERES
CELESTIAL MECHANICS

PERSONNEL
PI - I.I. SHAPIRO MASS INST OF TECH

BRIEF DESCRIPTION
This experiment used the S-bard and X-band radio signals for data measurements. The objectives were: (1) to model the gravity field of Venus, (2) to estimate the direction and magnitude of the Venus spin vector, (3) to bound the magnitude of (and possibly estimate) the polar motion of Venus, (4) to determine the density profile of the upper atmosphere, and (5) to determine a connection between the coordinate system of planetary ephemerides and an inertial coordinate syste reference to extragalactic radio sources.

------- MARINER 5, ESHLEMAN----------

INVESTIGATION NAME- TWO-FREQUENCY BEACON RECEIVER

NSSDC ID- 67-060A-02 INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS
SOLAR PHYSICS
IONOSPHERES AND RADIO PHYSICS

PERSONNEL
PI - V.R. ESHLEMAN STANFORD U
OI - T.A. CROFT SRI INTERNATIONAL

BRIEF DESCRIPTION
Both 423.3-MHz and the 2/17 subharmonic 49.8-MHz signals were transmitted from a 4.6-m steerable parabolic antenna at Stanford University to the two-frecuency radio receiver cn the spacecraft. The high-frequency signal served as a reference signal since its propagation time was not appreciably delayed. The low-frequency signal was delayed in proportior to the total electron content in the propagation path. On the spacecraft, a phase-locked receiver counted the beat-frequency zero crossings of the received signals to obtain measurements of phase-path differences. Differential delay of the group velccity was also observed, and these values were telemetered to the ground station. From calculated total electron content values, the ionospheric effect (up to a selected altitude obtained from other experimental techniques) car be subtracted to produce data describing the interplanetary electron content of the solar wind and its variations. The experiment operated nominally from launch to November 1967. For similar experiments coverirg other time periods, see Pioneers 6-9 (68-100A-03, 67-123A-03, 66-075A-04, and 65-105A-04). More detailed descriptions of the experiment can be found in J. Geophys. Res., v. 17, pp. 3325-3327, and in Radio Science, v. 6, pp. 55-63. NSSDC has all the data from this experiment.

------- MARINER 5, ANDERSON----------

INVESTIGATION NAME- CELESTIAL MECHANICS

NSSDC ID- 67-060A-07 INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
CELESTIAL MECHANICS

PERSONNEL
PI - J.D. ANDERSON NASA-JPL

BRIEF DESCRIPTION
Deep Space Network tracking data on Mariner 5 were used to obtain improved determinations of the masses of Venus and the moon, of the astronomical unit, and improved ephemerides of earth and Venus. The experiment used the onboard receiver and transmitter equipment in conjunction with Deep Space Station equipment to obtain Doppler measurements. The system performed well to distarces of 48.E6 km (November 5, 1967).

------- MARINER 10, HOWARD----------

INVESTIGATICN NAME- S- AND X-BAND RADIO PROPAGATION

NSSDC ID- 73-085A-02 INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
IONOSPHERES AND RADIO PHYSICS
PARTICLES AND FIELDS
PLANETARY ATMOSPHERES

PERSONNEL
PI - H.T. HOWARD STANFORD U
OI - G.S. LEVY NASA-JPL
OI - I.I. SHAPIRO MASS INST OF TECH
OI - G. FJELDBO(NLA) NASA-JPL
OI - A.J. KLIORE NASA-JPL
OI - J.D. ANDERSON NASA-JPL

BRIEF DESCRIPTION
This experiment used X- (8400 MHz) and S- (2113 MHz) band, on-board radio systems for whatever scientific purposes could be devised. Two primary approaches were made, one utilizing tracking information, the other taking advantage of radio trajectory variations associated with occultation of the earth-spacecraft signal. Tracking information was analyzed to determine mass and gravitational characteristics (including planetary internal composition and density estimates) of both Venus and Mercury. From anomalous characteristits observed in the X- and S-band signals during spacecraft passage through the planetary atmospheres just prior to, and subsequent to, occultation, temperature and pressure profiles were calculated. These profiles were useful to adjust atmospheric composition models. Signal cutoff provided useful information for determination of planetary radius.

------- PIONEER VENUS 1, KLIORE----------

INVESTIGATION NAME- RADIO OCCULTATION (OOCC)

NSSDC ID- 78-051A-20 INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY ATMOSPHERES

PERSONNEL
PI - A.J. KLIORE NASA-JPL

BRIEF DESCRIPTION
This experiment made use of the S-band and X-band radio signals for data measurements. The objectives were (1) to measure refractivity profiles, (2) to measure S- and X-band dispersion and absorption, (3) to measure electron density height profiles, and (4) to determine the dynamics of the lower atmosphere.

------- PICNEER VENUS 1, CROFT----------

INVESTIGATION NAME- GAS AND PLASMA ENVIRONMENT (OGPE)

NSSDC ID- 78-051A-03 INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
GEODESY AND CARTOGRAPHY
PLANETARY IONOSPHERES
PLANETARY ATMOSPHERES

PERSONNEL
TL - T.A. CROFT SRI INTERNATIONAL
TM - G.M. KEATING NASA-LARC
TM - A.J. KLIORE NASA-JPL
TM - R. PHILLIPS NASA-JPL
TM - I.I. SHAPIRO MASS INST OF TECH
TM - R. WOO NASA-JPL

BRIEF DESCRIPTION
This experiment used data obtained from the S-band and X-band radio signals. The objectives were (1) to determine the lateral variations in the Venusian atmosphere and ionosphere, (2) to study the solar wind microscopic flow, and (3) to analyze solar wind scintillations (scale and characteristics of the irregularities in the Venusian atmosphere).

------- PICNEER VENUS 1, PETTENGILL----------

INVESTIGATION NAME- RADAR MAPPER (ORAD)

NSSDC ID- 78-051A-02

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
GEODESY AND CARTOGRAPHY
PLANETOLOGY

PERSONNEL

PI - G. PETTENGILL		MASS INST OF TECH
OI - W.E. BROWN, JR.		NASA-JPL
OI - W.M. KAULA		U OF CALIF, LA
OI - D.H. STAELIN		MASS INST OF TECH

BRIEF DESCRIPTION
A radar altimeter was used to obtain information on the orbiter altitude, planetary surface temperature, and radar scattering properties in order to infer the surface topography, geology, and the thermal and mechanical properties of the interior of Venus. The weight of the instrument was 9.0 kg (20 lb), and the power consumption was 25 w.

------- PIONEER VENUS 1, PHILLIPS-------------------------------

INVESTIGATION NAME- INTERNAL DENSITY DISTRIBUTION (OIDD)

NSSDC ID- 78-051A-23

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETOLOGY
PLANETARY PHYSICS

PERSONNEL

PI - R.J. PHILLIPS	LUNAR & PLANETARY INST

BRIEF DESCRIPTION
This experiment used the S-band and X-band radio signals for data measurements. The objectives were (1) to determine the internal mass distribution and the physical processes that have operated to produce the distribution, (2) to determine the relationship of the surface morphology to the internal density distribution, (3) to determine the amount of isostatic compensation of the Venusian topography, and (4) to describe an evolutionary track for Venus that is consistent with the above.

ATMOSPHERE

------- PIONEER VENUS 1, BRACE---------------------------------

INVESTIGATION NAME- ELECTRON TEMPERATURE PROBE

NSSDC ID- 78-051A-01

INVESTIGATIVE PROGRAM
CODE EL-4/CO-OP, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY ATMOSPHERES
PLANETARY IONOSPHERES

PERSONNEL

PI - L.H. BRACE		NASA-GSFC
OI - M.B. MCELROY		HARVARD U
OI - A. PEDERSEN		ESA-ESTEC
OI - A.F. NAGY		U OF MICHIGAN
OI - T.M. DONAHUE		U OF MICHIGAN

BRIEF DESCRIPTION
This experiment consisted of a pair of cyclindrical Langmuir probes of the type used on the Atmospheric Explorer (AE) series. Two probes were required, so that one was always out of the wake of the spacecraft. In flight analysis, 56 measurements taken at a rate of one per second provided high spatial resolution for the measurements of Ne and Te. The results of these high-resolution measurements were used both to study the upper atmosphere and ionosphere and to investigate the interaction of the solar wind with the Venusian ionosphere. This experiment provided measurements over the whole region traversed by the orbiter, covering a large range of solar aspect angles, to yield a more complete configuration of the physical properties of the ionopause region.

------- PIONEER VENUS 1, NIEMANN-------------------------------

INVESTIGATION NAME- NEUTRAL MASS SPECTROMETER (ONMS)

NSSDC ID- 78-051A-11

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
AERONOMY
PLANETARY ATMOSPHERES

PERSONNEL

PI - H.B. NIEMANN		NASA-GSFC
OI - G.R. CARIGNAN		U OF MICHIGAN
OI - R.E. HARTLE		NASA-GSFC
OI - N.W. SPENCER		NASA-GSFC

BRIEF DESCRIPTION
The experiment used a quadrupole mass spectrometer with three ion-source operating modes and three mass-scanning modes. The ion source could be operated alternately in open and closed configurations to increase accuracy. An adaptive mass scan was used to reduce the bit rate required for a given information-return rate. The resolution was 1.E-4 for adjacent masses, and the mass range was 1 to 45 u. Vertical and horizontal density variations of the major neutral constituents of the upper atmosphere of Venus were detected and measured to define the dynamic, chemical, and thermal states of the upper atmosphere. Important constituents measured were He, O, O2, CO, CO2 and/or N2, and A. It was also possible to study H, D and/or H2, C, and NO.

------- PIONEER VENUS 2, VON ZAHN------------------------------

INVESTIGATION NAME- NEUTRAL MASS SPECTROMETER (BNMS)

NSSDC ID- 78-078A-03

INVESTIGATIVE PROGRAM
CODE EL-4/CO-OP, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY ATMOSPHERES
AERONOMY

PERSONNEL

PI - U. VON ZAHN		U OF BONN
OI - A.O.C.NIER		U OF MINNESOTA
OI - D.M. HUNTEN		U OF ARIZONA

BRIEF DESCRIPTION
This neutral particle mass spectrometer experiment obtained measurements which provided information on the origin and evolution of Venus' atmosphere, the present energy balance and dynamics of the upper atmosphere, and the interaction of the upper atmosphere with solar radiation and the interplanetary medium. A magnetic deflection, double-focusing mass spectrometer was flown to measure the upper atmosphere neutral molecules in the mass range 1 to 46 atomic mass units (u).

------- PIONEER VENUS PROBE LRG, HOFFMAN-----------------------

INVESTIGATION NAME- NEUTRAL PARTICLE MASS SPECTROMETER (LNMS)

NSSDC ID- 78-078D-06

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY ATMOSPHERES
AERONOMY

PERSONNEL

PI - J.H. HOFFMAN		U OF TEXAS, DALLAS
OI - R.R. HODGES, JR.		U OF TEXAS, DALLAS
OI - M. KOLPIN		TRW SYSTEMS GROUP
OI - M.B. MCELROY		HARVARD U
OI - T.M. DONAHUE		U OF MICHIGAN

BRIEF DESCRIPTION
The objective of this investigation was to measure the composition of the lower atmosphere of Venus. This investigation used a ceramic micro-leak gas inlet and a double-focusing magnetic deflection mass spectrometer. About 50 analyses of the Venusian atmosphere were planned during the probe descent. A separate sample of the atmosphere was analyzed for rare gasses. The analyzer had a mass range of 1 to 212 u and a dynamic range of 1.E+7. The instrument was based on a design flown previously.

------- PIONEER VENUS 1, KEATING-------------------------------

INVESTIGATION NAME- ATMOSPHERIC DRAG (OAD)

NSSDC ID- 78-051A-19

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY ATMOSPHERES

PERSONNEL

PI - G.M KEATING	NASA-LARC

BRIEF DESCRIPTION
This experiment made use of the spacecraft S-band and X-band radio signals for data measurements. The objectives were (1) to establish the diurnal variation of thermospheric density and density scale height (2) to determine the relationship of solar wind variations to variations in atmospheric density, (3) to determine the relationship of long and short term variation in solar extreme UV radiation to density variations, (4) to search for phenomena such as a semi-annual variation and super rotation of the thermosphere, and (5) to formulate a thermospheric model for the Venusian atmosphere.

------- PIONEER VENUS 2, COUNSELMAN----------

INVESTIGATION NAME- DIFFEREMTIAL LONG BASE LINE INTERFEROMETER (DLBI)

NSSDC ID- 78-078A-06

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY ATMOSPHERES
METEORCLOGY
PLANETOLOGY

PERSONNEL

PI - C.C.	COUNSELMAN	MASS INST OF TECH
OI - I.I.	SHAPIRO	MASS INST OF TECH
OI - R.G.	PRINN	MASS INST OF TECH
OI - J.	CHARNEY	MASS INST OF TECH
OI - G.	PETTENGILL	MASS INST OF TECH

BRIEF DESCRIPTION
This experiment used the Deep Space Network (DSN) telemetry signals. The objectives were to measure vector wind velocities by earth-based interferometric tracking for all four probes as they descended through the atmosphere of Venus using the bus telemetry signal as a reference. The results were combined with simultaneous temperature, pressure, thermal flux, and composition measurements from other experiments to test models of the atmospheric circulation.

------- PIONEER VENUS PROBE SM1, WOO----------

INVESTIGATION NAME- ATMOSPHERIC TURBULENCE (MTUR)

NSSDC ID- 78-078E-06

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY IONOSPHERES
RADIO PHYSICS
CELESTIAL MECHANICS
PLANETARY ATMOSPHERES

PERSONNEL

PI - R.	WOO	NASA-JPL

BRIEF DESCRIPTION
This experiment used the Deep Space Network (DSN) telemetry data. The objective was to measure and study the small-scale turbulence characteristics of the atmosphere of Venus. Information obtained included the variation of intensity of turbulence with altitude, wind velocity transverse to the line-of-sight path, and distribution of scale size in the atmosphere. These measurements contributed to an understanding of the atmosphere's circulation and dynamics.

------- PIONEER VENUS PROBE SM2, WOO----------

INVESTIGATION NAME- ATMOSPHERIC TURBULENCE (MTUR)

NSSDC ID- 78-078F-06

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY IONOSPHERES
RADIO PHYSICS
CELESTIAL MECHANICS
PLANETARY ATMOSPHERES

PERSONNEL

PI - R.	WOO	NASA-JPL

BRIEF DESCRIPTION
This experiment used the Deep Space Network (DSN) telemetry data. The objective was to measure and study the small-scale turbulence characteristics of the atmosphere of Venus. Information obtained included the variation of irtensity of turbulence with altitude, wind velocity transverse to the line-of-sight path, and distribution of scale size in the atmosphere. These measurements contributed to an understanding of the atmosphere's circulation and dynamics.

------- PIONEER VENUS PROBE SM3, WOO----------

INVESTIGATION NAME- ATMOSPHERIC TURBULENCE (MTUR)

NSSDC ID- 78-078G-06

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY IONOSPHERES
RADIO PHYSICS
CELESTIAL MECHANICS
PLANETARY ATMOSPHERES

PERSONNEL

PI - R.	WOO	NASA-JPL

BRIEF DESCRIPTION
This experiment used the Deep Space Network (DSN) telemetry data. The objective was to measure and study the small-scale turbulence characteristics of the atmosphere of venus. Information obtained included the variation of intensity of turbulence with altitude, wind velocity transverse to the line-of-sight path, and distribution of scale size in the atmosphere. These measurements contributed to an understanding of the atmosphere's circulation and dynamics.

------- PIONEER VENUS 1, WOO----------

INVESTIGATION NAME- ATMOSPHERIC AND SOLAR CORONA TURBULENCE (OTUR)

NSSDC ID- 78-051A-22

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY ATMOSPHERES

PERSONNEL

PI - R.	WOO	NASA-JPL

BRIEF DESCRIPTION
This experiment made use of the S-band and X-band radio signals for data measurements. The objectives of the experiment were to measure: (1) the intensity variation of turbulence with altitude, (2) planetary latitude and longitude, and (3) the distribution of scale sizes in the atmosphere.

------- PIONEER VENUS PROBE LRG, RAGENT----------

INVESTIGATION NAME- NEPHELOMETER (LN)

NSSDC ID- 78-078D-02

INVESTIGATIVE PROGRAM
CODE EL-4/CO-OP, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY ATMOSPHERES
AERONOMY
METEOROLOGY

PERSONNEL

PI - B.	RAGENT	NASA-ARC
PI - J.E.	BLAMONT	CNRS-SA

BRIEF DESCRIPTION
This experiment consisted of a nephelometer to measure the energy backscattered from cloud particles. It used a pulsed gallium arsenide laser diode to illuminate the clouds. The altitude history of the backscattered signal indicated the presence and vertical extent of clouds along the trajectory. Comparisons with the measurements from the small probes indicated the spatial variability of the cloud structure. The laser operated at about 9000 A. The experiment weighed about 0.5 kg and used about 1.3 W of power.

------- PIONEER VENUS PROBE SM1, RAGENT----------

INVESTIGATION NAME- NEPHELOMETER (SN)

NSSDC ID- 78-078E-02

INVESTIGATIVE PROGRAM
CODE EL-4/CO-OP, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY ATMOSPHERES
AERONOMY
METEOROLOGY

PERSONNEL

PI - B.	RAGENT	NASA-ARC
PI - J.E.	BLAMONT	CNRS-SA

BRIEF DESCRIPTION
This experiment consisted of a nephelometer to measure the energy backscattered from cloud particles. It used a pulsed gallium arsenide laser diode to illuminate the clouds. The altitude history of the backscattered signal indicated the presence and vertical extent of clouds along the trajectory. Comparisons with the measurements from the other Probes indicated the spatial variability of the cloud structure. The laser operated at about 9000 A. The experiment weighed about 0.6 kg and used about 1.3 W of power.

------- PIONEER VENUS PROBE SM2, RAGENT----------

INVESTIGATION NAME- NEPHELOMETER (SN)

NSSDC ID- 78-078F-02

INVESTIGATIVE PROGRAM
CODE EL-4/CO-OP, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY ATMOSPHERES
AERONOMY
METEOROLOGY

PERSONNEL

PI - B.	RAGENT	NASA-ARC
PI - J.E.	BLAMONT	CNRS-SA

BRIEF DESCRIPTION

This experiment consisted of a nephelometer to measure the energy backscattered from cloud particles. It used a pulsed gallium arsenide laser diode to illuminate the clouds. The altitude history of the backscattered signal indicated the presence and vertical extent of clouds along the trajectory. Comparisons with the measurements from the other Probes indicated the spatial variability of the cloud structure. The laser operated at about 9000 A. The experiment weighed about 0.6 kg and used about 1.2 W of power.

------- PIONEER VENUS PROBE SM3, RAGENT----------

INVESTIGATION NAME- NEPHELOMETER (SN)

NSSDC ID- 78-078G-02

INVESTIGATIVE PROGRAM
CODE EL-4/CO-OP, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY ATMOSPHERES
AERONOMY
METEOROLOGY

PERSONNEL

PI - B.	RAGENT	NASA-ARC
PI - J.E.	BLAMONT	CNRS-SA

BRIEF DESCRIPTION

This experiment consisted of a nephelometer to measure the energy backscattered from cloud particles. It used a pulsed gallium arsenide laser diode to illuminate the clouds. The altitude history of the backscattered signal indicated the presence and vertical extent of clouds along the trajectory. Comparisons with the measurements from the other probes indicated the spatial variability of the cloud structure. The laser operated at about 9000 A. The experiment weighed about 0.6 kg and used about 1.3 W of power.

------- PIONEER VENUS PROBE LRG, SEIFF----------

INVESTIGATION NAME- ATMOSPHERE STRUCTURE

NSSDC ID- 78-078D-01

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY ATMOSPHERES
METEOROLOGY
AERONOMY

PERSONNEL

PI - A.	SEIFF	NASA-ARC
OI - S.C.	SOMMER	NASA-ARC
OI - R.C.	BLANCHARD	NASA-LARC
OI - D.B.	KIRK	NASA-ARC
OI - R.E.	YOUNG	NASA-ARC
OI - J.S.	DERR	US GEOLOGICAL SURVEY

BRIEF DESCRIPTION

The instruments for this experiment included a three-axis accelerometer, pressure sensors, and temperature sensors. They were based on the technology demonstrated by the PAET rocket vehicle (Planetary Atmosphere Experiment Test R7106-2001). The measurements were used to construct a profile of atmosphere state properties for the large probe trajectory from the surface to approximately 140 km altitude. They were also used to determine vertical wind velocity, horizontal wind velocity, and turbulence. By comparing atmospheric conditions along the large probe trajectory with those measured by the small probes, circulation models of the atmosphere were determined. The instruments weighed about 2.5 kg and consumed about 4.7 W of power.

------- PIONEER VENUS PROBE SM1, SEIFF----------

INVESTIGATION NAME- ATMOSPHERE STRUCTURE (SAS)

NSSDC ID- 78-078E-01

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY ATMOSPHERES
METEOROLOGY
AERONOMY

PERSONNEL

PI - A.	SEIFF	NASA-ARC
OI - S.C.	SOMMER	NASA-GSFC
OI - D.B.	KIRK	NASA-ARC
OI - R.C.	BLANCHARD	NASA-LARC
OI - R.E.	YOUNG	NASA-ARC
OI - J.	DERR	US GEOLOGICAL SURVEY

BRIEF DESCRIPTION

The instruments for this experiment included a single-axis accelerometer, pressure sensors, and temperature sensors. They were based on the technology demonstrated by the PAET rocket vehicle (Planetary Atmosphere Experiment Test R 7106-2001). The measurements were used to construct a profile of atmospheric state properties for the trajectory from the surface to approximately 140 km altitude. They were also used to determine vertical wind velocity, horizontal wind velocity, and turbulence. By comparing atmospheric conditions along this trajectory with those measured by the other Probes, circulation models of the atmosphere were determined. The instruments weighed about 1.2 kg and consumed about 4.8 W of power.

------- PIONEER VENUS PROBE SM2, SEIFF----------

INVESTIGATION NAME- ATMOSPHERE STRUCTURE

NSSDC ID- 78-078F-01

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY ATMOSPHERES
METEOROLOGY
AERONOMY

PERSONNEL

PI - A.	SEIFF	NASA-ARC
OI - S.C.	SOMMER	NASA-GSFC
OI - D.B.	KIRK	NASA-ARC
OI - R.C.	BLANCHARD	NASA-LARC
OI - R.E.	YOUNG	NASA-ARC
OI - J.	DERR	US GEOLOGICAL SURVEY

BRIEF DESCRIPTION

The instruments for this experiment included a three-axis accelerometer, pressure sensors, and temperature sensors. They were based on the technology demonstrated by the PAET rocket vehicle (Planetary Atmosphere Experiment Test R 7106-2001). The measurements were used to construct a profile of atmospheric state properties for the trajectory from the surface to approximately 140 km altitude. They were also used to determine vertical wind velocity, horizontal wind velocity, and turbulence. By comparing atmospheric conditions along this trajectory with those measured by other Small Probes, circulation models of the atmosphere are determined. The instruments weighed about 1.2 kg and consumed about 3.4 W of power.

------- PIONEER VENUS PROBE SM3, SEIFF----------

INVESTIGATION NAME- ATMOSPHERE STRUCTURE

NSSDC ID- 78-078G-01

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY ATMOSPHERES

PERSONNEL

PI - A.	SEIFF	NASA-ARC
OI - S.C.	SOMMER	NASA-GSFC
OI - R.C.	BLANCHARD	NASA-LARC
OI - D.B.	KIRK	NASA-ARC
OI - R.E.	YOUNG	NASA-ARC
OI - J.	DERR	US GEOLOGICAL SURVEY

BRIEF DESCRIPTION

The instruments for this experiment included a three-axis accelerometer, pressure sensors, and temperature sensors. They were based on the technology demonstrated by the PAET rocket vehicle (Planetary Atmosphere Experiment test R 7106-2001). The measurements were used to construct a profile of atmospheric state properties for the trajectory from the surface to approximately 140 km altitude. They were also used to determine vertical wind velocity, horizontal wind velocity, and turbulence. By comparing atmospheric conditions along this trajectory with those measured by the other Probes, circulation models of the atmosphere were determined. The instruments weighed about 1.2 kg and consumed about 3.4 W of power.

------- PIONEER VENUS PROBE LRG, CROFT----------

INVESTIGATION NAME- ATMOSPHERIC PROPAGATION (MPRO)

NSSDC ID- 78-078D-11

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)

PERSONNEL

PI - T.A.	CROFT	SRI INTERNATIONAL

BRIEF DESCRIPTION

The objective of this experiment was to determine the atmospheric structure of Venus as it affected the intensity and refraction of probe telemetry signals. An investigation of the interference between the direct ray and a surface-reflected component was undertaken as means of assessing communications reliability for the design of future probe missions.

------- PIONEER VENUS PROBE SM1, CROFT-------------------------

INVESTIGATION NAME- ATMOSPHERIC PROPAGATION (MPRO)

NSSDC ID- 78-078E-07

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY IONOSPHERES
RADIO PHYSICS
CELESTIAL MECHANICS
PLANETARY ATMOSPHERES

PERSONNEL

PI -	T.A. CROFT	SRI INTERNATIONAL

BRIEF DESCRIPTION
This experiment used the Deep Space Network (DSN) telemetry data. The objectives were (1) to determine the atmospheric structure of Venus as it affects the intensity and refraction of Probe telemetry signals, and (2) to investigate the interference between the direct ray and a surface-reflected component as a means of assessing communications reliability for the design of future probe missions.

------- PIONEER VENUS PROBE SM2, CROFT-------------------------

INVESTIGATION NAME- ATMOSPHERIC PROPAGATION (MPRO)

NSSDC ID- 78-078F-07

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY IONOSPHERES
RADIO PHYSICS
CELESTIAL MECHANICS
PLANETARY ATMOSPHERES

PERSONNEL

PI -	T.A. CROFT	SRI INTERNATIONAL

BRIEF DESCRIPTION
This experiment used the Deep Space Network (DSN) telemetry data. The objectives were (1) to determine the atmospheric structure of Venus as it affects the intensity and refraction of Probe telemetry signals, and (2) to investigate the interference between the direct ray and a surface-reflected component as a means of assessing communications reliability for the design of future probe missions.

------- PIONEER VENUS PROBE SM3, CROFT-------------------------

INVESTIGATION NAME- ATMOSPHERIC PROPAGATION (MPRO)

NSSDC ID- 78-078G-07

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY IONOSPHERES
RADIO PHYSICS
CELESTIAL MECHANICS
PLANETARY ATMOSPHERES

PERSONNEL

PI -	T.A. CROFT	SRI INTERNATIONAL

BRIEF DESCRIPTION
This experiment used the Deep Space Network (DSN) telemetry data. The objectives were (1) to determine the atmospheric structure of Venus as it affects the intensity and refraction of Probe telemetry signals, and (2) to investigate the interference between the direct ray and a surface-reflected component as a means of assessing communications reliability for the design of future probe missions.

------- PIONEER VENUS PROBE LRG, COUNSELMAN--------------------

INVESTIGATION NAME- DIFFERENTIAL LONG BASELINE INTERFEROMETER (DLBI)

NSSDC ID- 78-078D-09

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY ATMOSPHERES
METEOROLOGY
AERONOMY

PERSONNEL

PI -	C.C. COUNSELMAN	MASS INST OF TECH
OI -	G. PETTENGILL	MASS INST OF TECH
OI -	I.I. SHAPIRO	MASS INST OF TECH
OI -	R.G. PRINN	MASS INST OF TECH
OI -	J. CHARNEY	MASS INST OF TECH

BRIEF DESCRIPTION
This experiment involved applying differential very-long-baseline interferometry techniques to the radio signals from the entry probe and bus in order to infer or place upper limits on wind speeds in the lower atmosphere. These results were used in modeling the circulation patterns of Venus' atmosphere. Data taken prior to probe entry were used, where feasible, to infer characteristics of Venus' gravity field for use with probe entry operations as well as in later scientific evaluation.

------- PIONEER VENUS PROBE SM1, COUNSELMAN--------------------

INVESTIGATION NAME- DIFFERENTIAL LONG BASELINE INTERFEROMETER (DLBI)

NSSDC ID- 78-078E-03

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY ATMOSPHERES
METEOROLOGY
AERONOMY

PERSONNEL

PI -	C.C. COUNSELMAN	MASS INST OF TECH
OI -	I.I. SHAPIRO	MASS INST OF TECH
OI -	R.G. PRINN	MASS INST OF TECH
OI -	J. CHARNEY	MASS INST OF TECH
OI -	G. PETTENGILL	MASS INST OF TECH

BRIEF DESCRIPTION
This experiment involved applying differential very-long-baseline interferometry techniques to the radio signals from the entry Probe and Bus in order to infer or place upper limits on wind speeds in the lower atmosphere. These results were used in modeling the circulation patterns of Venus' atmosphere. Data taken prior to Probe entry were used, where feasible, to infer characteristics of Venus' gravity field for use with Probe entry operations as well as in later scientific evaluation.

------- PIONEER VENUS PROBE SM2, COUNSELMAN--------------------

INVESTIGATION NAME- DIFFERENTIAL LONG BASELINE INTERFEROMETER (DLBI)

NSSDC ID- 78-078F-03

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY ATMOSPHERES
METEOROLOGY
AERONOMY

PERSONNEL

PI -	C.C. COUNSELMAN	MASS INST OF TECH
OI -	I.I. SHAPIRO	MASS INST OF TECH
OI -	R.G. PRINN	MASS INST OF TECH
OI -	J.G. CHARNEY	MASS INST OF TECH
OI -	G. PETTENGILL	MASS INST OF TECH

BRIEF DESCRIPTION
This experiment involved applying differential very-long-baseline interferometry techniques to the radio signals from the entry Probe and Bus in order to infer or place upper limits on wind speeds in the lower atmosphere. These results were used in modeling the circulation patterns of Venus' atmosphere. Data taken prior to Probe entry were used, where feasible, to infer characteristics of Venus' gravity field for use with Probe entry operations as well as in later scientific evaluation.

------- PIONEER VENUS PROBE SM3, COUNSELMAN--------------------

INVESTIGATION NAME- DIFFERENTIAL LONG BASELINE INTERFEROMETER (DLBI)

NSSDC ID- 78-078G-03

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY ATMOSPHERES
METEOROLOGY
AERONOMY

PERSONNEL

PI -	C.C. COUNSELMAN	MASS INST OF TECH
OI -	I.I. SHAPIRO	MASS INST OF TECH
OI -	R.G. PRINN	MASS INST OF TECH
OI -	J. CHARNEY	MASS INST OF TECH
OI -	G. PETTENGILL	MASS INST OF TECH

BRIEF DESCRIPTION
This experiment involved applying differential very-long-baseline interferometry techniques to the radio signals from the entry Probe and Bus in order to infer or place upper limits on wind speeds in the lower atmosphere. These results were used in modeling the circulation patterns of Venus' atmosphere. Data taken prior to probe entry were used, where feasible, to infer characteristics of Venus' gravity field for use with Probe entry operations as well as in later scientific evaluation.

------- PIONEER VENUS PROBE LRG, KNOLLENBERG--------------------

INVESTIGATION NAME- CLOUD PARTICLE SIZE SPECTROMETER (LCPS)

NSSDC ID- 78-078D-C3

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY ATMOSPHERES
AERONOMY

PERSONNEL

PI - R.	KNOLLENBERG	U OF CHICAGO
OI - D.M.	HUNTEN	U OF ARIZONA

BRIEF DESCRIPTION
The objective of this experiment was to measure Venus' cloud particle sizes and concentrations. A laser was used to illuminate cloud particles. Optical lenses imaged the particle shadows on arrays of detectors. The particle shadows were used to determine particle size and concentration. The flight sensor was similar to those flown in aircraft and balloons.

------- PIONEER VENUS PROBE LRG, OYAMA-------

INVESTIGATION NAME- GAS CHROMATOGRAPH (LGC)

NSSDC ID- 78-078D-C4

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY ATMOSPHERES
AERONOMY

PERSONNEL

PI - V.I.	OYAMA	NASA-ARC
OI - J.B.	POLLACK	NASA-ARC
OI - G.	CARLE	NASA-ARC
OI - F.	WOELLER	NASA-ARC

BRIEF DESCRIPTION
The objective of this experiment was to determine the composition of Venus' lower atmosphere. From these measurements, deductions were made of the gaseous sources of infrared opacity, the degree of differentiation of Venus' interior, the degree of similarity between the solid bodies of earth and Venus, and evolution of Venus' atmosphere. Two gas chromatograph columns were used to analyze samples of the atmosphere during probe descent.

------- PIONEER VENUS PROBE LRG, TOMASKO-------

INVESTIGATION NAME- SOLAR FLUX RADIOMETER (LSFR)

NSSDC ID- 78-078D-C7

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY ATMOSPHERES
AERONOMY

PERSONNEL

PI - M.G.	TOMASKO	U OF ARIZONA
OI - W.	WOLFE	U OF ARIZONA
OI - A.	CLEMENTS	U OF ARIZONA

BRIEF DESCRIPTION
The objective of this investigation was to determine the regions in Venus' atmosphere where solar energy is deposited. Six narrow-field-of-view detectors were used to measure the irtensity of scattered solar light. As the probe descended through the atmosphere, the difference between upward-looking and downward-looking detectors indicated the net downward flux.

POLARIZATION

------- PIONEER VENUS 1, HANSEN-------

INVESTIGATION NAME- CLOUD PHOTOPOLARIMETER

NSSDC ID- 78-051A-C6

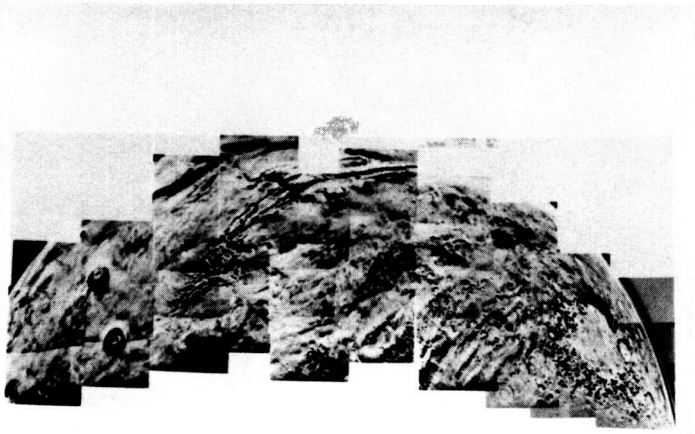
SEE THIS EXPERIMENT UNDER IMAGING

Mars

MARS

Plate 3. This is a composite of press release photographs from the Mariner 9, Vikings 1 and 2 Orbiter, and Vikings 1 and 2 Lander missions. (A) 211-5050 is a mosaic of Viking Orbiters' medium-resolution photos depicting most of one hemisphere of Mars and showing the Valles Marineris (4000-km-long canyon), the Tharsis bulge's giant volcanoes, and the very large Argyre basin. (B) P12732 is a Mariner 9 high-resolution photo of part of the Valles Marineris, discovered on this mission, showing some of the arroyos, the largest of which resembles our Grand Canyon in size and appearance. (C) 211-5248 is a mosaic from Viking Orbiter photography of Arsia Mons, one of the giant shield volcanoes on Mars. (D) P17002 is a Viking 1 Orbiter mosaic photo of the terrain near the Viking 1 Lander's site showing features that are best explained as the products from flowing water. Conditions in the past must have been different, permitting free water to form in large quantities, which is not possible at present on Mars. (E) 211-5685 is a Viking 1 Lander photo of the immediate surroundings of the spacecraft at its landing site in Chryse Planitia. Note the presence of many loose rocks, rock outcroppings, and dune-like areas. (F) P16848 is a Viking 1 Orbiter photo of Yuti, showing a type of crater unique to Mars which has an enormous, high central peak with a summit crater. The large central peak and large, multi-layered ejecta envelopes do not follow the Schroter rule for impact craters. (G) P12694 is a Mariner 9 photo of Phobos, the larger and closer of the two tiny satellites of Mars. The photo shows the moon to be irregular in shape (only 20 km long) and highly cratered. Mariner 9 was the first to obtain detailed photos of these moons. Viking Orbiter photos later revealed long grooves and crater chains on Phobos and deep dust on Deimos. (H) Viking 2 Lander photo shows the immediate surroundings of the spacecraft in the Utopia region of Mars. Note that most of the rocks have a pocked or vesicular surface and that they are quite different from those at the Lander 1 site in (E). One of the footpads landed on a rock.


C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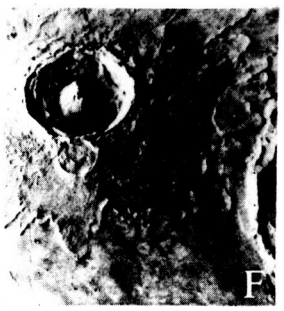
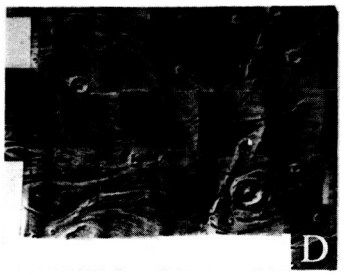
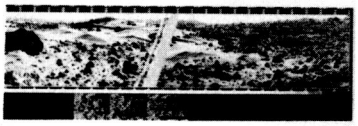

F


D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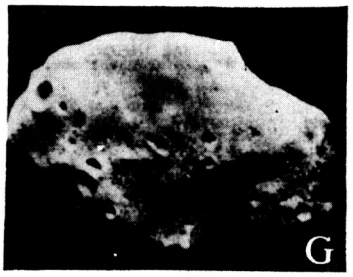
B


G


H

INTRODUCTION

Mars is the next planet out from the sun that is treated in this catalog. Six missions have been sent to Mars by the U.S. and several by the U.S.S.R., but since NSSDC has no data from the U.S.S.R. missions, they are omitted in this catalog. The last missions, Vikings 1 and 2, consisted of two spacecraft each: (1) Viking Orbiter and (2) Viking Lander. Each spacecraft is treated separately. On these missions there were 49 investigations for which NSSDC has data or sources from which data may be obtained. These investigations cover eight categories: (1) Imaging, (2) Particles and Fields, (3) Ultraviolet, (4) Infrared, (5) Radio Science and Celestial Mechanics, (6) Atmosphere, (7) Surface Chemistry, and (8) Biology. The last two categories of investigations are unique to Mars. Tables 1 and 2 and Appendix A give more details of these investigations.

********** MARINER 4**********

SPACECRAFT COMMON NAME- MARINER 4
ALTERNATE NAMES- 00942

NSSDC ID- 64-077A

LAUNCH DATE- 11/28/64 WEIGHT- 262. KG
LAUNCH SITE- CAPE CANAVERAL, UNITED STATES
LAUNCH VEHICLE- ATLAS

SPONSORING COUNTRY/AGENCY
UNITED STATES NASA-OSSA

INITIAL ORBIT PARAMETERS
ORBIT TYPE- MARS FLYBY

PERSONNEL
PM - J.N. JAMES NASA-JPL
PS - R.K. SLOAN(NLA) NASA-JPL

BRIEF DESCRIPTION
Mariner 4 was the fourth in a series of spacecraft used for planetary exploration in a flyby mode. It was designed to conduct closeup sciertific observaticns of the planet Mars and to transmit these observations to earth. Other mission objectives were to perform field and particle measurements in interplanetary space in the vicinity of Mars and to provide experience in and knowledge of the erçineering capabilities for interplanetary flights of long duration. After 7.5 months of flight, the spacecraft flew by Mars on July 14, 1965, and returned 21 pictures plus 21 lines cf picture 22. The closest approach was 9,846 km from the Martian surface. The spacecraft performed all programmed activities successfully at the proper times and returned useful data from launch until October 1965, when the distance from earth anc its antenra orientaticr temporarily halted the signal acquisition. Data acquisition resumed in late 1967 and continued until December 20, 1967.

********** MARINER 6**********

SPACECRAFT COMMON NAME- MARINER 6
ALTERNATE NAMES- PL-691E, MARINER MARS 69A
03759

NSSDC ID- 69-014A

LAUNCH DATE- 02/24/69 WEIGHT- 380. KG
LAUNCH SITE- CAPE CANAVERAL, UNITED STATES
LAUNCH VEHICLE- ATLAS

SPONSORING COUNTRY/AGENCY
UNITED STATES NASA-OSSA

INITIAL ORBIT PARAMETERS
ORBIT TYPE- MARS FLYBY

PERSONNEL
PM - H.M. SCHURMEIER NASA-JPL
PS - J.A. STALLKAMP NASA-JPL

BRIEF DESCRIPTION
Mariner 6 was the sixth in a series of spacecraft used for planetary explcration in the flyby mode. Mariner 6 was attitude stabilized in three axes (referenced to the sun and the star, Canopus). The spacecraft was solar powered and capable of continuous telemetry transmission. It was fully automatic in operation, although it could be reprogrammed frcr earth during the mission. The spacecraft was oriented entirely to planetary data acquisition, and no data were obtained during the trip to Mars or beyond Mars. Mariner 6 passed 3,431 km from Mars on July 31, 1969. The spacecraft instruments took TV images of Mars and measured the radio refractivity and UV and IR emissions of the Martian atmosphere. The mission was a success, and data frcm it were used to program Mariner 7.

********** MARINER 7**********

SPACECRAFT COMMON NAME- MARINER 7
ALTERNATE NAMES- PL-691F, MARINER MARS 69B
03837

NSSDC ID- 69-030A

LAUNCH DATE- 03/27/69 WEIGHT- 380. KG
LAUNCH SITE- CAPE CANAVERAL, UNITED STATES
LAUNCH VEHICLE- ATLAS

SPONSORING COUNTRY/AGENCY
UNITED STATES NASA-OSSA

INITIAL ORBIT PARAMETERS
ORBIT TYPE- MARS FLYBY

PERSONNEL
PM - H.M. SCHURMEIER NASA-JPL
PS - J.A. STALLKAMP NASA-JPL

BRIEF DESCRIPTION
Mariner 7 was the seventh in a series of spacecraft used for planetary exploration in the flyby mode. It was identical to the Mariner 6 spacecraft. Mariner 7 was attitude stabilized in three axes (referenced to the sun and the star, Canopus). The spacecraft was solar powered and capable of continuous telemetry transmission. It was fully automatic in operation although it could be reprogrammed from earth during the mission. The spacecraft was oriented entirely to planetary data acquisition, and no data were obtained during the trip to Mars or beycnd Mars. Mariner 7 passed 3,430 km from Mars on August 5, 1969. The spacecraft instruments took TV images of Mars and measured the radio refractivity and UV and IR emissions of the Martian atmosphere. The mission was a success.

********** MARINER 9**********

SPACECRAFT COMMON NAME- MARINER 9
ALTERNATE NAMES- MARINER-I, MARINER MARS 71
MARIN-I, PL-7128
05261

NSSDC ID- 71-051A

LAUNCH DATE- 05/30/71 WEIGHT- 907. KG
LAUNCH SITE- CAPE CANAVERAL, UNITED STATES
LAUNCH VEHICLE- ATLAS-CENT

SPONSORING COUNTRY/AGENCY
UNITED STATES NASA-OSSA

INITIAL ORBIT PARAMETERS
ORBIT TYPE- AREOCENTRIC EPOCH DATE- 11/14/71
ORBIT PERIOD- 754. MIN INCLINATION- 64.4 DEG
PERIAPSIS- 1387. KM ALT APOAPSIS- 16000. KM ALT

PERSONNEL
PM - D. SCHNEIDERMAN NASA-JPL
PS - R.H. STEINBACHER NASA-JPL

BRIEF DESCRIPTION
The Mariner Mars 71 mission was planned to consist of two spacecraft on complementary missions, but due to the failure of Mariner 8 to launch properly, only one spacecraft was available. Mariner 9 combined mission objectives of both Mariner 8 (mapping 70 % of the Martian surface) and Mariner 9 (a study of temporal changes in the Martian atmosphere and on the Martian surface). For the survey portion of the mission, the planetary surface was to be mapped with the same resolution as planned fcr the original mission, although the resolution of pictures of the polar regions would be decreased due to the increased slant range. The variable features experiments were changed from studies of six given areas every 5 days to studies of smaller regions every 17 days. Mariner 9 arrived at Mars on November 14, 1971. The spacecraft gathered data on the atmospheric composition, density, pressure, and temperature and also the surface composition, temperature, and topography of Mars. After depleting its supply of attitude control gas, the spacecraft was turned off October 27, 1972.

********** VIKING 1 ORBITER**********

SPACECRAFT COMMON NAME- VIKING 1 ORBITER
ALTERNATE NAMES- PL-733B, VIKING-B ORBITER
VIKNG-B

NSSDC ID- 75-075A

LAUNCH DATE- 08/20/75 WEIGHT- 1170. KG
LAUNCH SITE- CAPE CANAVERAL, UNITED STATES
LAUNCH VEHICLE- TITAN

SPONSORING COUNTRY/AGENCY
UNITED STATES NASA-OSSA

ORBIT PARAMETERS
ORBIT TYPE- AREOCENTRIC EPOCH DATE- 06/21/76
ORBIT PERIOD- 1479. MIN INCLINATION- 37.9 DEG
PERIAPSIS- 1513. KM ALT APOAPSIS- 32600. KM ALT

PERSONNEL
PM - J.S. MARTIN(NLA) NASA-JPL
PS - G.A. SOFFEN(NLA) NASA-LARC

BRIEF DESCRIPTION
The Viking spacecraft consisted of an orbiter and a lander. The lander separated from the orbiter, entered the Martian atmosphere, and soft-landed July 20, 1976. Scientific data were collected and transmitted to Earth from the lander during entry and while it was on the surface, and from the orbiter before and after lander separation. The orbiter was a solar-cell-powered satellite stabilized in three axes using inertial and celestial references. There was a 500-W power capacity for the orbiter. It carried instruments for conducting imaging, atmospheric water vapor, thermal mapping, and radio science investigations. The scientific and photographic analysis instruments had a mass of approximately

72 kg (158 lb). The orbiter was an octagon approximately 2.5 m across. The eight sides of the ring-like structure were .457 m high and were alternately 1.4 and 0.6 wide. The Viking Orbiter 1 operations were terminated on September 30, 1980. Experiment operations were terminated on August 7, 1980. For a detailed description of the Viking mission and experiments, see "Scientific Results of the Viking Project," J. Geophys. Res., v. 82, n. 28, 1977.

********** VIKING 2 ORBITER**********

SPACECRAFT COMMON NAME- VIKING 2 ORBITER
ALTERNATE NAMES- PL-733A, VIKG-A
VIKING-A ORBITER

NSSDC ID- 75-083A

LAUNCH DATE- 09/09/75 WEIGHT- 1092. KG
LAUNCH SITE- CAPE CANAVERAL, UNITED STATES
LAUNCH VEHICLE- TITAN

SPONSORING COUNTRY/AGENCY
UNITED STATES NASA-OSSA

ORBIT PARAMETERS
ORBIT TYPE- AREOCENTRIC EPOCH DATE- 08/09/76
ORBIT PERIOD- 1639. MIN INCLINATION- 55.2 DEG
PERIAPSIS- 1499. KM ALT APOAPSIS- 35800. KM ALT

PERSONNEL
PM - J.S. MARTIN(NLA) NASA-JPL
PS - G.A. SOFFEN(NLA) NASA-LARC

BRIEF DESCRIPTION
The Viking spacecraft consisted of an orbiter and a lander. The lander separated from the orbiter, entered the Martian atmosphere, and soft-landed September 3, 1976. Scientific data were collected and transmitted to Earth from the lander during entry and while it was on the surface, and from the orbiter before and after lander separation. The orbiter was a solar-cell-powered satellite stabilized in three axes using inertial and celestial references. There was a 500-W power capacity for the orbiter. It carried instruments for conducting imaging, atmospheric water vapor, thermal mapping, and radio science investigations. The scientific and photographic analysis instruments had a mass of approximately 72 kg (158 lb). Because of the loss of attitude fuel, the transmitters and experiments were turned off July 25, 1978. The orbiter was an octagon approximately 2.5 m across. The eight sides of the ring-like structure were .457 m high and were alternately 1.4 and 0.6 wide. For a detailed description of the Viking mission and experiments, see "Scientific Results of the Viking Project," J. Geophys. Res., v. 82, n. 28, 1977.

********** VIKING 1 LANDER**********

SPACECRAFT COMMON NAME- VIKING 1 LANDER
ALTERNATE NAMES- VIKING-B LANDER

NSSDC ID- 75-075C

LAUNCH DATE- 08/20/75 WEIGHT- 605. KG
LAUNCH SITE- CAPE CANAVERAL, UNITED STATES
LAUNCH VEHICLE- TITAN

SPONSORING COUNTRY/AGENCY
UNITED STATES NASA-OSSA

INITIAL ORBIT PARAMETERS
ORBIT TYPE- MARS LANDER

PERSONNEL
PM - J.S. MARTIN(NLA) NASA-JPL
PS - G.A. SOFFEN(NLA) NASA-LARC

BRIEF DESCRIPTION
This spacecraft was the landing vehicle for the two-part spacecraft mission. It soft-landed on July 20, 1976, in the Chryse region of Mars at 22.27 deg N latitude and 47.94 deg W longitude. The lander carried instruments to study the biology, chemical composition (organic and inorganic), meteorology, seismology, magnetic properties, surface appearance, and physical properties of the Martian surface and atmosphere. The lander had a 70-W power capacity and a scientific payload of approximately 91 kg (200 lb). Some of the data collected were returned by direct radio link to earth, but most of the data were returned by relay through one of the orbiters. The lander was approximately 3 m across and about 2 m high. For a detailed description of the Viking mission and experiments see "Scientific Results of the Viking Project," J. Geophys. Res., v. 82, n. 28, 1977.

********** VIKING 2 LANDER**********

SPACECRAFT COMMON NAME- VIKING 2 LANDER
ALTERNATE NAMES- VIKING-A LANDER

NSSDC ID- 75-083C

LAUNCH DATE- 09/09/75 WEIGHT- 598. KG
LAUNCH SITE- CAPE CANAVERAL, UNITED STATES
LAUNCH VEHICLE- TITAN

SPONSORING COUNTRY/AGENCY
UNITED STATES NASA-OSSA

INITIAL ORBIT PARAMETERS
ORBIT TYPE- MARS LANDER

PERSONNEL
PM - J.S. MARTIN(NLA) NASA-JPL
PS - G.A. SOFFEN(NLA) NASA-LARC

BRIEF DESCRIPTION
This spacecraft was the landing vehicle for the two-part spacecraft mission. It soft-landed on September 3, 1976, in the Utopia region of Mars at 47.67 deg N latitude and 225.71 deg W longitude. The lander carried instruments to study the biology, chemical composition (organic and inorganic), meteorology, seismology, magnetic properties, surface appearance, and physical properties of the Martian surface and atmosphere. The lander had a 70-W power capacity and a scientific payload of approximately 91 kg (200 lb). Some of the data collected were returned by direct radio link to earth, but most of the data were returned by relay through one of the orbiters. The lander was approximately 3 m across and about 2 m high. The Viking Lander 2 ceased operating on April 11, 1980. For a detailed description of the Viking mission and experiments see "Scientific Results of the Viking Project," J. Geophys. Res., v. 82, n. 28, 1977.

INVESTIGATIONS

IMAGING

------- MARINER 4, LEIGHTON-------

INVESTIGATION NAME- MARS TV CAMERA

NSSDC ID- 64-077A-01 INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETOLOGY

PERSONNEL
PI - R.B. LEIGHTON CALIF INST OF TECH

BRIEF DESCRIPTION
The Mars television experiment was designed to obtain photographs of the Martian surface and telemeter them to earth. The TV subsystem consisted of (1) a Cassegrain narrow-angle reflecting telescope with a 38.5-cm effective focal length and a 1.05- by 1.05-deg field of view, (2) a shutter and filter assembly that had 0.08- and 0.20-s exposure times and used red and green filters, (3) a slow scan vidicon tube, with a 0.22- by 0.22-in. sq target, which translated the optical image into an electrical video signal, and (4) related electronics including a TV data encoder. On July 14, 1965, at 0018 UT, the picture recording sequence commenced. Vidicon output underwent analog-to-digital conversion and data were stored at 240,000 bits per picture on a two-track, 1/4-in., 330-ft long, magnetic tape loop on the spacecraft. Two of every three pictures taken were recorded on the tape, resulting in a chain of pairs of overlapping, alternately filtered pictures extending across the disk of Mars. Data were transmitted after occultation of the spacecraft by Mars by the radio subsystem from July 15 to 24, 1965, and were processed in real time by a 7044/7094 system to format magnetic tapes of the image data for processing by the Ranger television processing programs and for conversion to a film record. Conversion from electrical signals to an optical image was performed by the video-to-film recorder using 64 shades. The experiment yielded 21 pictures plus 21 lines of picture 22. This performance indicated a normal recording sequence. Computer processing programs yielded photographs with greater contrast than the raw image data. A detailed description of the television experiment, data processing, and the various versions of the photography can be found in the JPL "Mariner Mars 1964 Project Report, Television Experiment, Part I, Investigators' Report," of the Mariner IV Pictures of Mars, TR 32-884, 1967.

------- MARINER 6, LEIGHTON-------

INVESTIGATION NAME- MARS TV CAMERA

NSSDC ID- 69-014A-01 INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETOLOGY

PERSONNEL

PI - R.B.	LEIGHTON	CALIF INST OF TECH

BRIEF DESCRIPTION

Two television cameras, one of medium resolution (wide angle) and the other of high resolution (narrow angle), were part of the Mariner 6 scientific instrumentation. The wide-angle camera, which had a field of view of 11 deg by 14 deg and a focal length of 50 mm, encompassed 100 times more surface area than the narrow-angle camera and was used only for near-encounter pictures. The narrow-angle camera, which was used for both near- and far-encounter pictures, had a focal length of 508 mm and provided 10 times the linear resolution of the wide-angle camera. Camera shutters were alternated and timed to provide overlapping of the wide-angle and narrow-angle pictures, providing 75 pictures from the two systems (25 near-encounter and 50 far-encounter). The near-encounter pictures were taken between 13 min 59 s before encounter and 2 min 55 s after encounter along a track that crossed the equatorial zones of the planet and included many known light and dark features of the Martian surface. The far-encounter pictures were obtained in two series of operations. In the first series, 33 pictures were obtained between 48 h and 28 h before encounter. In the second series, 17 pictures were obtained between 22 h and 7 h from closest approach. The picture data were encoded and recorded within the onboard television and data storage subsystems. For each picture produced by the cameras, three separate encoded versions were transmitted to earth -- a composite analog video (CAV) picture, a digital video (DV) picture, and an every twenty-eighth (ETE) digital picture. Video reconstruction consisted of combining the three data streams (CAV, DV, and ETE). This generated video data as they existed coming out of the camera heads. The telemetered video magnetic tapes were displayed on a CRT and photographed on 70-mm film to produce the raw images. They were also digitally processed by an IBM 360/44 computer for enhancement and by an IBM 360/75 for noise removal to obtain the versions contained in data sets -01C through -01H. Detailed information on the digital processing procedures can be found in "Digital Processing of the Mariner 6 and 7 pictures," T. C. Rindfleish et al, J. Geophys. Res., v. 76, p. 394-417, January 1971. Accurate trajectory and related geometrical data can be found in Mariner Mars 1969 Simulated TV Pictures (Final), J. K. Campbell, 1970, which was issued by JPL.

------- MARINER 7, LEIGHTON----------

INVESTIGATION NAME- MARS TV CAMERA

NSSDC ID- 69-030A-01

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETOLOGY

PERSONNEL

PI - R.B.	LEIGHTON	CALIF INST OF TECH

BRIEF DESCRIPTION

Two television vidicon cameras, one of medium resolution (wide angle) and the other of high resolution (narrow angle), were part of the Mariner 7 scientific instrumentation. The wide-angle camera, which had a FOV of 11 deg by 14 deg and a focal length of 50 mm, encompassed 100 times more surface area than the narrow-angle camera and was used only for near-encounter pictures. The narrow-angle camera, which was used for both near- and far-encounter pictures, had a focal length of 508 mm and provided 10 times the linear resolution of the wide-angle camera. Camera shutters were alternated and timed to provide overlapping of the wide-angle and narrow-angle pictures, providing 126 pictures from the two systems (33 near-encounter and 93 far-encounter). The near-encounter pictures were taken between 20 min 26 s before closest approach and 2 min 6 s after closest approach along a roughly north-south course that intersected the Mariner 6 track and included the Martian south polar cap. The far-encounter pictures were obtained in three series of operations between 68 h and 5 h before closest approach. Two fractional pictures were obtained at the end of the first two series. The picture data were encoded and recorded within the onboard television and data storage subsystems. For each picture produced by the cameras three separate encoded versions were transmitted to earth: a composite analog video (CAV) picture, a digital video (DV) picture, and an every twenty-eighth (ETE) digital picture. Video reconstruction consisted of combining the three data streams (CAV, DV, and ETE). This generated video data as they existed coming out of the camera heads. The telemetered video magnetic tapes were displayed on a CRT and photographed on 70-mm film to produce the raw images. They were also digitally processed by an IBM 360/44 computer for enhancement and by an IBM 360/75 for noise removal to obtain the versions contained in data sets -01C through -01H. Detailed information on the digital processing procedures can be found in "Digital Processing of the Mariner 6 and 7 Pictures," T. C. Rindfleish et al., J. Geophys. Res., v. 76, pp. 394-417, January 1971. Accurate trajectory and related geometrical data can be found in Mariner Mars 1969 Simulated TV Pictures (Final), J. K. Campbell, 1970, which was issued by JPL.

------- MARINER 9, MASURSKY----------

INVESTIGATION NAME- TELEVISION PHOTOGRAPHY

NSSDC ID- 71-051A-04

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETOLOGY

PERSONNEL

PI - H.	MASURSKY	US GEOLOGICAL SURVEY
OI - G.	DE VAUCOULEURS	U OF TEXAS, AUSTIN
OI - J.	LEDERBERG	STANFORD U
OI - W.	THOMPSON	BELLCOMM, INC

BRIEF DESCRIPTION

This experiment consisted of a 2-in. vidicon television camera which transmitted photography from Mars. It was a photometrically calibrated instrument providing overlapping, selectively filtered, low-resolution pictures and broadband (unfiltered) high-resolution pictures, each nested in a low-resolution overlap. Both types of pictures had approximately a 700- by 380-element format, and an order-of-magnitude difference in resolution between them. Resolution of 500 m/TV line and 50 m/TV line resulted from low (11 deg by 14 deg) and high (1.1 deg by 1.4 deg) resolution pictures taken at a periapsis altitude of 2000 km. The official ordering system of identification of pictures was by a 9-digit number called Data Automation Set (DAS) which is chronological and a kind of time. More than 7,300 pictures of the Martian surface, the Martian satellites, Saturn, and star fields were acquired during the mission. A variety of picture enhancement techniques had been applied to the original data resulting in more than 30,000 photographs being available through NSSDC. These different versions of the original imagery were processed using the Mission Test Video System (MTVS) and the Image Processing Laboratory (IPL) at JPL.

------- VIKING 1 ORBITER, CARR----------

INVESTIGATION NAME- ORBITER IMAGING

NSSDC ID- 75-075A-01

INVESTIGATIVE PROGRAM
CODE EL-4/CO-OP, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY ATMOSPHERES
PLANETOLOGY

PERSONNEL

TL - M.H.	CARR	US GEOLOGICAL SURVEY
TM - W.A.	BAUM	LOWELL OBSERVATORY
TM - H.	MASURSKY	US GEOLOGICAL SURVEY
TM - G.A.	BRIGGS	NASA HEADQUARTERS
TM - J.A.	CUTTS	SCIENCE APPL, INC
TM - T.C.	DUXBURY	NASA-JPL
TM - K.R.	BLASIUS	SCIENCE APPL, INC
TM - R.	GREELEY	ARIZONA STATE U
TM - J.E.	GUEST	U OF LONDON
TM - K.A.	HOWARD	US GEOLOGICAL SURVEY
TM - B.A.	SMITH	U OF ARIZONA
TM - L.A.	SODERBLOM	US GEOLOGICAL SURVEY
TM - J.	VEVERKA	CORNELL U
TM - J.B.	WELLMAN	NASA-JPL

BRIEF DESCRIPTION

The Viking visual imaging subsystem (VIS) consisted of twin high-resolution, slow-scan television framing cameras mounted on the scan platform of each orbiter with the optical axes offset by 1.38 deg. Each of the two identical cameras on each orbiter had a 475-mm focal length telescope; a 37-mm diameter vidicon, the central section of which was scanned in a raster format of 1056 lines by 1182 samples; and six color filters to restrict the spectral bandpass of an image to limited portions of the near-visual response characteristics. Each field of view was 1.54 deg x 1.69 deg with each picture element (pixel) subtending 25 microradians. The slight offset of the optical axes and the alternate shuttering mode of operation (the interval between frames being 4.48 s) provided overlapping, wide-swath coverage of the surface. Individual images are identified by picture number (PICNO), which is a unique identifier of the scene. Elements of the PICNO are as follows: the first three digits denote the revolution (REV) during which the image was shuttered; the letter A is Viking Orbiter 1, B is Viking Orbiter 2; and the last two digits are the frame number. Operation of this experiment was terminated on August 7, 1980.

------- VIKING 2 ORBITER, CARR----------

INVESTIGATION NAME- ORBITER IMAGING

NSSDC ID- 75-083A-01

INVESTIGATIVE PROGRAM
CODE EL-4/CO-OP, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY ATMOSPHERES
PLANETOLOGY

PERSONNEL

TL - M.H.	CARR	US GEOLOGICAL SURVEY
TM - W.A.	BAUM	LOWELL OBSERVATORY
TM - H.	MASURSKY	US GEOLOGICAL SURVEY
TM - G.A.	BRIGGS	NASA HEADQUARTERS
TM - J.A.	CUTTS	SCIENCE APPL, INC
TM - T.C.	DUXBURY	NASA-JPL
TM - K.R.	BLASIUS	SCIENCE APPL, INC
TM - R.	GREELEY	ARIZONA STATE U
TM - J.E.	GUEST	U OF LONDON
TM - K.A.	HOWARD	US GEOLOGICAL SURVEY
TM - B.A.	SMITH	U OF ARIZONA
TM - L.A.	SODERBLOM	US GEOLOGICAL SURVEY
TM - J.	VEVERKA	CORNELL U
TM - J.B.	WELLMAN	NASA-JPL

BRIEF DESCRIPTION

The Viking visual imaging subsystem (VIS) consisted of twin high-resolution, slow-scan television framing cameras mounted on the scan platform of each orbiter with the optical axes offset by 1.38 deg. Each of the two identical cameras on each orbiter had a 475-mm focal length telescope; a 57-mm diameter vidicon, the central section of which was scanned in a raster format of 1056 lines by 1182 samples; and six color filters to restrict the spectral bandpass of an image to limited portions of the cameras' near-visual response characteristics. Each field of view was 1.54 deg x 1.69 deg with each picture element (pixel) subtending 25 microradians. The slight offset of the optical axes and the alternate shuttering mode of operation (the interval between frames being 4.48 s) provided overlapping, wide-swath coverage of the surface. Individual images are identified by picture number (PICNO), which is a unique identifier of the scene. Elements of the PICNO are as follows: the first three digits denote the revolution (REV) during which the image was shuttered; letter A is Viking Orbiter 1, B is Viking Orbiter 2; and the last two digits are the frame number.

------- *VIKING 1 LANDER, MUTCH*----------

INVESTIGATION NAME- LANDER IMAGING

NSSDC ID- 75-075C-06

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY ATMOSPHERES
METEOROLOGY
PLANETOLOGY

PERSONNEL

TL - T.A.	MUTCH(DECEASED)	NASA HEADQUARTERS
TM - C.	SAGAN	CORNELL U
TM - A.B.	BINDER	U OF KIEL
TM - E.C.	MORRIS	US GEOLOGICAL SURVEY
TM - F.O.	HUCK	NASA-LARC
TM - E.C.	LEVINTHAL	NUCLEAR REGULATORY COM
TM - S.	LIEBES, JR.	STANFORD U
TM - J.B.	POLLACK	NASA-ARC
TM - R.E.	ARVIDSON	WASHINGTON U

BRIEF DESCRIPTION

The lander imaging experiment viewed the scene surrounding the lander, the surface sampler and other parts of the lander, the sun, Phobos, and Deimos to provide data for operational purposes and for geological and meteorological investigations. Two scanning cameras, capable of resolving 0.04 deg (high-resolution) or 0.12 deg (low-resolution, color, and IR) were used on each lander. Each image acquired covered a vertical field of 20 deg (high-resolution) or 60 deg (low-resolution, color, and IR) and a horizontal field that was commandable from 2.5 deg to 342.5 deg in 2.5-deg increments. Images were acquired from 40 deg above the nominal horizon to 60 deg below, and were commandable in 10-deg increments. The cameras were mounted 1.3 m above the nominal landing plane and were capable of viewing two footpads and most of the area accessible to the surface sampler. The two cameras were separated by 0.8 m, and stereoscopic pictures were obtained over most of the scene. Black-and-white images in either low or high resolution included radiation wavelengths from 0.4 to 1.1 micrometers. The use of a single detector to image an entire frame allowed a relative radiometric accuracy of plus or minus 10 percent. For more information concerning the cameras, see Huck et al., Space Science Instrumentation, v. 1, p. 189-214, 1975.

------- VIKING 2 LANDER, MUTCH----------

INVESTIGATION NAME- LANDER IMAGING

NSSDC ID- 75-083C-06

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY ATMOSPHERES
METEOROLOGY
PLANETOLOGY

PERSONNEL

TL - T.A.	MUTCH(DECEASED)	NASA HEADQUARTERS
TM - C.	SAGAN	CORNELL U
TM - A.B.	BINDER	U OF KIEL
TP - E.C.	MORRIS	US GEOLOGICAL SURVEY
TM - F.O.	HUCK	NASA-LARC
TM - E.C.	LEVINTHAL	NUCLEAR REGULATORY COM
TM - S.	LIEBES, JR.	STANFORD U
TM - J.B.	POLLACK	NASA-ARC
TM - R.E.	ARVIDSON	WASHINGTON U

BRIEF DESCRIPTION

The lander imaging experiment viewed the scene surrounding the lander, the surface sampler and other parts of the lander, the sun, Deimos, and Phobos to provide data for operational purposes and for geological and meteorological investigations. Two scanning cameras, capable of resolving 0.04 deg (high-resolution) or 0.12 deg (low-resolution, color, and IR) were used on each lander. Each image acquired covered a vertical field of 20 deg (high-resolution) or 60 deg (low-resolution, color, and IR) and a horizontal field that was commandable from 2.5 deg to 342.5 deg in 2.5-deg increments. Images were acquired from 40 deg above the nominal horizon to 60 deg below, and were commandable in 10-deg increments. The cameras were mounted 1.3 m above the nominal landing plane and were capable of viewing two footpads and most of the area accessible to the surface sampler. The two cameras were separated by 0.8 m, and stereoscopic pictures were obtained over most of the scene. Black-and-white images in either low or high resolution included radiation wavelengths from 0.4 to 1.1 micrometers. The use of a single detector to image an entire frame allowed a relative radiometric accuracy of plus or minus 10 %. For more information concerning the cameras, see Huck et al., Space Science Instrumentation, v. 1, pp. 189-241, 1975.

PARTICLES AND FIELDS

------- MARINER 4, SMITH----------

INVESTIGATION NAME- HELIUM MAGNETOMETER

NSSDC ID- 64-077A-02

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS
INTERPLANETARY PHYSICS

PERSONNEL

PI - E.J.	SMITH	NASA-JPL

BRIEF DESCRIPTION

A vector low-field helium magnetometer, not to be confused with the rubidium vapor or helium vapor magnetometer, was used to measure the interplanetary magnetic field. The three components of the field were measured essentially simultaneously but later transmitted sequentially. Each observation represented an average over approximately 1 s. The response dropped 3 dB for frequencies of 1 Hz, and higher frequency information was essentially lost. In each data frame, four vector measurements were made separated by intervals of 1.5, 0.9, and 2.4 s. The whole frame was repeated every 12.5 s. There was an uncertainty of plus or minus 0.35 nT per component. NSSDC has all the data from this experiment. Most of the data from this investigation was of the interplanetary region, but some data were obtained at Mars.

ULTRAVIOLET

------- MARINER 6, BARTH----------

INVESTIGATION NAME- UV SPECTROMETER

NSSDC ID- 69-014A-04

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY ATMOSPHERES

PERSONNEL

PI - C.A.	BARTH	U OF COLORADO
OI - C.W.	HORD	U OF COLORADO
OI - J.B.	PEARCE	RADIOPHYSICS, INC

BRIEF DESCRIPTION

Spectral measurements were made of the UV radiation emitted from the Martian atmosphere due to resonance scattering of solar radiation from the upper atmosphere, resonance reradiation, fluorescence, and photoelectron excitation of neutral and ionic constituents found in the lower part of the atmosphere. The following parameters were determined: the presence of certain atoms, ions and molecules in the upper and lower atmosphere, their respective scale heights, the degree of atmospheric Rayleigh scattering due to carbon dioxide, and surface reflectivity in the UV. The instrument was an

Ebert-Fastie scanning monochromator with dual photomultiplier detectors, used in the focal plane of a reflecting planetary coronograph. Incoming light passed through a baffled light shade and struck the primary telescope mirror, which focused the light through a preslit onto a secondary mirror. From there, the light was focused onto the entrance slit of the spectrometer. Entering the spectrometer, the radiation was collimated by the first half of the Ebert mirror onto a diffraction grating. Diffracted light was then focused onto exit slits by the second half of the Ebert mirror. A separate exit slit was provided for each of the two detectors. The position of the spectral images with respect to the exit slits was controlled by cyclically scanning the grating, with a scan from low- to high-wavelength taking 2.82 s, and the grating return taking 0.18 s. The wavelength region from 1900 A to 4300 A was covered in first order as seen by one of the two slits, and the range from 1100 A to 2100 A measured in second order by the other. The photomultiplier detector used for the long-wavelength range operated in two gain modes, so that valid measurements could be made over the entire dynamic range from 100 to 10,000 Rayleighs. The spectral resolution of the instrument was 20 A at 2950 A in first order. A spectrum was produced every 3 s, and contained 600 values from each of the two detectors. Thirty-six values were used as fiducial period measurements and 564 for spectral measurements. Measurements of Lyman-alpha raciation at 1216 A were also taken after encounter. Less than 30 min of data were obtained from both channels during the Mariner 6 near-encounter equatorial scan on July 31, 1969. The quality of the data was comparable to the best obtained by rockets in the 130-km-and-above region of the earth's atmosphere. More experiment details can be found in, "Mariner 6 and 7 Ultraviolet Spectrometers," J. B. Pearce, et al., Applied Optics, v. 10, n. 4, April 1971.

------- MARINER 7, BARTH----------

INVESTIGATION NAME- UV SPECTROMETER

NSSDC ID- 69-030A-04 INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY ATMOSPHERES

PERSONNEL

PI - C.A.	BARTH	U OF COLORADO
OI - C.W.	HORD	U OF COLORADO
OI - J.B.	PEARCE	RADIOPHYSICS, INC

BRIEF DESCRIPTION

Spectral measurements were made of the UV radiation emitted from the Martian atmosphere due to resonance scattering of solar radiation from the upper atmosphere, resonance reradiation, fluorescence, and photoelectron excitation of neutral and ionic constituents found in the lower part of the atmosphere. The following parameters were determined: the presence of certain atoms, ions and molecules in the upper and lower atmosphere, their respective scale heights, the degree of atmospheric Rayleigh scattering due to carbon dioxide, and surface reflectivity in the UV. The instrument was an Ebert-Fastie scanning monochromator with dual photomultiplier detectors used in the focal plane of a reflecting planetary coronograph. Incoming light passed through a baffled light shade and struck a primary telescope mirror that focused the light through a pre-slit onto a secondary mirror. From there, the light was focused onto the entrance slit of the spectrometer. Entering the spectrometer, the radiation was collimated by the first half of the Ebert mirror onto a diffraction grating. Diffracted light was then focused onto exit slits by the second half of the Ebert mirror. A separate exit slit was provided for each of the two detectors. The position of the spectral images with respect to the exit slits was controlled by cyclically scanning the grating, with a scan from low- to high-wavelength taking 2.82 s, and the grating return taking 0.18 s. The wavelength region from 1900 A to 4300 A was covered in first order as seen by one of the two slits, and the range from 1100 A to 2100 A measured in second order by the other. The photomultiplier detector used for the long-wavelength range operated in two gain modes so that valid measurements could be made over the entire dynamic range from 100 to 10,000 Rayleighs. The spectral resolution of the instrument was 20 A at 2950 A in first order. A spectrum was produced every 3 s, and contained 600 values from each of the two detectors. Thirty-six values were used as fiducial period measurements and 564 for spectral measurements. Measurements of Lyman-alpha radiation at 1216 A were also taken away from encounter. Less than 30 minutes of data were obtained from both channels during the Mariner 7 near-encounter scan of high latitude and polar regions in the Martian southern hemisphere on August 5, 1969. The quality of the data was comparable to the best obtained by sounding rockets in the 130-km and above region of the earth's atmosphere. Additional experiment details can be found in "Mariner 6 and 7 Ultraviolet Spectrometers," J. B. Pearce, et al., Applied Optics, v. 10, n. 4, April 1971.

------- MARINER 9, BARTH----------

INVESTIGATION NAME- ULTRAVIOLET SPECTROMETER (UVS)

NSSDC ID- 71-051A-02 INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETOLOGY
PLANETARY ATMOSPHERES

PERSONNEL

PI - C.A.	BARTH	U OF COLORADO
OI - J.B.	PEARCE	RADIOPHYSICS, INC
OI - C.W.	HORD	U OF COLORADO

BRIEF DESCRIPTION

The Mariner 9 ultraviolet spectrometer (UVS) experiment was designed to receive UV radiation (1100 to 3520 A) from the surface and atmosphere of Mars, scan selected bands of this radiation, and provide an intensity value as a function of wavelength on the basis of scan-cycle time. The scientific objectives of this experiment fell into two broad categories, UV cartography and UV aeronomy. The UV cartography involved measurements in the UV of the (1) local atmospheric pressure over the major portion of the planet, (2) local ozone concentration, (3) wave of darkening, (4) variability of surface features, (5) yellow clouds, blue haze, and blue clearing, and (6) local variations in the oxygen-ozone abundances for detecting signs of biological activity. The UV aeronomy involved measurements in the UV of the (1) composition and structure of the upper atmosphere as a function of latitude, longitude, and time, (2) variability of the rate of escape of atomic hydrogen from the exosphere, and (3) distribution and variability of the UV aurora and determination of the induced planetary magnetic field. In addition, when Mars was occulted from the instrument FOV, observations of strong stellar sources of UV were made. The optics and sensing portion of the UVS consisted of an Ebert grating spectrometer with two exit slits, a light baffle, an occulting slit telescope, and two photomultiplier tube (PMT) light sensors. The incident UV radiation passed through the baffling system, which eliminated any stray light, and entered into the telescope. The telescope primary mirror reflected the radiation to a secondary mirror through a preslit where it was focused onto the entrance slit of the Ebert spectrometer, which isolated monochromatic radiation from the incoming radiation. The radiation from the entrance slit filled half the Ebert mirror where it was collimated and reflected onto the grating (2160 lines/mm) so that the radiation filled the grating. The grating rotated over a small angle by means of a cam-follower drive and diffracted the radiation. Diffracted radiation of different wavelengths, depending on the grating angle, fell on the other half of the Ebert mirror, which focused it onto the two exit slits, thus providing the wavelength scan. The two photomultiplier tubes sensed radiation from their respective exit slit and were sensitive only to selected bands in the UV spectrum -- 1100 to 2000 A (channel 1) and 1450 to 3520 A (channel 2). Channel 1 was detected by the PMT with a cesium iodide photocathode and lithium fluoride window and included the data used in the UV aeronomy study. Channel 2 was detected by the PMT with a cesium telluride photocathode and sapphire window and included the data used in the UV cartography study. The UVS scanned the wavelength range with a 3-s period and a spectral resolution for first-order spectra of 15 A. The wavelength of any given photometric sample in the UV spectrum was known to plus or minus 5 A or better. The Mariner 9 Data Autcration Subsystem (DAS) caused each channel to be sampled every 5 ms. Channel 2 was sampled 2.5 ms after channel 1. There were 200 samples/s/channel, a total of 400 UVS samples/s. Each sample was digitized to eight bits and one sign bit in the DAS. The instrument had a dynamic range of 200 Rayleighs per 20-A interval to 50 kiloRayleighs per 20-A interval for channel 1 and 200 Rayleighs per 20-A interval to 50 megaRayleighs per 20-A interval for channel 2. Channel 1 had a field of view sufficient to permit imaging a portion of the Martian surface subtending 0.19 by 1.9 deg of arc, while channel 2 was limited to a 0.19- by 0.55-deg field of view. Channel 1, at a slant range of 5,700 km, viewed a column of space 100 km above the Martian surface that was 24 by 240 km. Channel 2, on the other hand, at a vertical distance of 1,250 km, viewed a 2.25- by 6.5-km area at the subspacecraft point on the planet's surface, while at a vertical distance of 850 km the area viewed was 1.5 by 4.5 km. The UVS had four fundamental measuring geometries during an orbit: (1) bright limb, (2) illuminated disk, (3) terminator, and (4) dark limb. In addition to taking complete UV spectra, the instrument design also allowed for sampling at 1216 A (Lyman-alpha) to utilize a lower data rate mode. This allowed Lyman-alpha data to be taken for a large percentage of each orbit. The experiment began collecting excellent data soon after orbital insertion on November 13, 1971, and continued until April 2, 1972, when the experiment was shut off to conserve spacecraft power during solar occultation. The experiment was reactivated on June 8, 1972, after the spacecraft emerged from solar occultation. It continued to operate normally until 2200 UT on October 27, 1972, when the experiment was shut off along with the rest of the Mariner 9 spacecraft.

INFRARED

------- MARINER 6, PIMENTEL----------

INVESTIGATION NAME- IR SPECTROMETER

NSSDC ID- 69-014A-02 INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY ATMOSPHERES
PLANETOLOGY

PERSONNEL

PI - G.C.	PIMENTEL	U OF CALIF, BERKELEY
OI - K.C.	HERR	U OF CALIF, BERKELEY

BRIEF DESCRIPTION

Spectral measurements of the thermal (IR) emission by the Martian surface and atmosphere were obtained to determine (1) the atmospheric composition, including polyatomic life-related molecules, (2) the surface temperature along the track of view, (3) the surface composition, (4) the surface topography, (5) the composition of the polar cap, and (6) the bright limb IR emission characteristics. The experiment, mounted on the bottom of the octagonal scan platform of the spacecraft, used an IR spectrometer that consisted of a telescope, optical focusing lenses and mirrors, a variable-wedge interference filter that selected the wavelengths reaching the detectors, and cooled IR detectors. The spectra observed covered the wavelength region of 1.9 to 14.3 micrometers and were provided by channel 1 (4.8 to 14.3 micrometers), which operated on emitted light from the planet and continued to obtain measurements on the dark side of the planet, and channel 2 (1.9 to 6.0 micrometers), which operated on reflected solar radiation. The instrument telescope had a field of view of 2 deg and, thus, at closest approach (about 3,100 km) the geographical resolution was about 120 km by 3 km and, during a single scan, about 120 km by 120 km. The spectral resoltion obtained was 0.5 to 1 %. About 29 min of data were obtained during the Mariner 6 near-encounter equatorial scan on July 31, 1969. However, due to the failure of the channel 1 cryostat, only channel 2 measurements were obtained. The quality of the data is excellent.

------- MARINER 7, PIMENTEL----------

INVESTIGATION NAME- IR SPECTROMETER

NSSDC ID- 69-030A-02 INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY ATMOSPHERES
PLANETOLOGY

PERSONNEL

PI - G.C.	PIMENTEL	U OF CALIF, BERKELEY
OI - K.C.	HERR	U OF CALIF, BERKELEY

BRIEF DESCRIPTION

Spectral measurements of the thermal IR emission from the Martian surface and atmosphere were obtained to determine (1) the atmospheric composition, including polyatomic life-related molecules, (2) the surface temperature along the track of view, (3) the surface composition, (4) the surface topography, (5) the composition of the polar cap, and (6) the bright limb IR emission characteristics. The experiment, mounted on the bottom of the octagonal scan platform of the spacecraft, used an IR spectrometer consisting of a telescope, optical focusing lenses and mirrors, a variable-wedge interference filter that selected the wavelengths reaching the detectors, and cooled IR detectors. The spectra observed covered a wavelergth region of 1.9 to 14.3 micrometers and were provided by channel 1 (4.8 to 14.3 micrometers), which operated on emitted light from the planet and continued to obtain measurements on the dark side of the planet, and channel 2 (1.9 to 6.0 micrometers), which operated on reflected solar radiation. The instrument telescope had a FOV of 2 deg and, thus, at closest approach (about 3400 km), the geographical resolution was about 120 km by 3 km and, during a single scan, 120 km by 120 km. The spectral resolution obtained was 0.5 to 1 %. About 34 min of data were obtained from both channels during the Mariner 7 near-encounter scan of high-latitude and polar regions of the Martian southern hemisphere on August 5, 1969. The quality of the data is excellent.

------- MARINER 9, HANEL----------

INVESTIGATION NAME- INFRARED INTERFEROMETER SPECTROMETER (IRIS)

NSSDC ID- 71-051A-03 INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY ATMOSPHERES
PLANETOLOGY

PERSONNEL

PI - R.A.	HANEL	NASA-GSFC
OI - B.J.	CONRATH	NASA-GSFC
OI - C.	PRABHAKARA(NLA)	NASA-GSFC
OI - G.V.	LEVIN	BIOSPHERICS, INC
OI - B.	SCHLACHMAN(NLA)	NASA-GSFC
OI - W.A.	HOVIS	NOAA-NESS
OI - V.G.	KUNDE	NASA-GSFC
OI - P.D.	LOWMAN, JR.	NASA-GSFC
OI - J.A.	PIRRAGLIA	NASA-GSFC
OI - T.E.	BURKE(NLA)	NASA-JPL
OI - J.C.	PEARL	NASA-GSFC

BRIEF DESCRIPTION

The Mariner 9 infrared interferometer spectrometer (IRIS) experiment was designed to provide information on the vertical structure, composition, and dynamics of the atmosphere and on the emissive properties of the surface of Mars. Measurements were made in the region of thermal emission spectra from 6 to 50 micrometers, using a modified Michelson interferometer with a spectral resolution of 2.4 inverse cm (apodized) and 1.2 inverse cm (unapodized), to determine the vertical temperature profile, general atmospheric circulation, minor atmospheric constituents, and surface temperature, composition, and thermal properties as a function of latitude and local time for dark and bright areas and the polar cap region. The instrumentation, mounted on the bottom of the spacecraft on a multiple-pointing, motor-driven scan platform, consisted primarily of (1) a scan mirror, (2) a coated cesium iodide entrance window, (3) a cesium iodide beam splitter, (4) a fixed mirror, (5) a movable mirror with electromagnetic drive, (6) a condensing mirror, (7) a thermistor bolometer detector, (8) a reference interferometer, (9) an internal warm blackbody calibrator, and (10) a programmer. The scan mirror selected IR radiation from one of three directions: Mars, deep space, or the internal warm blackbody. From this mirror, the radiation was reflected to the interferometer through the entrance window, which acted as an IR filter and had an effective aperture area of 10 sq cm. The beam splitter then divided the incoming radiation into two approximately equal components. After reflections from the fixed and moving mirrors, respectively, the two beams interfered with each other and were focused by the condensing mirror onto the bolometric detector, which provided an electrical output proportional to the intensity as a function of the path length difference or phase difference between the IR radiation reflected or transmitted by the beam splitter. The electrical output, converted from analog to digital form, was called an interferogram and represented a circular fringe pattern that appeared at the focal plane of the condensing mirror. Each interferogram had a duration of 18.2 s and contained 4,096 samples. After seven interferograms were taken in the operating mode, one was taken of the internal warm (298 plus or minus 3 deg K) blackbody, followed by another set of seven Mars interferograms, and finally by an interferogram from the deep space background (4 deg). The IRIS, which had a field of view of 4.5 deg, viewed an area 116 km in diameter from an orbital altitude of 1,600 km. The instrument was identical in all critical areas to the interferometers designed for the Nimbus-B and -D meteorological satellites, except that the Mariner 9 IRIS had better spectral resolution. The experiment began collecting excellent data soon after orbital insertion. NSSDC has all the useful data that exist from this investigation.

------- MARINER 6, NEUGEBAUER----------

INVESTIGATION NAME- TWO-CHANNEL IR RADIOMETER MARS SURFACE TEMPERATURE

NSSDC ID- 69-014A-03 INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETOLOGY

PERSONNEL

PI - G.	NEUGEBAUER	CALIF INST OF TECH
OI - G.	MUNCH	MPI-HEIDELBERG
OI - S.C.	CHASE, JR.	SANTA BARBARA RES CTR

BRIEF DESCRIPTION

The equivalent blackbody temperature of the Martian surface was determined by means of a two-channel infrared radiometer, which measured the infrared energy emitted in the 8- to 12-micrometer and 18- to 25-micrometer bands and had a dynamic range of 120 to 330 deg K. The two channels, located in atmospheric windows, emphasized the upper and lower temperatures of this range, respectively. The experiment package was located on the bottom of the octagonal scan platform of the spacecraft. The radiometer consisted of two refracting telescopes each equipped with an uncooled antimony-bismuth thermopile detector. The experiment used an optical train that included a rotatable plane mirror, which reflected the incident energy into the detector telescopes. The mirror had three orthogonal positions. The first position viewed empty space and obtained a zero energy reference, the second viewed the planet, and the third measured the thermal energy radiated by a temperature calibration plate. After space was viewed for one frame count (4.2 s), 13 observations of the planet were made at 2.1-s intervals in each wavelength channel. Then, following a short look at the temperature reference plate, 14 more planetary observations were made. The cycle, which lasted 63 s (15 frame counts), was then repeated, beginning with a view of space. About 21 min of data were

obtained on July 31, 1969, during near encounter, across and beyond the terminator over equatorial regions. The data were used to determine the thermal inertia of the surface material as well as the nature of the varying ground structure. The quality of the data is good. The data have been corrected for the greater than expected response to off-axis radiation.

------- MARINER 7, NEUGEBAUER----------

INVESTIGATION NAME- TWO-CHANNEL IR RADIOMETER MARS SURFACE TEMPERATURE

NSSDC ID- 69-030A-03

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETOLOGY

PERSONNEL

PI - G.	NEUGEBAUER	CALIF INST OF TECH
OI - G.	MUNCH	MPI-HEIDELBERG
OI - S.C.	CHASE, JR.	SANTA BARBARA RES CTR

BRIEF DESCRIPTION

The equivalent blackbody temperature of the Martian surface was determined by means of a two-channel infrared radiometer, which measured the infrared energy emitted in the 8- to 12-micrometer and 18- to 25-micrometer bands and had a dynamic range of 120 to 330 deg K. The two channels, located in atmospheric windows, emphasized the upper and lower temperatures of this range, respectively. The experiment package was located on the bottom of the octagonal scan platform of the spacecraft. The radiometer consisted of two refracting telescopes, each equipped with an uncooled antimony-bismuth thermopile detector. The experiment used an optical train that included a rotatable plane mirror, which reflected the incident energy into the detector telescopes. The mirror had three orthogonal positions. The first position viewed empty space and obtained a zero energy reference, the second viewed the planet, and the third measured the thermal energy radiated by a temperature calibration plate. After space was viewed for one frame count (4.2 s), 13 observations of the planet were made at 2.1-s intervals in each wavelength channel. Then, following a short look at the temperature reference plate, 14 more planetary observations were made. The cycle, which lasted 63 s (15 frame counts), was then repeated, beginning with a view of space. Data for about 27 min were obtained on August 5, 1969, over high latitudes and polar regions of the Martian southern hemisphere during near encounter. These data provided valuable information concerning the composition of the polar cap and surface conditions in thaw regions near the edge of the polar cap. The quality of the data is good. The data have been corrected for the greater-than-expected response to off-axis radiation.

------- MARINER 9, NEUGEBAUER----------

INVESTIGATION NAME- INFRARED RADIOMETER (IRR)

NSSDC ID- 71-051A-01

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETOLOGY

PERSONNEL

PI - G.	NEUGEBAUER	CALIF INST OF TECH
OI - H.H.	KIEFFER	US GEOLOGICAL SURVEY
OI - G.	MUNCH	MPI-HEIDELBERG
OI - S.C.	CHASE, JR.	SANTA BARBARA RES CTR
OI - E.D.	MINER	NASA-JPL

BRIEF DESCRIPTION

The Mariner 9 infrared radiometer (IRR) experiment was designed to provide, over a wide coverage of the surface of Mars, brightness temperatures of the soil as a function of local time by measuring the energy radiated in the 8-to 12-micrometer and 18- to 25-micrometer wavelength bands. From these temperatures, the following information was derived: (1) the large-scale distribution of the thermal inertial of the surface materials, (2) the occurrence of irregularities in the cooling curve, (3) the existence of "hot spots" that may indicate sources of internal heat, and (4) the temperature of the polar cap and adjacent area. The instrument consisted of two telescope/thermopile-detector assemblies. Each assembly contained two lenses, a spectral filter, a field stop, and a thermopile-detector. The detectors in each assembly were identical. However, the lenses and filters through which the radiation must pass were of different materials so that one detector responded to the radiation in the 8-to 12-micrometer band (channel 1) whereas the other detector responded to radiation in the 18-to 25-micrometer band (channel 2). The channel 1 assembly, which had a field of view of 0.53 by 0.53 deg, had a germanium spectral filter and field lens and an infrared transmission (IRTRAN) -2 objective lens. The channel 2 assembly, which had a 0.7 by 0.7 deg field of view, had a silicon spectral filter, an IRTRAN-6 field lens, and an IRTRAN-6 objective lens. The detectors were 13-junction bismuth-antimony differential thermopiles, which generated a voltage in response to incident radiant heat flux. Channels 1 and 2 had sensitive areas of 0.25 by 0.25 mm and 0.4 by 0.4 mm, respectively. Radiation was measured from three sources (space, Mars, and a thermal reference source) by means of a three-position scan mirror rotated clockwise by a bidirectional digital stepping motor. The 42-s scan cycle was controlled by the Mariner 9 Data Automation Subsystem (DAS) and consisted of the following viewing modes each separated by a 0.25-s scan interval: planet (19.2 s), space (2.4 s), planet (18.0 s), and thermal reference (2.4 s). The radiation from the source being viewed at a given time entered the IRR, was reflected off the scan mirror, passed through the objective lens, spectral filter, and field lens, and was focused onto the detector. The detector then converted the incident radiant flux to a voltage. The IRR data samples were taken in pairs, each pair consisting of a channel-1 sample and a channel-2 sample. Data pairs appeared at 1.2-s intervals, while the interval between samples in a pair was 200 ms. The dynamic range of the instrument was optimal from 150 to 325 deg K. The sensitivity of the IRR was plus or minus 0.12 deg K at 300 deg K and plus or minus 0.6 deg K at 140 deg K. Mounted on the Mariner 9 planetary scan platform, the IRR had a 20-sq-cm aperture with an unobstructed view of Mars subtending a minimum of 15 deg half-angle. At 90 deg to this aperture and directly opposite the thermal reference plate (flat-black curved aluminum plate), the aperture had an unobstructed view of deep space subtending 20 by 20 deg. The IRR, which was boresighted with the narrow-angle TV camera to within plus or minus 0.3 deg, had a resolution at the subsatellite point on the surface of Mars of 20 by 20 km and 25 by 25 km for channels 1 and 2, respectively, from the periapsis altitude of 2000 km. The instrument was basically the same as that flown on the Mariner Mars 1969 missions, except that a focal-plane diaphragm (field stop) had been placed in front of the detectors to reduce the response to off-axis radiation. The experiment began collecting high-quality data soon after orbital insertion on November 13, 1971, and continued until April 2, 1972, when the experiment was shut off to conserve spacecraft power during solar occultation. The experiment was turned back on June 8, 1972, after the spacecraft emerged from solar occultation. It continued to operate normally until 2200 UT on October 27, 1972, when the experiment was turned off along with the rest of the Mariner 9 spacecraft.

------- VIKING 1 ORBITER, KIEFFER----------

INVESTIGATION NAME- INFRARED THERMAL MAPPING (IRTM)

NSSDC ID- 75-075A-02

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY ATMOSPHERES
PLANETOLOGY

PERSONNEL

TL - H.H.	KIEFFER	US GEOLOGICAL SURVEY
TM - G.	MUNCH	MPI-HEIDELBERG
TM - E.D.	MINER	NASA-JPL
TM - G.	NEUGEBAUER	CALIF INST OF TECH
TM - S.C.	CHASE, JR.	SANTA BARBARA RES CTR
TM - F.D.	PALLUCONI	NASA-JPL

BRIEF DESCRIPTION

The purpose of the IRTM experiment was to measure the temperatures of the atmosphere and areas on the surface of Mars. The amount of sunlight reflected by the planet was also measured. The IRTM was a multichannel radiometer mounted on the orbiter's scan platform. Four small telescopes, each with seven infrared detectors, were aimed parallel to the visual imaging optical axis, and made observations every 1.12 s. The instrument was capable of measuring differences of 1 C throughout a temperature range of -130 deg C to +57 deg C. The field of view was circular, 5 milliradians in diameter. Operation of this experiment was terminated on August 7, 1980.

------- VIKING 2 ORBITER, KIEFFER----------

INVESTIGATION NAME- INFRARED THERMAL MAPPING (IRTM)

NSSDC ID- 75-083A-02

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY ATMOSPHERES
PLANETOLOGY

PERSONNEL

TL - H.H.	KIEFFER	US GEOLOGICAL SURVEY
TM - G.	MUNCH	CALIF INST OF TECH
TM - E.D.	MINER	NASA-JPL
TM - G.	NEUGEBAUER	CALIF INST OF TECH
TM - S.C.	CHASE, JR.	SANTA BARBARA RES CTR
TM - F.D.	PALLUCONI	NASA-JPL

BRIEF DESCRIPTION

The purpose of the IRTM experiment was to measure the temperatures of the atmosphere and areas on the surface of Mars. The amount of sunlight reflected by the planet was also measured. The IRTM was a multichannel radiometer mounted on the orbiter's scan platform. Four small telescopes, each with seven infrared detectors, were aimed parallel to the visual imaging optical axis, and made observations every 1.12 s. The instrument was capable of measuring differences of 1 deg C throughout a temperature range of -130 C to +57 C. The field of view was circular, 5 milliradians in diameter.

RADIO SCIENCE AND CELESTIAL MECHANICS

------- MARINER 4, ANDERSON----------

INVESTIGATION NAME- CELESTIAL MECHANICS

NSSDC ID- 64-077A-09

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
CELESTIAL MECHANICS

PERSONNEL

PI -	J.D. ANDERSON	NASA-JPL
OI -	G.W. NULL	NASA-JPL

BRIEF DESCRIPTION

Deep Space Network tracking data from Mariner 4 were used to obtain improved measurements of the masses of Mars and the moon, the astronomical unit, and improved ephemerides of the earth and Mars. The experiment used the onboard receiver and transmitter equipment in conjunction with the Deep Space Station tracking equipment to obtain Doppler measurements. The experiment produced data of good quality from 28, 1964, to December 8, 1967, although the period near May 1967 was noisy because of low signal strength.

------- MARINER 6, ANDERSON----------

INVESTIGATION NAME- CELESTIAL MECHANICS

NSSDC ID- 69-014A-05

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
CELESTIAL MECHANICS

PERSONNEL

PI -	J.D. ANDERSON	NASA-JPL

BRIEF DESCRIPTION

In this experiment the spacecraft range and range-rate data were obtained using an onboard transponder (round trip delay time yielding spacecraft range from earth) and the spacecraft telemetry signal (Doppler shift yielding the range rate). These data were in turn used to provide an accurate determination of a variety of astronomical quantities such as the mass of Mars, ephemerides of Mars and earth, and the symmetry of the gravity field of Mars.

------- MARINER 7, ANDERSON----------

INVESTIGATION NAME- CELESTIAL MECHANICS

NSSDC ID- 69-030A-05

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
CELESTIAL MECHANICS

PERSONNEL

PI -	J.D. ANDERSON	NASA-JPL

BRIEF DESCRIPTION

In this experiment, the spacecraft range and range-rate data were obtained using an onboard transponder (round trip delay time yielding spacecraft range from earth) and the spacecraft telemetry signal (Doppler shift yielding the range rate). These data were in turn used to provide accurate determinations of a variety of astronomical quantities such as the mass of Mars, ephemerides of Mars and earth, and the symmetry of the gravity field of Mars.

------- MARINER 6, KLIORE----------

INVESTIGATION NAME- S-BAND OCCULTATION

NSSDC ID- 69-014A-06

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
IONOSPHERES AND RADIO PHYSICS
PLANETARY ATMOSPHERES

PERSONNEL

PI -	A.J. KLIORE	NASA-JPL

BRIEF DESCRIPTION

In this experiment the changes in the frequency, phase, and amplitude of the S-band (2300 MHz) tracking and telemetry signal, immediately prior to and following the occultation of the spacecraft by the planet, were used to derive the temperature, pressure, and density of the lower gaseous atmosphere of Mars and the density of charged particles in the Martian ionosphere.

------- MARINER 7, KLIORE----------

INVESTIGATION NAME- S-BAND OCCULTATION

NSSDC ID- 69-030A-06

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY ATMOSPHERES
IONOSPHERES AND RADIO PHYSICS

PERSONNEL

PI -	A.J. KLIORE	NASA-JPL

BRIEF DESCRIPTION

In this experiment, the changes in the frequency, phase, and amplitude of the S-band (2300 MHz) tracking and telemetry signal (immediately prior to and following the occultation of the spacecraft by the planet) were used to derive the temperature, pressure, and density of the lower gaseous atmosphere of Mars, and the density of charged particles in the Martian ionosphere.

------- MARINER 9, KLIORE----------

INVESTIGATION NAME- S-BAND OCCULTATION

NSSDC ID- 71-051A-08

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
IONOSPHERES AND RADIO PHYSICS
PLANETARY ATMOSPHERES

PERSONNEL

PI -	A.J. KLIORE	NASA-JPL
OI -	D.L. CAIN	NASA-JPL
OI -	G. FJELDBO(NLA)	NASA-JPL
OI -	B.L. SEIDEL	NASA-JPL

BRIEF DESCRIPTION

The Doppler shift of the S-band telemetry signal during occultation of the spacecraft by Mars provided the vertical distribution of the index of refraction of the Martian atmosphere. These data yield the vertical distribution of neutral and ionized species.

------- VIKING 1 ORBITER, MICHAEL, JR.----------

INVESTIGATION NAME- ORBITER RADIO SCIENCE

NSSDC ID- 75-075A-04

INVESTIGATIVE PROGRAM
CODE EL-4/CO-OP, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY IONOSPHERES
METEOROLOGY

PERSONNEL

TL -	W.H. MICHAEL, JR.	NASA-LARC
TM -	I.I. SHAPIRO	MASS INST OF TECH
TM -	G.F. LINDAL	NASA-JPL
TM -	J.G. DAVIES	U OF MANCHESTER
TM -	D.L. CAIN	NASA-JPL
TM -	M.D. GROSSI	RAYTHEON CORP
TM -	G.L. TYLER	STANFORD U
TM -	J.P. BRENKLE	NASA-JPL
TM -	R.H. TOLSON	NASA-LARC
TM -	C.T. STELZRIED	NASA-JPL
TM -	G. BORN	NASA-JPL
TM -	R. REASENBERG	MASS INST OF TECH

BRIEF DESCRIPTION

There are four distinct sets of Viking radio science data, three using orbiter data and one primarily using lander data with calibrations from orbiter data. The orbiter tracking data, obtained from the two-way orbiter-earth S-band and X-band radio links, consist of Doppler frequencies and time-of-flight range measurements. These determined the position and motion of the orbiters, and can be used to study the Mars gravitational field, the plasma in interplanetary space, and the structure of the solar corona. The occultation data were obtained from these same radio links by analog recording of the signal when a spacecraft was passing into or out of occultation with Mars. The data can be used to produce altitude profiles of the temperature, density, and pressure of the atmosphere (including the ionosphere) and to measure the radius of the planet using a large number of surface points. The surface-properties aspect of this investigation utilized the UHF (381 MHz) signal on which the landers transmitted data to the orbiters. At the beginning or end of a data transmission session, when the orbiter was near the lander's horizon, the strength of the received signal was recorded as a function of time. These signal "fading patterns," resulting from interaction of the radio waves with the Martian surface, contain information about the physical properties of the surface near the landers. The lander tracking data from the two-way direct lander-earth S-band links permit determination of the location of the landers and studies of the motion of the planet. Operation of this experiment was terminated on August 7, 1980.

------- VIKING 2 ORBITER, MICHAEL, JR.----------

INVESTIGATION NAME- ORBITER RADIO SCIENCE

NSSDC ID- 75-083A-04

INVESTIGATIVE PROGRAM
CODE EL-4/CO-OP, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY IONOSPHERES
PLANETARY ATMOSPHERES
PLANETOLOGY

PERSONNEL

TL - W.H.	MICHAEL, JR.	NASA-LARC
TM - I.I.	SHAPIRO	MASS INST OF TECH
TM - G.F.	LINDAL	NASA-JPL
TM - J.G.	DAVIES	U OF MANCHESTER
TM - D.L.	CAIN	NASA-JPL
TM - M.D.	GROSSI	RAYTHEON CORP
TM - G.L.	TYLER	STANFORD U
TM - J.P.	BRENKLE	NASA-JPL
TM - R.H.	TOLSON	NASA-LARC
TM - C.T.	STELZRIED	NASA-JPL
TM - G.	BORN	NASA-JPL
TM - R.	REASENBERG	MASS INST OF TECH

BRIEF DESCRIPTION

There are four distinct sets of Viking radio science data, three using orbiter data and one primarily using lander data with calibrations from orbiter data. The orbiter tracking data, obtained from the two-way, orbiter-earth S-band and X-band radio links, consist of Doppler frequencies and time-of-flight range measurements. These determined the position and motion of the orbiters, and can be used to study the Mars gravitational field, the plasma in interplanetary space, and the structure of the solar corona when the spacecraft was on the opposite side of the sun. The occultation data were obtained from these same radio links by analog recording of the signal when a spacecraft was passing into or out of occultation with Mars. The data can be used to produce altitude profiles of the temperature, density, and pressure of the atmosphere (including the ionosphere) and to measure the radius of the planet using a large number of surface points. The surface properties aspect of this investigation utilized the UHF (381 MHz) signal on which the landers transmitted data to the orbiters. At the beginning or end of a data transmission session, when the orbiter was near the lander's horizon, the strength of the received signal was recorded as a function of time. These signal "fading patterns," resulting from interaction of the radio waves with the Martian surface, contain information about the physical properties of the surface near the landers. The lander tracking data from the two-way direct lander-earth S-band links permit determination of the location of the landers and studies of the motion of the planet.

------- VIKING 1 LANDER, MICHAEL, JR.----------

INVESTIGATION NAME- LANDER RADIO SCIENCE

NSSDC ID- 75-075C-11

INVESTIGATIVE PROGRAM
CODE EL-4/CO-OP, SCIENCE

INVESTIGATION DISCIPLINE(S)
ASTRONOMY
IONOSPHERES
PLANETARY ATMOSPHERES
PLANETOLOGY

PERSONNEL

TL - W.H.	MICHAEL, JR.	NASA-LARC
TM - I.I.	SHAPIRO	MASS INST OF TECH
TM - G.F.	LINDAL	NASA-JPL
TM - J.G.	DAVIES	U OF MANCHESTER
TM - D.L.	CAIN	NASA-JPL
TM - M.D.	GROSSI	RAYTHEON CORP
TM - G.L.	TYLER	STANFORD U
TM - J.P.	BRENKLE	NASA-JPL
TM - R.H.	TOLSON	NASA-LARC
TM - C.T.	STELZRIED	NASA-JPL
TM - G.	BORN	NASA-JPL
TM - R.	REASENBERG	MASS INST OF TECH

BRIEF DESCRIPTION

This experiment used the lander S-band radio transmitter to acquire doppler and range for the lander, utilizing the same Deep Space Network facilities that were used by the orbiters. The resulting data were used to determine the location of the lander on the planet's surface. They also provided more precise information about the orbital, rotational, and precessional motion of Mars than had previously been available. The two principal differences between orbiter and lander tracking data are (1) lander tracking periods were never longer than 2 h and were sometimes much shorter because of thermal constraints on the duration of lander transmitter operation, and (2) landers had no X-band signals to provide the corrections to range data for the interplaretary plasma effects. Consequently, lander ranging sessions were scheduled to be nearly simultaneous with orbiter ranging whenever possible, so that the orbiter S- and X-band data could supply these corrections.

------- VIKING 2 LANDER, MICHAEL, JR.----------

INVESTIGATION NAME- LANDER RADIO SCIENCE

NSSDC ID- 75-083C-11

INVESTIGATIVE PROGRAM
CODE EL-4/CO-OP, SCIENCE

INVESTIGATION DISCIPLINE(S)
ASTRONOMY
IONOSPHERES AND RADIO PHYSICS
PLANETARY ATMOSPHERES
PLANETOLOGY

PERSONNEL

TL - W.H.	MICHAEL, JR.	NASA-LARC
TM - I.I.	SHAPIRO	MASS INST OF TECH
TM - G.	FJELDBO(NLA)	NASA-JPL
TM - J.G.	DAVIES	U OF MANCHESTER
TM - D.L.	CAIN	NASA-JPL
TM - M.D.	GROSSI	RAYTHEON CORP
TM - G.L.	TYLER	STANFORD U
TM - J.P.	BRENKLE	NASA-JPL
TM - R.H.	TOLSON	NASA-LARC
TM - C.T.	STELZRIED	NASA-JPL
TM - G.	BORN	NASA-JPL
TM - R.	REASENBERG	MASS INST OF TECH

BRIEF DESCRIPTION

This experiment used the S-band radio transmitter to acquire Doppler and range data for the lander, utilizing the same Deep Space Network facilities that were used by the orbiters. The resulting data were used to determine the location of the lander on the planet surface. They also provided more precise information about the orbital, rotational, and precessional motion of Mars than had previously been available. The two principal differences between orbiter and lander tracking data are (1) lander tracking periods are never longer than 2 h and are sometimes much shorter because of thermal constraints on the duration of lander transmitter operation, and (2) landers have no X-band signals to provide the corrections to range data for the interplanetary plasma effects. Consequently, lander ranging sessions were scheduled to be nearly simultaneous with orbiter ranging whenever possible, so that the orbiter S- and X-band data could supply these corrections.

ATMOSPHERE

------- VIKING 1 ORBITER, FARMER----------

INVESTIGATION NAME- MARS ATMOSPHERIC WATER DETECTION (MAWD)

NSSDC ID- 75-075A-03

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY ATMOSPHERES
PLANETOLOGY

PERSONNEL

TL - C.B.	FARMER	NASA-JPL
TM - D.D.	LAPORTE	SANTA BARBARA RES CTR
TM - D.W.	DAVIES	NASA-JPL

BRIEF DESCRIPTION

The MAWD used an infrared grating spectrometer mounted on the orbiter scan platform that was boresighted with the television cameras and the IRTM. The instrument measured solar infrared radiation reflected from the surface through the atmosphere to the spacecraft. Spectral intervals were selected coincident with the wavelength of water-vapor absorption lines in the 1.4-micrometer band. The quantity of water vapor along the line of sight was measured from 1 to 100 micrometers of precipitable water with an accuracy of 5 % or better. The instantaneous field of view of the instrument was 2 x 17 milliradians, and a stepping mirror rotated the line of sight through 15 positions to provide a roughly rectangular field of view of 17 x 31 milliradians. Operation of this experiment was terminated on August 7, 1980.

------- VIKING 2 ORBITER, FARMER----------

INVESTIGATION NAME- MARS ATMOSPHERIC WATER DETECTION (MAWD)

NSSDC ID- 75-083A-03

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY ATMOSPHERES
PLANETOLOGY

PERSONNEL

TL - C.B.	FARMER	NASA-JPL
TM - D.D.	LAPORTE	SANTA BARBARA RES CTR
TM - D.W.	DAVIES	NASA-JPL

BRIEF DESCRIPTION
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------- VIKING 1 LANDER, NIER----------

INVESTIGATION NAME- ENTRY SCIENCE ATMOSPHERIC STRUCTURE

NSSDC ID- 75-075C-02
INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE
INVESTIGATION DISCIPLINE(S)
PLANETARY ATMOSPHERES

PERSONNEL
TL - A.O.C.NIER — U OF MINNESOTA
TM - A. SEIFF — NASA-ARC
TM - N.W. SPENCER — NASA-GSFC

BRIEF DESCRIPTION
The entry science atmospheric structure experiment (one of three that were part of the entry science investigation) studied the Martian atmosphere below an altitude of 132 km. A variety of instruments (accelerometers, radar altimeters, thermometers, pressure sensors) collected data to provide altitude profiles of pressure and temperature of the atmosphere and acceleration of the lander capsule. From these data, atmospheric density and mean atomic mass can be calculated.

------- VIKING 2 LANDER, NIER----------

INVESTIGATION NAME- ENTRY SCIENCE ATMOSPHERIC STRUCTURE

NSSDC ID- 75-083C-02
INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE
INVESTIGATION DISCIPLINE(S)
PLANETARY ATMOSPHERES

PERSONNEL
TL - A.O.C.NIER — U OF MINNESOTA
TM - A. SEIFF — NASA-ARC
TM - N.W. SPENCER — NASA-GSFC

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------- VIKING 1 LANDER, NIER----------

INVESTIGATION NAME- ENTRY SCIENCE NEUTRAL ATMOSPHERIC COMPOSITION

NSSDC ID- 75-075C-12
INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE
INVESTIGATION DISCIPLINE(S)
IONOSPHERES
PLANETARY ATMOSPHERES

PERSONNEL
TL - A.O.C.NIER — U OF MINNESOTA
TM - M.B. MCELROY — HARVARD U
TM - N.W. SPENCER — NASA-GSFC

BRIEF DESCRIPTION
The Viking entry science neutral atmospheric composition experiment (one of three that were part of the entry science investigation) was designed to provide the composition data for the various neutral species that were needed to define the present physical and chemical state of the Martian atmosphere. Mounted in an opening in the aeroshell with its electron-impact open ion source recessed below the surface of the aeroshell, a double-focusing (electrostatic and magnetic) mass spectrometer was used to measure the concentrations of the atmospheric species that have mass-to-charge ratios from 1 to 49. Two collectors were used, one for the mass range from 1 to 7 u, and the other simultaneously measuring in the mass range from 7 to 49 u. Mass spectra were obtained by sweeping the ion acceleration voltage and the deflection voltage across the electrostatic plates. The sweep period was approximately 5 s, and a dynamic range of 1.E5 was provided within each spectrum.

------- VIKING 2 LANDER, NIER----------

INVESTIGATION NAME- ENTRY SCIENCE NEUTRAL ATMOSPHERIC COMPOSITION

NSSDC ID- 75-083C-12
INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE
INVESTIGATION DISCIPLINE(S)
INTERPLANETARY PHYSICS
PLANETARY ATMOSPHERES

PERSONNEL
TL - A.O.C.NIER — U OF MINNESOTA
TM - M.B. MCELROY — HARVARD U
TM - N.W. SPENCER — NASA-GSFC

BRIEF DESCRIPTION
The Viking entry science neutral atmospheric composition experiment (one of three that were part of the entry science investigation) was designed to provide the composition data for the various neutral species that were needed to define the present physical and chemical state of the Martian atmosphere. Mounted in an opening in the aeroshell with its electron-impact open ion source recessed below the surface of the aeroshell, a double-focusing (electrostatic and magnetic) mass spectrometer was used to measure the concentrations of the atmospheric species that have mass-to-charge ratios from 1 to 49. Two collectors were used, one covering the mass range from 1 to 7 u, and the other simultaneously covering the range from 7 to 49 u. Mass spectra were obtained by sweeping the ion acceleration voltage and the deflection voltage across the electrostatic plates. The sweep period was approximately 5 s, and a dynamic range of 1.E5 was provided within each spectrum.

------- VIKING 1 LANDER, NIER----------

INVESTIGATION NAME- ENTRY SCIENCE IONOSPHERIC PROPERTIES

NSSDC ID- 75-075C-14
INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE
INVESTIGATION DISCIPLINE(S)

PERSONNEL
TL - A.O.C.NIER — U OF MINNESOTA
TM - W.B. HANSON — U OF TEXAS, DALLAS
TM - N.W. SPENCER — NASA-GSFC

BRIEF DESCRIPTION
The Viking entry science ionospheric properties experiment (one of three that were part of the entry science investigation) studied the composition, structure, and temperature of the ionosphere, which were probed during the descent of the lander capsule by means of a retarding potential analyzer (RPA) mounted flush with the front face of the aeroshell. To conserve battery power, the instrument was operated intermittently between 16,000 and 5,000 km altitude but continuously from 5,000 to 100 km. The instrument comprised a current-collecting plate with seven grids ahead of it. A fixed program of potentials was applied to the grids, and the collected currents were measured at 10-ms intervals. The instrument operated in three phases to measure energetic electrons, thermal electrons, and thermal ions.

------- VIKING 2 LANDER, NIER----------

INVESTIGATION NAME- ENTRY SCIENCE IONOSPHERIC PROPERTIES

NSSDC ID- 75-083C-14
INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE
INVESTIGATION DISCIPLINE(S)

PERSONNEL
TL - A.O.C.NIER — U OF MINNESOTA
TM - W.B. HANSON — U OF TEXAS, DALLAS
TM - N.W. SPENCER — NASA-GSFC

BRIEF DESCRIPTION
The Viking entry science ionospheric properties experiment (one of three that were part of the entry science investigation) studied the composition, structure, and temperature of the ionosphere, which were probed during the descent of the lander capsule by means of retarding potential analyzer (RPA) mounted flush with the front face of the aeroshell. To conserve battery power, the instrument was operated intermittently between 16,000 and 5,000 km altitude but continuously from 5,000 to 100 km. The instrument comprised a current-collecting plate with seven grids ahead of it. A fixed program of potentials was applied to the grids, and the collected currents were measured at 10-ms intervals. The instrument operated in three phases to measure energetic electrons, thermal electrons, and thermal ions.

------- VIKING 1 LANDER, HESS----------

INVESTIGATION NAME- METEOROLOGY

NSSDC ID- 75-075C-07

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY ATMOSPHERES
METEOROLOGY

PERSONNEL

TL - S.L.	HESS(DECEASED)	FLORIDA STATE U
TM - C.B.	LEOVY	U OF WASHINGTON
TM - R.M.	HENRY	U OF WASHINGTON
TM - J.A.	RYAN	CALIF ST U, FULLERTON
TM - J.E.	TILLMAN	U OF WASHINGTON

BRIEF DESCRIPTION
This experiment analyzed the meteorological environment near the planetary surface and obtained information about motion systems of various scales. The atmospheric parameters determined were pressure, temperature, wind speed, and wind direction. Diurnal and seasonal variations were of particular importance. The sampling rates and durations for any one Martian day (sol) were selectable by ground command. The sensors were mounted on an erected boom. Three hot-film anemometers, through which an electric current was passed to heat two glass needles coated with platinum and overcoated with aluminum oxide, were used to measure wind speed. The electric power needed to maintain these sensors at a fixed temperature above the surrounding air was the measure of wind speed. Atmospheric temperature was measured by three fine-wire thermocouples in parallel. A thin metal diaphragm, mounted in a vacuum-sealed case, was used to measure atmospheric pressure.

------- VIKING 2 LANDER, HESS----------

INVESTIGATION NAME- METEOROLOGY

NSSDC ID- 75-083C-07

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY ATMOSPHERES
METEOROLOGY

PERSONNEL

TL - S.L.	HESS(DECEASED)	FLORIDA STATE U
TM - C.B.	LEOVY	U OF WASHINGTON
TM - R.M.	HENRY	U OF WASHINGTON
TM - J.A.	RYAN	CALIF ST U, FULLERTON
TM - J.E.	TILLMAN	U OF WASHINGTON

BRIEF DESCRIPTION
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SURFACE CHEMISTRY

------- VIKING 1 LANDER, BIEMANN----------

INVESTIGATION NAME- MOLECULAR ANALYSIS

NSSDC ID- 75-075C-04

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY ATMOSPHERES
PLANETARY BIOLOGY
PLANETOLOGY

PERSONNEL

TL - K.	BIEMANN	MASS INST OF TECH
TM - H.C.	UREY(DECEASED)	U OF CALIF, SAN DIEGO
TM - D.M.	ANDERSON	USA-CRREL
TM - T.	OWEN	STATE U OF NEW YORK
TM - J.	ORO	U OF HOUSTON
TM - L.E.	ORGEL	SALK INST BIOL STUDIES
TM - A.O.C.NIER		U OF MINNESOTA
TM - P.	TOULMIN, 3RD	US GEOLOGICAL SURVEY

BRIEF DESCRIPTION
The molecular analysis experiment searched for chemical compounds in the upper surface layer of Mars and measured atmospheric composition near the surface. The soil analyses were performed using a gas chromatograph mass spectrometer (GCMS) that had high sensitivity, high structural specificity, and broad applicability to a wide range of compounds. Substances were vaporized from the surface material by a heating process while CO2 (labeled with C-13) swept through. The material was then carried into a tenex gas-chromatographic column that was swept with hydrogen as a carrier gas. While passing through the column, substances were separated by different degrees of retention. The residual stream moved into the mass spectrometer (after hydrogen was removed by hydrogen-only-permeable palladium), and a mass spectrum (masses from 12 to 200 u) was obtained every 10 s for the 84 min of the gas chromatogram. In some cases, the same sample was reheated at a higher temperature and analyzed to detect less volatile materials. For atmospheric measurements, gases were directly introduced into the mass spectrometer, bypassing the gas chromatograph column.

------- VIKING 2 LANDER, BIEMANN----------

INVESTIGATION NAME- MOLECULAR ANALYSIS

NSSDC ID- 75-083C-04

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY ATMOSPHERES
PLANETARY BIOLOGY
PLANETOLOGY

PERSONNEL

TL - K.	BIEMANN	MASS INST OF TECH
TM - H.C.	UREY(DECEASED)	U OF CALIF, SAN DIEGO
TM - D.M.	ANDERSON	USA-CRREL
TM - T.	OWEN	STATE U OF NEW YORK
TM - J.	ORO	U OF HOUSTON
TM - L.E.	ORGEL	SALK INST BIOL STUDIES
TM - A.O.C.NIER		U OF MINNESOTA
TM - P.	TOULMIN, 3RD	US GEOLOGICAL SURVEY

BRIEF DESCRIPTION
The molecular analysis experiment searched for chemical compounds in the upper surface layer of Mars and measured atmospheric composition near the surface. The soil analyses were performed using a gas chromatograph mass spectrometer (GCMS) that had high sensitivity, high structural specificity, and broad applicability to a wide range of compounds. Substances were vaporized from the surface material by a heating process while CO2 (labeled with C-13) swept through. The material was then carried into a tenex gas-chromatographic column that was swept with hydrogen as a carrier gas. While passing through the column, substances were separated by different degrees of retention. The residual stream moved into the mass spectrometer (after hydrogen was removed by hydrogen-only-permeable palladium, and a mass spectrum (masses from 12 to 200 u) was obtained every 10 s for the 84 min of the gas chromatogram. In some cases, the same sample was reheated at a higher temperature and analyzed to detect less volatile materials. For atmospheric measurements, gases were directly introduced into the mass spectrometer, bypassing the gas chromatograph column.

------- VIKING 2 LANDER, SHORTHILL----------

INVESTIGATION NAME- PHYSICAL PROPERTIES

NSSDC ID- 75-083C-01

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETOLOGY

PERSONNEL

TL - R.W.	SHORTHILL	U OF UTAH
TM - R.E.	HUTTON	TRW SYSTEMS GROUP
TM - H.J.	MOORE, II	US GEOLOGICAL SURVEY
TM - R.F.	SCOTT	CALIF INST OF TECH

BRIEF DESCRIPTION
The purpose of the physical properties investigation was to determine the physical properties of the Martian surface and environment at the landing site, primarily using engineering measurements and scientific instruments required to meet other mission objectives. In particular, it attempted to determine such properties as bulk density, bearing strength, angle of repose, cohesion, angle of internal friction, particle characteristics, thermal parameters, eolian transportability, topography, and certain environmental properties such as wind, temperature, and solar flux levels. Maximum use was made of hardware and instruments intended for other applications, such as the mechanical subsystems and lander cameras. Only passive devices, such as mirrors and landing leg stroke gauges, were added for this experiment.

------- VIKING 1 LANDER, TOULMIN, 3RD----------

INVESTIGATION NAME- INORGANIC ANALYSIS

NSSDC ID- 75-075C-13

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETOLOGY

PERSONNEL

TL - P. TOULMIN, 3RD		US GEOLOGICAL SURVEY
TM - A.K. BAIRD		POMONA COLLEGE
TM - K. KEIL		U OF NEW MEXICO
TM - H.J. ROSE		US GEOLOGICAL SURVEY
TM - B.C. CLARK		MARTIN-MARIETTA AEROSP

BRIEF DESCRIPTION

This experiment utilized an energy-dispersive X-ray fluorescence spectrometer (XRFS) in which four sealed, gas-filled proportional counters detected X rays emitted from samples of Martian surface materials irradiated by X rays from radioisotope sources (iron-55 and cadmium-109). The output of the proportional counters was subjected to pulse-height analysis by an onboard step-scanning, single-channel analyzer with adjustable counting periods. This instrument was located inside the lander body, and samples were delivered to it by the lander surface sampler. Calibration standards were an integral part of the instrument. Reconstructed spectra yielded surface composition data with accuracies ranging from a few tens of parts per million for trace elements to a few percent for major elements.

------- VIKING 2 LANDER, TOULMIN, 3RD----------

INVESTIGATION NAME- INORGANIC ANALYSIS

NSSDC ID- 75-083C-13

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETOLOGY

PERSONNEL

TL - P. TOULMIN, 3RD		US GEOLOGICAL SURVEY
TM - A.K. BAIRD		POMONA COLLEGE
TM - K. KEIL		U OF NEW MEXICO
TM - H.J. ROSE		US GEOLOGICAL SURVEY
TM - B.C. CLARK		MARTIN-MARIETTA AEROSP

BRIEF DESCRIPTION

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------- VIKING 1 LANDER, HARGRAVES----------

INVESTIGATION NAME- MAGNETIC PROPERTIES

NSSDC ID- 75-075C-10

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETOLOGY

PERSONNEL

TL - R.B. HARGRAVES		PRINCETON U

BRIEF DESCRIPTION

The magnetic properties experiment detected the presence of magnetic particles in Martian surface material. It used three pairs of samarium-cobalt magnets, two mounted on the backhoe of the surface-sampler collector head and one on top of the lander. Each pair consisted of an outer ring magnet about 2.5 cm in diameter with an inner core magnet of opposite polarity. The magnets were directly imaged by the camera system in black and white and in color. A 4-power magnifying mirror was used for maximum resolution.

------- VIKING 2 LANDER, HARGRAVES----------

INVESTIGATION NAME- MAGNETIC PROPERTIES

NSSDC ID- 75-083C-10

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETOLOGY

PERSONNEL

TL - R.B. HARGRAVES		PRINCETON U

BRIEF DESCRIPTION

The magnetic properties experiment detected the presence of magnetic particles in Martian surface material. It used three pairs of samarium-cobalt magnets, two mounted on the backhoe of the surface-sampler collector head and one on top of the lander. Each pair consisted of an outer ring magnet about 2.5 cm in diameter with an inner core magnet of opposite polarity. The magnets were directly imaged by the camera system in black and white and in color. A 4-power magnifying mirror was used for maximum resolution.

BIOLOGY

------- VIKING 1 LANDER, KLEIN----------

INVESTIGATION NAME- BIOLOGY

NSSDC ID- 75-075C-03

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY BIOLOGY

PERSONNEL

TL - H.P. KLEIN		NASA-ARC
TM - J. LEDERBERG		STANFORD U
TM - A. RICH		MASS INST OF TECH
TM - N.H. HOROWITZ		CALIF INST OF TECH
TM - V.I. OYAMA		NASA-ARC
TM - G.V. LEVIN		BIOSPHERICS, INC

BRIEF DESCRIPTION

The biology experiment searched for the presence of Martian organisms by looking for metabolic products. Three distinct instruments (pyrolytic release (PR), labeled release (LR), and gas exchange (GEX)) incubated samples of the Martian surface under a number of different environmental conditions. In some instances a sample was heat sterilized and reprocessed as a control. The PR, or carbon assimilation, instrument sought to detect the photosynthetic or chemical fixation of CO2 or CO containing C-14. The samples were incubated for several days in the presence of the radioactive gas mixture, some samples with simulated sunlight and some without. Next, each sample was heated to 120 C to remove unreacted CO2 and CO. The soil was pyrolized at 650 C and any organic products were collected in an organic vapor trap (OVT). Finally, the trap was heated to combust the organic material to CO2 and any evolved radioactive gas was measured. The LR experiment sought to detect metabolic processes through radiorespirometry. Liquid nutrients labeled with radioactive carbon were added to the samples and the atmosphere above was continuously monitored to detect any radioactive gases released from these nonvolatile nutrients. The GEX measured the production and/or uptake of CO2, N2, CH4, H2, and O2 during incubation of a soil sample. The sample was sealed and purged by He; then a mixture of He, Kr, and CO2 was introduced as an initial incubation atmosphere. After the addition of a selected quantity of a nutrient solution (saturated with the diagnostic gas, neon), the sample was incubated. At certain intervals, samples of the atmosphere were removed and analyzed by a gas chromatograph with a thermal conductivity detector.

------- VIKING 2 LANDER, KLEIN----------

INVESTIGATION NAME- BIOLOGY

NSSDC ID- 75-083C-03

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY BIOLOGY

PERSONNEL

TL - H.P. KLEIN		NASA-ARC
TM - J. LEDERBERG		STANFORD U
TM - A. RICH		MASS INST OF TECH
TM - N.H. HOROWITZ		CALIF INST OF TECH
TM - V.I. OYAMA		NASA-ARC
TM - G.V. LEVIN		BIOSPHERICS, INC

BRIEF DESCRIPTION

The biology experiment searched for the presence of Martian organisms by looking for metabolic products. Three distinct instruments (pyrolytic release (PR), labeled release (LR), and gas exchange (GEX)) incubated samples of the Martian surface under a number of different environmental conditions. In some instances a sample was heat sterilized and reprocessed as a control. The PR, or carbon assimilation, instrument sought to detect the photosynthetic or chemical fixation of CO2 or CO containing C-14. The samples were incubated for several days in the presence of the radioactive gas mixture, some samples with simulated sunlight and some without. Next, each sample was heated to 120 C to remove unreacted CO2 and CO. The soil was pyrolized at 650 C and any organic products were collected in an organic vapor trap (OVT). Finally, the trap was heated to combust the organic material to CO2 and any evolved radioactive gas was measured. The LR experiment sought to detect metabolic processes through radiorespirometry. Liquid nutrients labeled with radioactive carbon were added to the samples and the atmosphere above was continuously monitored to detect any radioactive gases released from these nonvolatile nutrients. The GEX measured the production and/or uptake of CO2, N2, CH4, H2, and O2 during incubation of a soil sample. The sample was sealed and purged by He, then a mixture of He, Kr, and CO2 was introduced as an initial incubation atmosphere. After the addition of a selected quantity of a nutrient solution (saturated with the diagnostic gas, neon), the sample was incubated. At certain intervals, samples of the atmosphere were removed and analyzed by a gas chromatograph with a thermal conductivity detector.

BRIEF DESCRIPTION

The biology experiment searched for the presence of Martian organisms by looking for metabolic products. Three distinct instruments (pyrolytic release (PR), labeled release (LR), and gas exchange (GEX)) incubated samples of the Martian surface under a number of different environmental conditions. In some instances a sample was heat sterilized and reprocessed as a control. The PR, or carbon assimilation, instrument sought to detect the photosynthetic or chemical fixation of CO2 or CO containing C-14. The samples were incubated for several days in the presence of the radioactive gas mixture, some samples with simulated sunlight and some without. Next, each sample was heated to 120 C to remove unreacted CO2 and CO. The soil was pyrolized at 650 C and any organic products were collected in an organic vapor trap (OVT). Finally, the trap was heated to combust the organic material to CO2 and any evolved radioactive gas was measured. The LR experiment sought to detect metabolic processes through radiorespirometry. Liquid nutrients labeled with radioactive carbon were added to the samples and the atmosphere above was continuously monitored to detect any radioactive gases released from these nonvolatile nutrients. The GEX measured the production and/or uptake of CO2, N2, CH4, H2, and O2 during incubation of a soil sample. The sample was sealed and purged by He, then a mixture of He, Kr, and CO2 was introduced as an initial incubation atmosphere. After the addition of a selected quantity of a nutrient solution (saturated with the diagnostic gas, neon), the sample was incubated. At certain intervals, samples of the atmosphere were removed and analyzed by a gas chromatograph with a thermal conductivity detector.

------- VIKING 1 LANDER, BIEMANN----------

INVESTIGATION NAME- MOLECULAR ANALYSIS

NSSDC ID- 75-075C-04

SEE THIS EXPERIMENT UNDER SURFACE CHEMISTRY

------- VIKING 2 LANDER, BIEMANN----------

INVESTIGATION NAME- MOLECULAR ANALYSIS

NSSDC ID- 75-083C-04

SEE THIS EXPERIMENT UNDER SURFACE CHEMISTRY

------- VIKING 2 LANDER, ANDERSON----------

INVESTIGATION NAME- SEISMOLOGY

NSSDC ID- 75-083C-08

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETOLOGY
PLANETARY PHYSICS

PERSONNEL

TL - D.L.	ANDERSON	CALIF INST OF TECH
TM - M.N.	TOKSOZ	MASS INST OF TECH
TM - G.H.	SUTTON	U OF HAWAII
TM - R.L.	KOVACH	STANFORD U
TM - G.V.	LATHAM	U OF TEXAS, GALVESTON
TM - F.	DUENNEBIER	U OF HAWAII

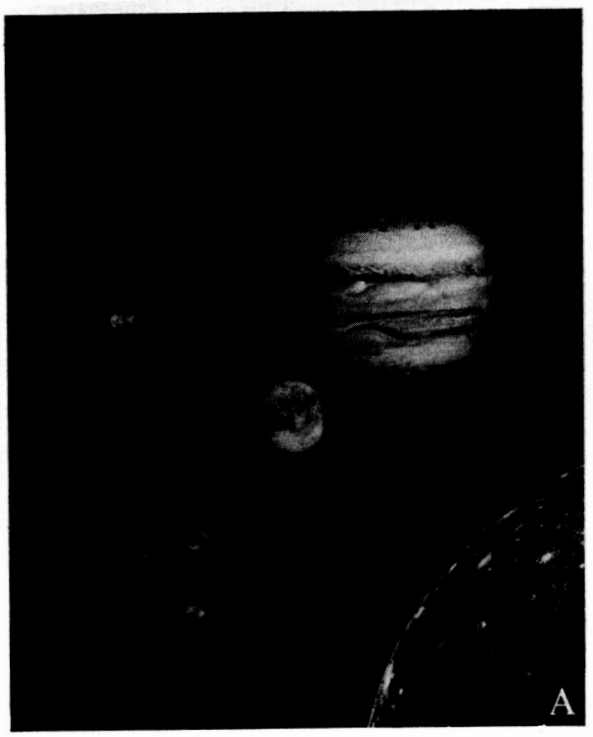
BRIEF DESCRIPTION

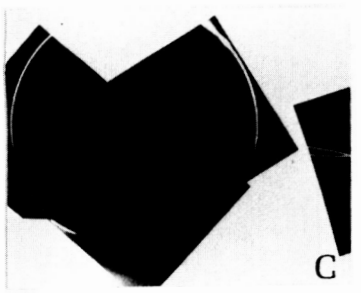
The seismology experiment was designed to determine the level of seismic activity on Mars and its internal structure. The seismology instrument contained three mutually perpendicular seismometers. Each seismometer consisted of a moving coil and a fixed magnet. The operating modes were (1) selection of various filters for frequency content or to adjust to best reception of specific types of data, (2) a low sampling rate for general activity, (3) a high data rate for detailed examination of events, (4) and a compressed medium rate for continuous monitoring of Marsquakes that were dormant until activated by an event. The data were compressed for transmission to Earth by averaging the amplitude of normal ground noise over a 15-s period. When an event occurred, a trigger activated a higher data rate mode that sampled the amplitude of the overall event envelope, which required only one amplitude sample per second to indicate its shape. At the same time, the change in polarity of the data signal (caused by crossing the zero axis) was sampled once each second. The shape of the envelope and its incremental frequency content was transmitted to Earth and reconstructed to approximate the original event. The Viking 1 seismometer failed to uncage and could not be used in a seismic network with the Viking 2 instrument.

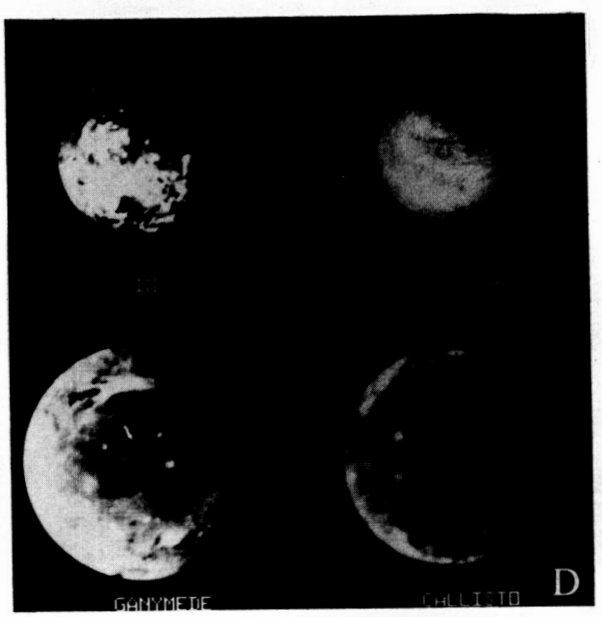
Jupiter

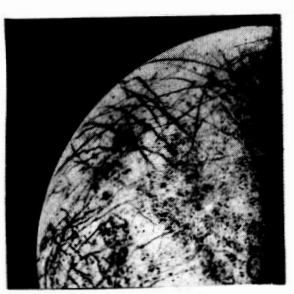
JUPITER

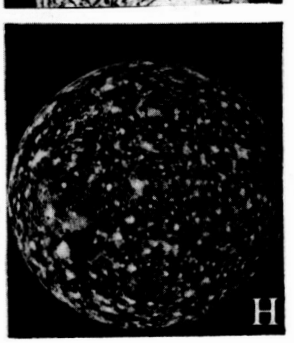
Plate 4 is a collection of press release photographs from the Pioneer 11 and Voyagers 1 and 2 missions. (A) P21631 is a Voyager 1 montage of Jupiter and its four Galilean satellites (the four largest of its 16 known moons). (B) 79HC679, a Pioneer 11 photo of Jupiter showing the north polar region as it passed over it, showing the polar region's lack of belts but with many convection cells. This is a view and aspect never seen from earth. The Great Red Spot is at the bottom. (C) P21774, a Voyager 2 photo of the nightside of Jupiter showing the sunlit atmospheric halo and the Jovian ring discovered on Voyager 1. (D) P21195, a composite of Voyager 1 photos of the four Galilean moons illustrating their relative sizes. Io (3632 km diam.) is about 200 km larger than our moon and Europa (3126 km diam.) is about 300 km smaller than our moon (3478 km diam). Callisto (4820 km diam.) is the size of the planet Mercury and Ganymede (the largest moon in the solar system) at about 5150 km is about 350 km larger than Mercury. (E) P21305, Voyager 1 photo of Io showing its completely volcanic surface and an erupting volcano on the limb. Io's volcanic activity was discovered by Voyager 1. Io is the most volcanically active of any solar system body known, and the only one other than the earth known to have current volcanic activity. (F) P21266, Voyager 1 photo of part of the surface of Ganymede showing the mysterious grooved bands with their criss-cross nature and lateral slip fault movement. (G) P21758, Voyager 2 photo of Europa showing the unique linear features which have no relief, and which look as if they were painted on. Europa's icy surface has apparently flowed and filled in the fissures. (H) P21745, Voyager 1 photo of Callisto showing its crater-saturated surface and the strange multi-ringed structure, Valhalla.











ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

INTRODUCTION

Jupiter, next in line from the sun, has been visited by four U.S. spacecraft. These were Pioneers 10 and 11 and Voyagers 1 and 2. There were 41 investigations for which NSSDC has data or knows the sources thereof, and they cover seven categories, which are (1) Imaging, (2) Particles and Fields, (3) Ultraviolet, (4) Infrared, (5) Radio Science and Celestial Mechanics, (6) Atmosphere, and (7) Polarization. Both the categories Atmosphere and Polarization were obtained from photopolarimeters which are presented under Imaging. Tables 1 and 2 and Appendix A show the investigations in more detail.

********** PIONEER 10**********

SPACECRAFT COMMON NAME- PIONEER 10
ALTERNATE NAMES- PIONEER-F, PL-723D
05860

NSSDC ID- 72-012A

LAUNCH DATE- 03/03/72 WEIGHT- 231. KG
LAUNCH SITE- CAPE CANAVERAL, UNITED STATES
LAUNCH VEHICLE- ATLAS

SPONSORING COUNTRY/AGENCY
UNITED STATES NASA-OSSA

INITIAL ORBIT PARAMETERS
ORBIT TYPE- JUPITER FLYBY

PERSONNEL
PM - C.F. HALL(NLA) NASA-ARC
PS - P. DYAL NASA-ARC

BRIEF DESCRIPTION
This mission was the first to be sent to the outer solar system, and after encountering the planet Jupiter it assured an escape trajectory from the solar system. The spacecraft body was mounted behind a 2.74-m-diameter parabolic dish antenna that was 46 cm deep. The spacecraft structure was a 36-cm-deep flat equipment compartment, the top and bottom being regular hexagons. Its sides were 71 cm long. One side joined a smaller compartment that carried the scientific experiments. The high-gain antenna feed was situated on three struts, which projected forward about 1.2 m. This feed was topped with a medium-gain antenna. A low-gain omnidirectional antenna extended about 0.76 m behind the equipment compartment and was mounted below the high-gain antenna. Power for the spacecraft was obtained by four SNAP-19 radioisotope thermonuclear generators (RTG), which were held about 3 m from the center of the spacecraft by two three-rod trusses 120 deg apart. A third boom extended 6.6 m from the experiment compartment to hold the magnetometer away from the spacecraft. The four RTG's generated about 155 watts at launch and decayed to approximately 140 watts by the time the spacecraft reached Jupiter on December 3, 1973, 21 months after launch. There were three reference sensors: a star sensor for Canopus, and two sun sensors. Attitude position could be calculated from the reference directions to the earth and the sun, with the known direction to Canopus as a backup. Three pairs of rocket thrusters provided spin-rate control (maintained at 4.8 rpm) and changed the velocity of the spacecraft. These thrusters could be pulsed or fired steadily by command. Communications were maintained via the omnidirectional and medium-gain antennas, which operated together, connected to one receiver, while the high-gain antenna was connected to another receiver. These receivers could be interchanged by command to provide some redundancy. Two radio transmitters, coupled to two traveling-wave tube amplifiers, produced 8 watts at 2292 MHz each. Uplink was accomplished at 2110 MHz, while data transmission downlink was at 2292 MHz. The data were received by NASA's Deep Space Network. The spacecraft was temperature-controlled between minus 23 deg C and plus 38 deg C. Fifteen experiments were carried to study the interplanetary and planetary magnetic fields; solar wind parameters; cosmic rays; transition region of the heliosphere; neutral hydrogen abundance; distribution, size, mass, flux, and velocity of dust particles; Jovian aurorae; Jovian radio waves; atmosphere of Jupiter and some of its satellites, particularly Io; and to photograph Jupiter and its satellites. Instruments carried for these experiments were magnetometer, plasma analyzer, charged particle detector, ionizing detector, non-imaging telescopes with overlapping fields of view to detect sunlight reflected from passing meteoroids, sealed pressurized cells of argon and nitrogen gas for measuring the penetration of meteoroids, UV photometer, IR radiometer, and an imaging photopolarimeter, which produced photographs and measured polarization. Further scientific information was obtained from the tracking and occultation data. The spacecraft achieved its closest approach on December 3, 1973, when it reached approximately three Jovian radii (about 210,000 km). The spacecraft contains plaques that have drawings depicting a man, a woman, and the location of the sun and the earth in our galaxy. It is leaving the solar system and passing into interstellar space.

********** PIONEER 11**********

SPACECRAFT COMMON NAME- PIONEER 11
ALTERNATE NAMES- PIONEER-G, PL-733C
6421

NSSDC ID- 73-019A

LAUNCH DATE- 04/06/73 WEIGHT- 231. KG
LAUNCH SITE- CAPE CANAVERAL, UNITED STATES
LAUNCH VEHICLE- ATLAS

SPONSORING COUNTRY/AGENCY
UNITED STATES NASA-OSSA

INITIAL ORBIT PARAMETERS
ORBIT TYPE- SATURN FLYBY

PERSONNEL
PM - C.F. HALL(NLA) NASA-ARC
PS - P. DYAL NASA-ARC

BRIEF DESCRIPTION
This was the second mission to investigate Jupiter and the outer solar system. Pioneer 11, like Pioneer 10, used Jupiter's gravitational field to alter its trajectory radically. It passed close to Saturn and then it followed an escape trajectory from the solar system. The spacecraft was 2.9 m (9.5 ft) long and contained a 2.74-m (9-ft) diameter high-gain antenna of aluminum honeycomb sandwich material whose feed was topped with a medium-gain antenna. A low-gain, omnidirectional antenna was mounted below the high-gain dish. It contained two nuclear electric-power generators, which generated 144 W at Jupiter, but decreased to 100 W at Saturn. There were three reference sensors: a star (Canopus) sensor, and two sun sensors. Attitude position could be calculated from the reference direction to the earth and the sun, with the known direction to Canopus as backup. Pioneer 11's star sensor gain and threshold settings were modified, based on experience gained from the settings used on Pioneer 10. Three pairs of rocket thrusters provided spin-axis control (at 4.8 rpm) and change of the spacecraft velocity. The thrusters could be either fired steadily or pulsed, by command. Communications were maintained via the omnidirectional and medium-gain antennas, which operated together, connected to one receiver, while the high-gain antenna was connected to the other receiver. The receivers could be interchanged by command. Two radio transmitters, coupled to two traveling wave tube amplifiers, produced 8 W power each in S-band. Communication uplink (earth to spacecraft) operated at 2110 MHz, and downlink (spacecraft to earth) at 2292 MHz. At Jupiter's distance, round-trip communication time took 92 min. Data were received at the Deep Space Network (DSN). The spacecraft was temperature-controlled to between -23 and +38 deg C (-10 to +100 deg F). An additional experiment, a low-sensitivity fluxgate magnetometer, was added to the Pioneer 11 payload. Instruments studied the interplanetary and planetary magnetic fields; solar wind properties; cosmic rays; transition region of the heliosphere; neutral hydrogen abundance; distribution, size, mass, flux, and velocity of dust particles; Jovian aurorae; Jovian radio waves; the atmospheres of planets and satellites; and the surfaces of Jupiter, Saturn, and some of their satellites. Instruments carried for these experiments were magnetometer, plasma analyzer (for solar wind), charged-particle detector, ionizing detector, non-imaging telescopes with overlapping fields of view to detect sunlight reflected from passing meteoroids, sealed pressurized cells of argon and nitrogen gas for measuring penetration of meteoroids, UV photometer, IR radiometer, and an imaging photopolarimeter, which produced photographs and measured the polarization. Further scientific information was obtained from celestial mechanics and occultation phenomena. This spacecraft, like Pioneer 10, contains a plaque that has a drawing depicting man, woman, and the location of the sun and earth in the galaxy. Pioneer 11 was 36,800 km from Jupiter during its closest approach, December 4, 1974, to within 43,000 km of its cloud tops. It passed by Saturn on Aug. 5, 1979 at a distance of 21,400 km from Saturn's cloud tops.

********** VOYAGER 1**********

SPACECRAFT COMMON NAME- VOYAGER 1
ALTERNATE NAMES- MARINER JUPITER/SATURN A, OUTER PLANETS A
MARINER 77A, MJS 77A
10321

NSSDC ID- 77-084A

LAUNCH DATE- 09/05/77 WEIGHT- 700. KG
LAUNCH SITE- CAPE CANAVERAL, UNITED STATES
LAUNCH VEHICLE- TITAN

SPONSORING COUNTRY/AGENCY
UNITED STATES NASA-OSSA

INITIAL ORBIT PARAMETERS
ORBIT TYPE- SATURN FLYBY

PERSONNEL
PM - J.R. CASANI NASA-JPL
PS - E.C. STONE CALIF INST OF TECH

BRIEF DESCRIPTION
The overall objectives of Voyager were to conduct exploratory investigations of the planetary systems of Jupiter and Saturn and of the interplanetary medium out to Saturn. Primary emphasis was placed on comparative studies of these two planetary systems by obtaining (1) measurements of the environment, atmosphere, and body characteristics of the planets and the satellites of each planet, (2) studies of the nature of the rings of Saturn, and (3) exploration of the interplanetary (or interstellar) medium at increasing distances from the sun. These objectives were attained by using a variety of instruments and methods including imaging, a coherent S- and X-band RF receiver, an infrared interferometer

ard radiometer, UV spectrometer, fluxgate magnetometers, Faraday cups, a charged-particle analyzer, plasma detector, plasma-wave radio receiver, cosmic-ray telescopes, photopolarimeter, and a sweep-frequency radio receiver. Voyager 1 had its closest encounter with Jupiter on March 5, 1979, and with Saturn on November 12, 1980.

********** VOYAGER 2**********

SPACECRAFT COMMON NAME- VOYAGER 2
ALTERNATE NAMES- MARINER JUPITER/SATURN B, OUTER PLANETS B
MARINER 77B, MJS 77B
10271

NSSDC ID- 77-076A

LAUNCH DATE- 08/20/77 WEIGHT- 700. KG
LAUNCH SITE- CAPE CANAVERAL, UNITED STATES
LAUNCH VEHICLE- TITAN

SPONSORING COUNTRY/AGENCY
UNITED STATES NASA-OSSA

INITIAL ORBIT PARAMETERS
ORBIT TYPE- SATURN FLYBY

PERSONNEL
PM - J.R. CASANI NASA-JPL
PS - E.C. STONE CALIF INST OF TECH

BRIEF DESCRIPTION
The overall objectives of Voyager 2 were to conduct exploratory investigations of the planetary systems of Jupiter, Saturn, Uranus, and Neptune, and of the interplanetary medium. Primary emphasis was placed on comparative studies of these planetary systems by obtaining (1) measurements of the *environment*, atmosphere, and body characteristics of the planets and one or more of the satellites of each planet, (2) studies of the nature of the rings of Saturn and Uranus, and (3) exploration of the interplanetary (or interstellar) medium at increasing distances from the sun. These objectives were met using a variety of instruments and methods including imaging, a coherent S- and X-band RF receiver, an IR interferometer and radiometer, a UV spectrometer, fluxgate magnetometers, Faraday cups, a charged-particle analyzer, plasma detector, plasma-wave radio receiver, cosmic-ray telescopes, photopolarimeter, and a sweep-frequency radio receiver. Jupiter close encounter was achieved on July 9, 1979, and Saturn on August 5, 1981.

INVESTIGATIONS

IMAGING

------- PIONEER 10, GEHRELS----------

INVESTIGATION NAME- IMAGING PHOTOPOLARIMETER (IPP)

NSSDC ID- 72-012A-07 INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
ASTRONOMY
PLANETARY ATMOSPHERES

PERSONNEL

PI - T.	GEHRELS	U OF ARIZONA
OI - D.L.	COFFEEN	NASA-GISS
OI - J.	HAMEEN-ANTTILA	U OF ARIZONA
OI - C.E.	KENKNIGHT	U OF ARIZONA
OI - R.F.	HUMMER	SANTA BARBARA RES CTR
OI - M.G.	TOMASKO	U OF ARIZONA
OI - W.	SWINDELL	U OF ARIZONA

BRIEF DESCRIPTION
The Imaging Photopolarimeter (IPP) experiment (used also on Pioneer 11) used during Jovian encounter made simultaneous, two-color (blue - 3900 to 4900 A, red - 5800 to 7000 A) polarimetric and radiometric measurements, and moderate-resolution (about 200 km at best) spin-scan images of Jupiter and the Jovian satellites. The polarimetric and radiometric work was performed using an 8- x 8- mrad field-stop aperture, while the spin-scan imaging used a 0.5- by 0.5-mrad aperture stop. Relative radiometric calibration was derived using an internal tungsten lamp. Long-term absolute calibration of the instrument was accomplished by means of a sunlight diffuser/attenuator element located in the spacecraft antenna structure. Primary radiometric calibration was obtained throughout the mission by periodically commanding the telescope to view this diffuse backlighted (sunlight) source. The experimental train for the IPP package consisted of the following elements: (1) a *near-diffraction-limited* 2.54-cm Maksutov catadioptric telescope of focal ratio f/3.4, (2) a focal-plane wheel containing field-of-view (FOV) apertures, depolarizers, calibration sources, etc., (3) a Wollaston prism to split light into two orthogonally polarized beams, (4) a 45-deg dichromatic mirror that reflected wavelengths shorter than 5500 A (blue beam) and transmitted all light of greater wavelength (red beam), (5) for each spectral beam, two Bendix Channeltron detectors (blue bialkali S-11 photocathodes and red S-20 photocathodes) to register the intensity in each polarization component. Polarization data also include the interplanetary region.

------- *PIONEER 11, GEHRELS*----------

INVESTIGATION NAME- IMAGING PHOTOPOLARIMETER (IPP)

NSSDC ID- 73-019A-07 INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
ASTRONOMY
PLANETARY ATMOSPHERES
PLANETOLOGY

PERSONNEL

PI - T.	GEHRELS	U OF ARIZONA
OI - D.L.	COFFEEN	NASA-GISS
OI - J.	HAMEEN-ANTTILA	U OF ARIZONA
OI - C.E.	KENKNIGHT	U OF ARIZONA
OI - R.F.	HUMMER	SANTA BARBARA RES CTR
OI - M.G.	TOMASKO	U OF ARIZONA
OI - W.	SWINDELL	U OF ARIZONA

BRIEF DESCRIPTION
The Imaging Photopolarimeter (IPP) experiment used during Jovian and Saturnian encounter made simultaneous, two-color (blue - 3900 to 4900 A, red - 5800 to 7000 A) polarimetric and radiometric measurements, and moderate-resolution (about 200 km at best) spin-scan images of Jupiter and the Jovian satellites and Saturn and some of its satellites. The polarimetric and radiometric work was performed using an 8- by 8-mrad field-stop aperture, while the spin-scan imaging used a 0.5- by 0.5-mrad aperture stop. Relative radiometric calibration was derived using an internal tungsten lamp. Long-term absolute calibration of the instrument was accomplished by means of a sunlight diffusor/attenuator element located in the spacecraft antenna structure. Primary radiometric calibration was obtained throughout the mission by periodically commanding the telescope to view this diffuse backlighted (sunlight) source. The experimental train for the IPP package consisted of the following elements: (1) a near-diffraction-limited 2.54-cm Maksutov telescope of focal ratio f/3.4, (2) a focal-plane wheel containing field-of-view (FOV) apertures, depolarizers, calibration source, etc., (3) a Wollaston prism to split the light into two orthogonally polarized beams, (4) a 45-deg dichromatic mirror that reflected wavelengths of less than 5500 A (blue beam) and transmitted all light of longer wavelength (red beam), (5) a filtering-coated relay lens and folding mirrors for each spectral beam (the two polarizations were separated), and (6) two Bendix channeltron (blue - bialkali S-11, red - S-20) photocathodes for each spectral beam to register the intensity in each polarization component. Polarization data include the interplanetary region.

------- VOYAGER 1, SMITH----------

INVESTIGATION NAME- IMAGING

NSSDC ID- 77-084A-01 INVESTIGATIVE PROGRAM
CODE EL-4/CO-OP, SCIENCE

INVESTIGATION DISCIPLINE(S)
METEOROLOGY
PLANETARY ATMOSPHERES
PLANETOLOGY
ATMOSPHERIC PHYSICS

PERSONNEL

TL - B.A.	SMITH	U OF ARIZONA
DT - L.A.	SODERBLOM	US GEOLOGICAL SURVEY
TM - G.A.	BRIGGS	NASA HEADQUARTERS
TM - A.F.	COOK	SAO
TM - G.E.	DANIELSON	CALIF INST OF TECH
TM - M.E.	DAVIES	RAND CORP
TM - G.E.	HUNT	U COLLEGE LONDON
TM - T.	*OWEN*	*STATE U OF NEW YORK*
TM - C.	SAGAN	CORNELL U
TM - V.E.	SUOMI	U OF WISCONSIN
TM - T.V.	JOHNSON	NASA-JPL
TM - H.	MASURSKY	US GEOLOGICAL SURVEY

BRIEF DESCRIPTION
The photographic experiment used a two-camera system, *based on the Mariner 10 system.* This system included one narrow-angle, long-focal-length camera and one wide-angle, short-focal-length camera. The maximum resolution achievable depended on the actual trajectory on this multi-encounter mission, but the resolution was as high as 0.5 to 1.0 km on the closest approaches to some objects. At Jupiter and Saturn, the resolution was better than 20 km and 5 km, respectively. The objectives of the experiment were to photograph global motions *and cloud distributions* on Jupiter and Saturn, gross dynamical properties, zonal rotation, orientation of spin axis, zonal shear, vertical shear, flow instabilities, spots, and spectrum of scale of atmospheric motions in time and space. Additional objectives included the study of the mode of release of internal energy flux (search for convection cells and rolls), study of growth, dissipation, morphology, and vertical structure of cloud complexes, gross optical properties, global *and* localized scattering function in the visible spectrum, polarimetry, nature of chromophores (their structure and

development), and high resolution of the Great Red Spot. The objectives of the satellite encounters included the following: (1) gross characteristics (size, shape, rotation, spin axis, cartography, improved ephemerides and masses,) (2) geology (major physiographic provinces, impact and volcanic features, lineaments, polar caps, erosion processes, and low- and high-density satellite comparative studies, detection of atmospheres, frosts, and limb stratification of aerosols,) (3) surface properties (colorimetry, scattering function, nature of brightness variation, and search for new satellites.) Studies of Saturn's rings included: (1) resolution of individual ring components or clumps of material, (2) vertical and radial distribution of material at very high resolution, (3) scattering function, (4) coarse polarimetry, (5) occultation - optical depth, and (6) distinguishing different types of material in the rings. Other objectives were to search for new comets, asteroids, and targets of opportunity.

------- VOYAGER 2, SMITH----------

INVESTIGATION NAME- IMAGING

NSSDC ID- 77-076A-01

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
METEOROLOGY
PLANETARY ATMOSPHERES
PLANETOLOGY

PERSONNEL

TL - B.A.	SMITH	U OF ARIZONA
DT - L.A.	SODERBLOM	US GEOLOGICAL SURVEY
TM - G.A.	BRIGGS	NASA HEADQUARTERS
TM - A.F.	COOK	SAO
TM - G.E.	DANIELSON	CALIF INST OF TECH
TM - M.E.	DAVIES	RAND CORP
TM - G.E.	HUNT	U COLLEGE LONDON
TM - T.	OWEN	STATE U OF NEW YORK
TM - C.	SAGAN	CORNELL U
TM - V.E.	SUOMI	U OF WISCONSIN
TM - T.V.	JOHNSON	NASA-JPL
TM - H.	MASURSKY	US GEOLOGICAL SURVEY

BRIEF DESCRIPTION

The photographic experiment used a two-camera system, based on the Mariner 10 system. This system included one narrow-angle, long-focal-length camera and one wide-angle, short-focal-length camera. The maximum resolution achievable depended greatly on the actual trajectory on this multi-encounter mission, but was as high as 0.5 to 1.0 km on the closest approaches to some objects. At Jupiter and Saturn, the resolution that was achieved was better than 20 km and 5 km, respectively. The objectives of the experiment were to photograph global motions and cloud distributions on Jupiter, Saturn, Uranus, and Neptune, gross dynamical properties, zonal rotation, orientation of spin axis, zonal shear, vertical shear, flow instabilities, spots, and spectrum of scale of atmospheric motions in time and space. Additional objectives included the study of the mode of release of internal energy flux (search for convection cells and rolls), study of growth, dissipation, morphology, and vertical structure of cloud complexes, gross optical properties, global and localized scattering function in the visible spectrum, polarimetry, nature of chromophores (their structure and development), and high resolution of the Great Red Spot. The objectives of the satellite encounters included (1) gross characteristics (size, shape, rotation, spin axis, cartography, improved ephemerides and masses;) (2) geology (major physiographic provinces, impact and volcanic features, lineaments, polar caps, erosion processes, and low- and high-density satellite comparative studies, detection of atmospheres, frosts, and limb stratification of aerosols;) and (3) surface properties (colorimetry, scattering function, nature of brightness variation, and search for new satellites.) Studies of Saturn's rings were carried out and will be for Uranus' rings. Objectives included (1) resolution of individual ring components of clumps of material; (2) vertical and radial distribution of material at very high resolution; (3) scattering function; (4) coarse polarimetry; (5) occultation - optical depth; and (6) distinguishing different types of material in the rings. Other objectives were to search for new comets, asteroids, and targets of opportunity.

PARTICLES AND FIELDS

------- PIONEER 10, WOLFE----------

INVESTIGATION NAME- PLASMA

NSSDC ID- 72-012A-13

INVESTIGATIVE PROGRAM
CODE EL-4/CO-OP, SCIENCE

INVESTIGATION DISCIPLINE(S)
SPACE PLASMAS
PARTICLES AND FIELDS

PERSONNEL

PI - J.H.	WOLFE	NASA-ARC
OI - L.A.	FRANK	U OF IOWA
OI - R.	LUST	MPI-HEADQUARTERS
OI - D.S.	INTRILIGATOR	U OF SOUTHERN CALIF
OI - D.D.	MCKIBBIN	NASA-ARC
OI - V.T.	ZAVIENTSEFF(NLA)	NASA-ARC
OI - F.L.	SCARF	TRW SYSTEMS GROUP
OI - H.R.	COLLARD	NASA-ARC
OI - W.C.	FELDMAN	LOS ALAMOS NAT LAB
OI - Z.A.	SMITH	NOAA-SEL

BRIEF DESCRIPTION

The instrument (also carried on Pioneer 11) consisted of dual 90-deg quadrispherical electrostatic analyzers, one with 26 individual particle detectors and the other with 5 current collectors. The system was capable of measuring incident plasma distribution parameters over the energy range 0.1 to 18 keV for protons and approximately 1-500 eV for electrons. The high-resolution analyzer, with a constant of 9 keV/Q per kV applied to the plates, had a mean plate radius of 9 cm and separation of 0.5 cm. This analyzer, which was used to measure ions only, had 26 channeltrons mounted on the semicircular exit to the analyzer. The aperture pointed through a wide slit in the back of the spacecraft high-gain antenna reflector and pointed along the spin axis toward the earth (and therefore the sun). The edges of the antenna reflector limited the viewing of the instrument to 73 deg with respect to the spin axis. The channeltrons covered a range of plus or minus 51 deg. Each channeltron near the center covered 3 deg, and approximately 8 deg near the edges of the analyzer. The angular width perpendicular to the long angular width was about 2 deg. In one half the spin period, the whole cone of half angle 51 deg, centered on the sun, was swept out. A medium-energy analyzer with a mean radius of 12 cm and a 1-cm plate separation (constant of 6 keV/Q per kV applied) was used to detect both ions and electrons. The detectors were five flat-surface current collectors. The three center collectors each covered 15 deg and covered the angular range of plus or minus 22.5 deg from the spin axis. The two outside collectors had an angular width of 47.5 deg and were located at plus or minus 46.25 deg from the center of the analyzer. There were a variety of possible operating modes for the experiment; however, the principal mode utilized during the encounter phase was one in which the analyzer plate potential was stepped through its range every one-half revolution of the spacecraft, and all current collectors or channeltrons were read out at the peak flux roll angle. The high- and medium-resolution analyzers operated independently, so that a cross-check between these analyzers was possible. The dynamic range for the particle fluxes was from 1.0E+2 to 3.0E+9/sq cm s and the proton temperature could be ascertained down to 2.0E+3 deg K. Data include the interplanetary region.

------- PIONEER 11, WOLFE----------

INVESTIGATION NAME- PLASMA

NSSDC ID- 73-019A-13

INVESTIGATIVE PROGRAM
CODE EL-4/CO-OP, SCIENCE

INVESTIGATION DISCIPLINE(S)
SPACE PLASMAS
PARTICLES AND FIELDS

PERSONNEL

PI - J.H.	WOLFE	NASA-ARC
OI - L.A.	FRANK	U OF IOWA
OI - R.	LUST	MPI-HEADQUARTERS
OI - D.S.	INTRILIGATOR	U OF SOUTHERN CALIF
OI - V.T.	ZAVIENTSEFF(NLA)	NASA-ARC
OI - Z.A.	SMITH	NOAA-SEL
OI - F.L.	SCARF	TRW SYSTEMS GROUP
OI - H.R.	COLLARD	NASA-ARC
OI - W.C.	FELDMAN	LOS ALAMOS NAT LAB
OI - D.D.	MCKIBBIN	NASA-ARC

BRIEF DESCRIPTION

The instrument consisted of dual 90-deg quadrispherical electrostatic analyzers, one with 26 individual particle detectors and the other with 5 current collectors. The system was capable of measuring incident plasma distribution parameters over the energy range 0.1 to 18 keV for protons and approximately 1-500 eV for electrons. The high-resolution analyzer with a constant of 9 keV/Q per kV applied to the plates, had a mean plate radius of 9 cm and separation of 0.5 cm. This analyzer was used to measure ions only, and had 26 channeltrons mounted on the semicircular exit to the analyzer. The aperture pointed through a wide slit in the back of the spacecraft high-gain antenna reflector and pointed along the spin axis toward the earth (and therefore the sun). The edges of the antenna reflector limited the viewing of the instrument to 73 deg with respect to the spin axis. The channeltrons covered a range of plus or minus 51 deg. Each channeltron near the center covered 3 deg and approximately 8 deg near the edges of the analyzer. The angular width perpendicular to the long angular width was about 2 deg. In half the pin period the whole cone of half-angle 51 deg centered on the sun was swept out. A medium-energy analyzer with a mean radius of 12 cm and a 1 cm plate separation (constant of 6 keV/Q per kV applied) was used to detect both ions and electrons. The detectors were five flat-surface current collectors. The three center collectors each covered 15 deg and covered the angular range of plus or minus 22.5 deg from the spin axis. The two outside

collectors had an angular width of 47.5 deg and were located at plus or minus 46.25 deg from the center of the analyzer. There was a variety of possible operating modes for the experiment; however, the principal mode utilized during the encounter phase was one in which the analyzer plate potential was stepped through its range every one-half revolution of the spacecraft, and all current collectors or channeltrons were read out at the peak flux roll angle. The high and medium resolution analyzers operated independently, so a cross check between these analyzers was possible. The dynamic range for the particle fluxes was from 1.0E+2 to 3.0E+9/sq cm s and the proton temperature down to 2.0E+3 deg K could be ascertained. Data include the interplanetary region.

------- VOYAGER 1, KRIMIGIS----------

INVESTIGATION NAME- LOW-ENERGY CHARGED PARTICLE ANALYZER AND TELESCOPE

NSSDC ID- 77-084A-07

INVESTIGATIVE PROGRAM
CODE EL-4/CO-OP, SCIENCE

INVESTIGATION DISCIPLINE(S)
COSMIC RAYS
MAGNETOSPHERIC PHYSICS
PARTICLES AND FIELDS

PERSONNEL

PI - S.M.	KRIMIGIS	APPLIED PHYSICS LAB
CI - C.Y.	FAN	U OF ARIZONA
CI - G.	GLOECKLER	U OF MARYLAND
CI - L.J.	LANZEROTTI	BELL TELEPHONE LAB
CI - T.P.	ARMSTRONG	U OF KANSAS
CI - W.I.	AXFORD	MPI-AERONOMY
CI - C.O.	BOSTROM	APPLIED PHYSICS LAB
CI - E.P.	KEATH	APPLIED PHYSICS LAB

BRIEF DESCRIPTION
The objective of this experiment was to study the magnetospheres of Jupiter and Saturn, using a low-energy magnetospheric particle analyzer. This detector made measurements in (1) the distant magnetosphere and bow shock of Jupiter, (2) the magnetosphere of Saturn, and (3) the trapped-radiation belts in the vicinity of Jupiter. Additionally, this detector was able to study low-energy particles in the interplanetary medium. The energy range of this detector was 10 keV to 1.1 MeV for electrons and 10 keV to 150 MeV for ions. During the interplanetary cruise period, protons, alpha particles, and heavier nuclei (z from 3 to 26) were separately identified and their energy measured in the range from 0.05 to 30 MeV, using a low-energy particle telescope.

------- VOYAGER 2, KRIMIGIS----------

INVESTIGATION NAME- LOW-ENERGY CHARGED PARTICLE ANALYZER AND TELESCOPE

NSSDC ID- 77-076A-07

INVESTIGATIVE PROGRAM
CODE EL-4/CO-OP, SCIENCE

INVESTIGATION DISCIPLINE(S)
COSMIC RAYS
MAGNETOSPHERIC PHYSICS
PARTICLES AND FIELDS

PERSONNEL

PI - S.M.	KRIMIGIS	APPLIED PHYSICS LAB
CI - C.O.	BOSTROM	APPLIED PHYSICS LAB
CI - T.P.	ARMSTRONG	U OF KANSAS
CI - W.I.	AXFORD	MPI-AERONOMY
CI - G.	GLOECKLER	U OF MARYLAND
CI - L.J.	LANZEROTTI	BELL TELEPHONE LAB
CI - C.Y.	FAN	U OF ARIZONA
CI - E.P.	KEATH	APPLIED PHYSICS LAB

BRIEF DESCRIPTION
The objective of this experiment was to study the magnetospheres of Jupiter, Saturn, Uranus, and Neptune, using a low-energy magnetospheric particle analyzer. This detector made measurements in (1) the distant magnetosphere and bow shock of Jupiter, (2) the magnetosphere of Saturn and possible magnetosphere of Uranus and Neptune, and (3) the trapped radiation belts in the vicinity of these planets. Additionally, this detector was able to study low-energy particles in the interplanetary medium. The energy range of this detector was 10 keV to 1.1 MeV for electrons and 10 keV to 150 MeV for ions. During the interplanetary cruise period, protons, alpha particles, and heavier nuclei (z from 3 to 26) were separately identified and their energies measured in the range from 0.05 to 30 MeV, using a low-energy particle telescope.

------- VOYAGER 1, SCARF----------

INVESTIGATION NAME- PLASMA WAVE (.01-56 KHZ)

NSSDC ID- 77-084A-13

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS
MAGNETOSPHERIC PHYSICS
PLANETARY IONOSPHERES

PERSONNEL

PI - F.L.	SCARF	TRW SYSTEMS GROUP
CI - D.A.	GURNETT	U OF IOWA

BRIEF DESCRIPTION
This investigation provided continuous, sheath-independent measurements of the electron-density profiles at Jupiter and Saturn. It also gave basic information on local wave-particle interaction required to carry out comparative studies of the physics of the Jupiter and Saturn magnetospheres. The instrumentation consisted of a 16-channel, step-frequency receiver and a low-frequency waveform receiver, with associated electronics. The frequency range for this instrument was from 10 Hz to 56 kHz. This instrument shared the 10-m antennas developed for the investigation of planetary radio astronomy.

------- VOYAGER 2, SCARF----------

INVESTIGATION NAME- PLASMA WAVE (.01-56 KHZ)

NSSDC ID- 77-076A-13

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY IONOSPHERES
PARTICLES AND FIELDS
MAGNETOSPHERIC PHYSICS

PERSONNEL

PI - F.L.	SCARF	TRW SYSTEMS GROUP
CI - D.A.	GURNETT	U OF IOWA

BRIEF DESCRIPTION
This investigation provided continuous, sheath-independent measurements of the electron density profiles at Jupiter and Saturn and will for Uranus and Neptune. It also gave basic information on local wave-particle interactions required to carry out comparative studies of the physics of the magnetospheres of these planets. The instrumentation consisted of a 16-channel step frequency receiver and a low-frequency waveform receiver with associated electronics. The frequency range for this instrument was from 10 Hz to 56 kHz. This instrument shared the 10-m antennas developed for the planetary radio astronomy investigation.

------- VOYAGER 1, BRIDGE----------

INVESTIGATION NAME- PLASMA SPECTROMETERS

NSSDC ID- 77-084A-06

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS
SPACE PLASMAS

PERSONNEL

PI - H.S.	BRIDGE	MASS INST OF TECH
CI - J.W.	BELCHER	MASS INST OF TECH
CI - C.K.	GOERTZ	MPI-AERONOMY
CI - A.J.	LAZARUS	MASS INST OF TECH
CI - S.	OLBERT	MASS INST OF TECH
CI - V.M.	VASYLIUNAS	MPI-AERONOMY
CI - L.F.	BURLAGA	NASA-GSFC
CI - R.E.	HARTLE	NASA-GSFC
CI - K.W.	OGILVIE	NASA-GSFC
CI - G.L.	SISCOE	U OF CALIF, LA
CI - A.J.	HUNDHAUSEN	NATL CTR FOR ATMOS RES
CI - J.D.	SULLIVAN	MASS INST OF TECH
CI - J.D.	SCUDDER	NASA-GSFC

BRIEF DESCRIPTION
The plasma investigation made use of two Faraday-cup detectors, one pointed along the earth-spacecraft line and one at right angles to this line. The earth-pointing detector determined the macroscopic properties of the plasma ions, obtaining accurate values of their velocity, density, and pressure. Three sequential energy scans were employed with (delta E)/E equal to 20, 7.2, and 1.8 %, allowing a coverage from subsonic to highly supersonic flow. The side-looking Faraday cup measured electrons in the energy range from 5 eV to 1 keV.

------- VOYAGER 2, BRIDGE----------

INVESTIGATION NAME- PLASMA SPECTROMETERS

NSSDC ID- 77-076A-06

INVESTIGATIVE PROGRAM
CODE EL-4/CO-OP, SCIENCE

INVESTIGATION DISCIPLINE(S)
SPACE PLASMAS
PARTICLES AND FIELDS

PERSONNEL

PI - H.S.	BRIDGE	MASS INST OF TECH
CI - A.J.	LAZARUS	MASS INST OF TECH
CI - S.	OLBERT	MASS INST OF TECH
CI - J.W.	BELCHER	MASS INST OF TECH
CI - V.M.	VASYLIUNAS	MPI-AERONOMY
CI - L.F.	BURLAGA	NASA-GSFC
CI - C.K.	GOERTZ	MPI-AERONOMY
CI - G.L.	SISCOE	U OF CALIF, LA
CI - A.J.	HUNDHAUSEN	NATL CTR FOR ATMOS RES
CI - R.E.	HARTLE	NASA-GSFC
CI - K.W.	OGILVIE	NASA-GSFC
CI - J.D.	SULLIVAN	MASS INST OF TECH
CI - J.D.	SCUDDER	NASA-GSFC

BRIEF DESCRIPTION

The plasma investigation made use of two Faraday-cup detectors, one pointed along the earth-spacecraft line and one at right angles to this line. The earth-pointing detector determined the macroscopic properties of the plasma ions, obtaining accurate values of their velocity, density, and pressure. Three sequential energy scans were employed with (delta E)/E equal to 29, 7.2, and 1.8 %, allowing a coverage from subsonic to highly supersonic flow. The side-looking Faraday cup measurec electrons in the energy range from 5 eV to 1 keV.

------- PIONEER 10, SMITH----------

INVESTIGATION NAME- MAGNETIC FIELDS

NSSDC ID- 72-012A-01

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS
PLANETARY MAGNETIC FIELD
MAGNETOSPHERIC PHYSICS

PERSONNEL

PI - E.J.	SMITH	NASA-JPL
OI - D.S.	COLBURN	NASA-ARC
OI - P.	DYAL	NASA-ARC
OI - C.P.	SONETT	U OF ARIZONA
OI - P.J.	COLEMAN, JR.	U OF CALIF, LA
OI - L.	DAVIS, JR.	CALIF INST OF TECH
OI - D.E.	JONES	BRIGHAM YOUNG U

BRIEF DESCRIPTION

The magnetometer on Pioneer 10 (also carried on Pioneer 11) is a triaxial helium magnetometer with seven dynamic ranges, from plus or minus 2.5 nT to plus or minus 10 gauss. The linearity was 0.1%, and the noise threshold was 0.01% rms for 0-1 Hz. The accuracy was 0.5% of full scale range. No further useful data were obtained. The experimenter has used RTN coordinates in his data analysis. In this system, R (or X) is radially outward from the sun, T (or Y) is parallel to the sun's equatorial plane and has its direction given by the cross product of the sun's spin vector into the radial direction (i.e., into R) and N (or Z) completes the right-handed orthogonal system (positive northward). A detailed instrument description may be found in Smith et al., IEEE Trans. On Magnetics, Mag-11, p. 962, July 1975. Some data also include the interplanetary region.

------- PIONEER 11, SMITH----------

INVESTIGATION NAME- MAGNETIC FIELDS

NSSDC ID- 73-019A-01

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
MAGNETOSPHERIC PHYSICS
PLANETARY MAGNETIC FIELD
PARTICLES AND FIELDS

PERSONNEL

PI - E.J.	SMITH	NASA-JPL
OI - D.S.	COLBURN	NASA-ARC
OI - P.	DYAL	NASA-ARC
OI - C.P.	SONETT	U OF ARIZONA
OI - P.J.	COLEMAN, JR.	U OF CALIF, LA
OI - L.	DAVIS, JR.	CALIF INST OF TECH
OI - D.E.	JONES	BRIGHAM YOUNG U

BRIEF DESCRIPTION

The magnetometer on Pioneer 11 was a triaxial helium magnetometer with seven dynamic ranges, from plus or minus 2.5 nT to plus or minus 1.0E-3 T. The linearity was 0.1% and the noise threshold was 0.01 nT rms for 0-1 Hz. The accuracy was 0.5% of full scale range. The experimenter used RTN coordinates in the data analysis. In this system, R (or X) is radially outward from the sun, T (or Y) was parallel to the sun's equatorial plane and had its direction given by the cross product of the sun's spin vector into the radial direction (i.e., into R) and N (or Z) completed the right-handed orthogonal system (positive northward). A detailed instrument description may be found in Smith et al., IEEE Trans. On Magnetics, v. M-11, p. 962, July 1975. Data include the interplanetary region.

------- VOYAGER 1, NESS----------

INVESTIGATION NAME- TRIAXIAL FLUXGATE MAGNETOMETERS

NSSDC ID- 77-084A-05

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY MAGNETIC FIELD
PARTICLES AND FIELDS
INTERPLANETARY MAGNETIC FIELDS

PERSONNEL

PI - N.F.	NESS	NASA-GSFC
CI - M.H.	ACUNA	NASA-GSFC
CI - K.W.	BEHANNON	NASA-GSFC
CI - L.F.	BURLAGA	NASA-GSFC
CI - R.P.	LEPPING	NASA-GSFC
CI - F.M.	NEUBAUER	BRAUNSCHWEIG TECH U

BRIEF DESCRIPTION

This experiment was designed to investigate the magnetic fields of Jupiter and Saturn, the solar-wind interaction with the magnetospheres of these planets, and the interplanetary magnetic field out to the solar wind boundary with the interstellar magnetic field and beyond, if crossed. The investigation was carried out using two high-field and two low-field triaxial fluxgate magnetometers. Data accuracy of the interplanetary fields was plus or minus 0.1 nT, and the range of measurements was from 0.01 nT to 2.E-3 T.

------- VOYAGER 2, NESS----------

INVESTIGATION NAME- TRIAXIAL FLUXGATE MAGNETOMETERS

NSSDC ID- 77-076A-05

INVESTIGATIVE PROGRAM
CODE EL-4/CO-OP, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY MAGNETIC FIELD
PARTICLES AND FIELDS
INTERPLANETARY MAGNETIC FIELDS

PERSONNEL

PI - N.F.	NESS	NASA-GSFC
CI - R.P.	LEPPING	NASA-GSFC
CI - F.M.	NEUBAUER	BRAUNSCHWEIG TECH U
CI - K.W.	BEHANNON	NASA-GSFC
CI - L.F.	BURLAGA	NASA-GSFC
CI - M.H.	ACUNA	NASA-GSFC

BRIEF DESCRIPTION

This experiment was designed to investigate (1) the magnetic fields of Jupiter, Saturn, Uranus, and Neptune; and (2) the solar-wind interaction of the magnetospheres of these planets with the interplanetary magnetic field out to the solar-wind boundary with the interstellar magnetic field, and beyond, if crossed. The investigation was carried out using two high-field and two low-field triaxial fluxgate magnetometers. Data accuracy of the interplanetary fields was plus or minus 0.1 nT, and the range of measurements is from 0.01 nT to 2.E-3 T.

------- PIONEER 11, ACUNA----------

INVESTIGATION NAME- JOVIAN MAGNETIC FIELD

NSSDC ID- 73-019A-14

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
MAGNETOSPHERIC PHYSICS
PLANETARY MAGNETIC FIELD

PERSONNEL

PI - M.H.	ACUNA	NASA-GSFC
OI - N.F.	NESS	NASA-GSFC

BRIEF DESCRIPTION

This instrument, designed to measure the Jovian and Saturnian magnetic field, consisted of a single-range triaxial fluxgate magnetometer sensor and associated electronics capable of measuring fields from 1.E-6 to 1.E-3 T (0.01 to 10 gauss) along each orthogonal axis. Use of a 10-bit A-to-D converter yielded a quantization step size of minus to plus 600 nT for fields less than 2.E-4 T. Instantaneous vector measurements were made once every three revolutions of the spacecraft (36 s) and transmitted to the ground with no further onboard processing. More instrumental details are given in Sp. Sci. Instrum., v. 1, p. 177, 1975. Principal Jovian scientific results can be found in J. Geophys. Res., v. 81, p. 2917, 1976.

------- PIONEER 10, SIMPSON----------

INVESTIGATION NAME- CHARGED PARTICLE COMPOSITION

NSSDC ID- 72-012A-02

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS
COSMIC RAYS

PERSONNEL

PI - J.A.	SIMPSON	U OF CHICAGO
OI - J.J.	O'GALLAGHER	U OF MARYLAND
OI - A.	TUZZOLINO	U OF CHICAGO

BRIEF DESCRIPTION

This experiment (carried also on Pioneer 11) measured charged-particle composition and spectra using four detector systems: (1) the main telescope, consisting of seven elements and providing energy spectra (approximately 3 to 68 MeV for protons and 10 to 150 MeV/N for oxygen), element resolution (through oxygen), and isotope resolution (for H and He); (2) the low-energy subsystem telescope, consisting of two elements and using a very small thin first element to extend the high-sensitivity proton measurements below 1 MeV (0.3 to 9 MeV) in the presence of a high gamma-ray background aboard the spacecraft; (3) the electron-current detector (or ECD), consisting of a beryllium-shield silicon detector operated in current mode to measure high fluxes of electrons with energies above 3 MeV; and (4) the fission cell detector, recording fission fragments from the nucleon-induced fission of thorium 232 sandwiched between two large-area silicon detectors to measure fluxes of protons (above 30 MeV) in the presence of high fluxes of electrons. The experiment sample time was synchronized with the spacecraft spin, permitting sectoring of the readout of the main and low-energy telescopes into eight octants about the spin axis. Data also include the interplanetary region.

------- PIONEER 11, SIMPSON----------

INVESTIGATION NAME- CHARGED PARTICLE COMPOSITION

NSSDC ID- 73-019A-02

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS
COSMIC RAYS

PERSONNEL

PI - J.A.	SIMPSON	U OF CHICAGO
OI - J.J.	O'GALLAGHER	U OF MARYLAND
OI - A.	TUZZOLINO	U OF CHICAGO

BRIEF DESCRIPTION

This experiment used two telescopes to measure the composition and energy spectra of solar (and galactic) particles above about 0.5 MeV/nucleon. The main telescope consisted of five collinear elements (three solid state, one CsI, and one sapphire Cerenkov) surrounded by a plastic anticoincidence shield. The telescope had a 60-deg, full-angle acceptance cone with its axis approximately normal to the spacecraft spin axis, permitting 8-sectored information on particle arrival direction. Four elements of the main telescope were pulse-height analyzed, and low- and high-gain modes could be selected by command to permit resolution of the elements H through Ni or of the electrons of H and He and the isotopes of H and He and light nuclei. A selection-priority scheme was included to permit sampling of less abundant particle species under normal and solar-flare conditions. The low-energy telescope was essentially a two-element, shielded, solid-state detector with a 70-deg, full-angle acceptance cone. The first element was pulse-height analyzed, and data were recorded by sectors. Data include the interplanetary region.

------- PIONEER 10, VAN ALLEN----------

INVESTIGATION NAME- JOVIAN CHARGED PARTICLES

NSSDC ID- 72-012A-11

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS
MAGNETOSPHERIC PHYSICS

PERSONNEL

PI - J.A.	VAN ALLEN	U OF IOWA

BRIEF DESCRIPTION

This experiment (also carried on Pioneer 11) used seven miniature Geiger tubes in three arrays to measure proton and electron fluxes in interplanetary space and in the vicinity of Jupiter. Detector groupings were as follows: (1) a three-element (A, B, and C) differentially shielded telescope, with tube C shielded omnidirectionally and used for background subtraction to provide directional rates such as A-C (5-21 MeV electrons and 30-77.5 MeV protons) and B-C (0.55-21 MeV electrons and 6.6-77.5 MeV protons), (2) a three-element (D, E, and F) triangular array, each element responding to electrons above 31 MeV and protons above 77.5 MeV, and (3) a thin-window tube (G) with a gold-plated elbow as the aperture which admitted scattered electrons above 0.06 MeV while discriminating strongly against protons. Single element and coincidence rates were telemetered from the first two telescopes. The telemetry bit rate prevailing during the Jupiter encounter permitted directional sampling in intervals of about 14 deg of roll about the spin axis. For further details, see Baker and Van Allen, J. Geophys. Res., v. 81, p. 617, 1976.

------- PIONEER 11, VAN ALLEN----------

INVESTIGATION NAME- JOVIAN CHARGED PARTICLES

NSSDC ID- 73-019A-11

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS
MAGNETOSPHERIC PHYSICS

PERSONNEL

PI - J.A.	VAN ALLEN	U OF IOWA

BRIEF DESCRIPTION

This experiment used seven miniature Geiger tubes in three arrays to measure proton and electron fluxes near Jupiter and Saturn. Detector groupings were as follows: (1) a three-element (A, B, and C) differentially shielded telescope. Tube C was shielded omnidirectionally and was used for background subtraction to provide rates such as A-C (5 to 21 MeV electrons and 30 to 77.5 MeV protons) and B-C (0.55 to 21 MeV electrons and 6.6 to 77.5 MeV protons); (2) a three-element triangular array, each element responding to electrons above 31 MeV and protons above 77.5 MeV; and (3) a thin-window tube (G) with a gold-plated elbow as the entrance aperture to admit scattered electrons above 0.06 MeV while discriminating strongly against protons. For a description of the similar experiment on Pioneer 10, see Van Allen et al., J. Geophys. Res., v. 79, p. 3395, 1974. Early results are given in Science, v. 188, p. 459, 1975. Data include the interplanetary region.

------- PIONEER 10, FILLIUS----------

INVESTIGATION NAME- JOVIAN TRAPPED RADIATION

NSSDC ID- 72-012A-05

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS
MAGNETOSPHERIC PHYSICS

PERSONNEL

PI - R.W.	FILLIUS	U OF CALIF, SAN DIEGO
OI - C.E.	MCILWAIN	U OF CALIF, SAN DIEGO

BRIEF DESCRIPTION

This experiment consisted of an array of five particle detectors with electron thresholds in the range .01 to 35 MeV and proton thresholds in the range 0.15 to 60 MeV. A Cerenkov counter (C) had four output channels (C1, C2, C3, and CDC) sensitive to electrons having energies above 6, 9, 13, and 1 MeV, respectively. An electron-scatter counter (E) had three output channels (E1, E2, and E3) sensitive to electrons above .16, .26, and .46 MeV. A minimum ionization counter (M) had three output channels, M1 sensitive to electrons having energies greater than 35 MeV, M2 that measured background, and M3 that was sensitive to protons having energies greater than 80 MeV. The last two sensors were scintillator detectors (SP and SE), both of which had energy thresholds of 10 keV for electrons and 150 keV for protons. The sensitivity of the SE detector to protons was about a factor of 10 lower than its sensitivity to electrons. Thus, the SEDC channel effectively measured the electron flux, which could then be subtracted from the SPDC channel response to obtain the proton flux. Several other channels, listed above, required corrections to obtain the fluxes of the species indicated. Three of the channels (CDC, SPDC, and SEDC) were read out through a common electrometer. Due to a malfunction that occurred between launch and Jovian encounter, these three channels produced no usable encounter data. The detector channels could be programmed for readout in any one of four patterns at each of the eight spacecraft bit rate modes. During encounter when the spacecraft was operating in the highest bit rate mode, the minimum time to sample one channel was 1.5 s and the time to obtain a complete scan through all channels was 108 s. Since the directional detectors pointed perpendicular to the spin axis and the spin rate was 5 rpm, pitch-angle measurements were obtained. While the experiment was primarily designated for encounter studies, some data were obtained at low rates in interplanetary space. A description of the instrumentation and initial results was published in J. Geophys. Res., v. 79, p. 3589, 1974.

------- PIONEER 11, FILLIUS----------

INVESTIGATION NAME- JOVIAN TRAPPED RADIATION

NSSDC ID- 73-019A-05

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS
MAGNETOSPHERIC PHYSICS
PLANETOLOGY

PERSONNEL

PI - R.W. FILLIUS		U OF CALIF, SAN DIEGO
OI - C.E. MCILWAIN		U OF CALIF, SAN DIEGO

BRIEF DESCRIPTION

This experiment consisted of an array of five particle detectors with electron thresholds in the range .01 to 35 MeV and proton thresholds in the range 0.15 to 80 MeV. A Cerenkov counter (C) had four output channels (C1, C2, C3, and COC) sensitive to electrons having energies above 5, 8, 12, and 1 MeV, respectively. An electron scatter counter (E) had three output channels (E1, E2, and E3) sensitive to electrons above .16, .26, and .46 MeV. A minimum ionization counter (M) has three output channels: M1, sensitive to electrons having energies greater than 35 MeV; M2, measuring background; and M3, sensitive to protons having energies greater than 80 MeV. The last two sensors were scintillator detectors (SP and SE), both of which had energy thresholds of 10 keV for electrons and 150 keV for protons. The sensitivity of the SE detector to protons was about a factor of 10 lower than its sensitivity to electrons. Thus, the SEDC channel effectively measured the electron flux, which could then be subtracted from the SPDC channel response to obtain the proton flux. Several other channels listed above required corrections to obtain the fluxes of the species indicated. The detector channels could be programmed for readout in any one of four patterns at each of the eight spacecraft bit-rate modes. During encounter when the spacecraft was operating in the highest bit-rate mode, the minimum time to sample one channel was 1.5 s and the time to obtain a complete scan through all channels was 108 s. Since the directional detectors pointed perpendicularly to the spin axis and the spin rate was 5 rpm, pitch-angle measurements were obtained. Although this experiment was primarily designed for encounter studies, some data were obtained at low rates in interplanetary space. A description of the instrumentation and initial Pioneer 10 results was published in J. Geophys. Res., v. 79,p. 3589, 1974.

------- PIONEER 10, MCDONALD----------

INVESTIGATION NAME- COSMIC-RAY SPECTRA

NSSDC ID- 72-012A-12

INVESTIGATIVE PROGRAM
CODE EL-4/CO-OP, SCIENCE

INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS
COSMIC RAYS

PERSONNEL

PI - F.B. MCDONALD		NASA-GSFC
OI - K.G. MCCRACKEN		CSIRO
OI - W.R. WEBBER		U OF NEW HAMPSHIRE
OI - E.C. ROELOF		APPLIED PHYSICS LAB
OI - J.H. TRAINOR		NASA-GSFC
OI - B.J. TEEGARDEN		NASA-GSFC

BRIEF DESCRIPTION

This experiment consisted of three multi-element, solid-state telescopes, all looking normal to the spacecraft spin axis. It was also carried on Pioneer 11. The high-energy telescope (HET) consisted of five collinear sensors, and measured stopping particles (Z = 1 to 8) in the energy range 20 to 50 MeV/nucleon and penetrating particles in the range 50 to 800 MeV/nucleon. Charge resolution for penetrating particles was possible up to 200 MeV/nucleon. The first low-energy telescope (LET-I) had four elements and measured stopping (Z = 1 to 8) particles in the energy range 3 to 32 MeV/nucleon. The second low-energy telescope (LET-II) had three elements and measured stopping electrons between 50 and 1000 keV and stopping protons between 50 keV and 20 MeV. For each telescope, count rates were obtained for each of several sensor coincidence-anticircidence modes. Some of the rates from each telescope were sectored into eight octants in the spacecraft spin plane. In addition, three-sensor pulse-height analysis, with priority schemes favoring the analysis of heavier particles, was associated with each telescope.

------- PIONEER 11, MCDONALD----------

INVESTIGATION NAME- COSMIC-RAY SPECTRA

NSSDC ID- 73-019A-12

INVESTIGATIVE PROGRAM
CODE EL-4/CO-OP, SCIENCE

INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS
COSMIC RAYS

PERSONNEL

PI - F.B. MCDONALD		NASA-GSFC
OI - K.G. MCCRACKEN		CSIRO
OI - W.R. WEBBER		U OF NEW HAMPSHIRE
OI - E.C. ROELOF		APPLIED PHYSICS LAB
OI - B.J. TEEGARDEN		NASA-GSFC
OI - J.H. TRAINOR		NASA-GSFC

BRIEF DESCRIPTION

This experiment consisted of three 3-element telescopes, all looking normal to the spacecraft spin axis. A bidirectional telescope measured 20- to 800-MeV/nucleon particles with 5 to 10% energy resolution. Another telescope measured 3- to 22-MeV/nucleon particles with 5% resolution. These two telescopes measured particles with Z values between 1 and 8. The third telescope measured 50-keV to 1-MeV electrons and 50-keV to 20-MeV protons with 20% resolution. Data include the interplanetary region.

------- VOYAGER 1, VOGT----------

INVESTIGATION NAME- HIGH- AND MODERATELY LOW-ENERGY COSMIC-RAY TELESCOPE

NSSDC ID- 77-084A-08

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
COSMIC RAYS
MAGNETOSPHERIC PHYSICS

PERSONNEL

PI - R.E. VOGT		CALIF INST OF TECH
CI - J.R. JOKIPII		U OF ARIZONA
CI - E.C. STONE		CALIF INST OF TECH
CI - F.B. MCDONALD		NASA-GSFC
CI - J.H. TRAINOR		NASA-GSFC
CI - W.R. WEBBER		U OF NEW HAMPSHIRE
CI - A.W. SCHARDT		NASA-GSFC

BRIEF DESCRIPTION

This investigation studied the origin and acceleration process, life history, and dynamic contribution of interstellar cosmic rays, the nucleosynthesis of elements in cosmic-ray sources, the behavior of cosmic rays in the interplanetary medium, and the trapped planetary energetic-particle environment. The instrumentation included a High-Energy Telescope System (HETS) and a Low-Energy Telescope System (LETS). The HETS covered an energy range between 6 and 500 MeV/nucleon for nuclei ranging in atomic numbers from 1 through 30. In addition, electrons in the energy range between 3 and 100 MeV/nucleon were measured by this telescope and an electron telescope (TET). The LETS measured the energy and determined the identity of nuclei for energies between 30. The instruments also measured the anisotropies of electrons and nuclei. In addition, electrons in the energy range between 3 and 100 MeV/nucleon were measured by an electron telescope.

------- VOYAGER 2, VOGT----------

INVESTIGATION NAME- HIGH- AND MODERATELY LOW-ENERGY COSMIC-RAY TELESCOPE

NSSDC ID- 77-076A-08

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
COSMIC RAYS
MAGNETOSPHERIC PHYSICS

PERSONNEL

PI - R.E. VOGT		CALIF INST OF TECH
CI - J.R. JOKIPII		U OF ARIZONA
CI - E.C. STONE		CALIF INST OF TECH
CI - F.B. MCDONALD		NASA-GSFC
CI - J.H. TRAINOR		NASA-GSFC
CI - W.R. WEBBER		U OF NEW HAMPSHIRE
CI - A.W. SCHARDT		NASA-GSFC

BRIEF DESCRIPTION

This investigation studied the origin and acceleration process, life history, and dynamic contribution of interstellar cosmic rays, the nucleosynthesis of elements in cosmic-ray sources, the behavior of cosmic rays in the interplanetary medium, and the trapped planetary energetic particle environment. The instrumentation included a High-Energy Telescope System (HETS) and a Low-Energy Telescope System (LETS). The HETS covered an energy range between 6 and 500 MeV/nucleon for nuclei ranging in atomic numbers from 1 through 30. In addition, electrons in the energy range between 3 and 100 MeV were measured by this telescope and an electron telescope (TET). The LETS measured the energy and determined the identity of nuclei for energies between .15 and 30 MeV/nucleon and atomic numbers from 1 to 30. The instruments also measured the anisotropies of electrons and nuclei. In addition, electrons in the energy range between 3 and 100 MeV were measured by an electron telescope.

ULTRAVIOLET

------- PIONEER 10, JUDGE----------

INVESTIGATION NAME- ULTRAVIOLET PHOTOMETRY

NSSDC ID- 72-012A-06

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
ASTRONOMY
PLANETARY ATMOSPHERES

PERSONNEL

PI - D.L.	JUDGE	U OF SOUTHERN CALIF
OI - R.W.	CARLSON	NASA-JPL

BRIEF DESCRIPTION
This experiment (on both Pioneers 10 and 11) consisted of a broadband photometer sensitive between 200 and 800 A. During the cruise phase of the mission, this experiment was used to search for the supersonic-to-subsonic transition region in the solar wind. During the Jovian encounter, this experiment was used to look for evidence of ar auroral oval on the Jovian dayside, to find the ratio of hydrogen to helium in the Jovian atmosphere, and to find the temperature of the outer portion of the Jovian atmosphere. Evidence of helium was found in the interplanetary region indicating interactions between chargeo particles and neutral hydrogen.

------- PIONEER 11, JUDGE----------

INVESTIGATION NAME- ULTRAVIOLET PHOTOMETRY

NSSDC ID- 73-019A-06

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
ASTRONOMY
PLANETARY ATMOSPHERES
PLANETOLOGY
PARTICLES AND FIELDS

PERSONNEL

PI - D.L.	JUDGE	U OF SOUTHERN CALIF
OI - R.W.	CARLSON	NASA-JPL

BRIEF DESCRIPTION
This experiment consisted of a broadband photometer, sensitive between 200 and 800 A. During the cruise phase of the mission, this experiment was used to search for the supersonic-to-subsoric transition region in the solar wind. During the Jovian encounter, this experiment was used to look for evidence of an auroral oval on the Jovian dayside, tc find the ratio of hydrogen to helium in the Jovian atmosphere, and to find the temperature of the outer portion of the Jovian atmosphere. Evidence of helium was found in the interplanetary region, indicating interactions between charged particles and neutral hydrogen.

------- VOYAGER 1, BROADFOOT----------

INVESTIGATION NAME- ULTRAVIOLET SPECTROSCOPY

NSSDC ID- 77-084A-04

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY ATMOSPHERES

PERSONNEL

PI - A.L.	BROADFOOT	U OF SOUTHERN CALIF
CI - H.W.	MOOS	JOHNS HOPKINS U
CI - M.J.S.	BELTON	KITT PEAK NATL OBS
CI - D.F.	STROBEL	US NAVAL RESEARCH LAB
CI - T.M.	DONAHUE	U OF MICHIGAN
CI - M.B.	MCELROY	HARVARD U
CI - J.C.	MCCONNELL	YORK U
CI - R.M.	GOODY	HARVARD U
CI - A.	DALGARNO	SAO
CI - J.E.	BLAMONT	CNRS-SA
CI - J.L.	BERTAUX	CNRS-SA
CI - S.K.	ATREYA	U OF MICHIGAN
CI - B.R.	SANDEL	U OF SOUTHERN CALIF
CI - D.E.	SHEMANSKY	U OF SOUTHERN CALIF

BRIEF DESCRIPTION
The UV spectrometer was designed to measure atmospheric properties, and tc measure radiatien in the wavelength range from 0.04 to 0.16 micrometers (400 to 1600 A). Two modes of instrument operation were planned, airglow and occultation. In the airglow mode the atmospheric radiation was measured. This radiation is predcminantly resonance-scattered solar radiation, where the scattering is by molecular or atomic atmospheric constituents such as hydrogen (1216 A) or helium (584 A). In the occultatien mcde, sunlight was reflected into the spectrometer, and the solar spectrum was recorded. As the atmosphere moved between the spacecraft and the sun, the absorption characteristics of the atmosphere were obtained over the measured wavelength region. The absorptior spectrum was used to identify the absorber as well as to measure its abundance in the line of sight to the sun. In addition, the atmospheric thermal structure could be inferred.

------- VOYAGER 2, BROADFOOT----------

INVESTIGATION NAME- ULTRAVIOLET SPECTROSCOPY

NSSDC ID- 77-076A-04

INVESTIGATIVE PROGRAM
CODE EL-4/CO-OP, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY ATMOSPHERES

PERSONNEL

PI - A.L.	BROADFOOT	U OF SOUTHERN CALIF
CI - A.	DALGARNO	SAO
CI - J.C.	MCCONNELL	YORK U
CI - R.M.	GOODY	HARVARD U
CI - T.M.	DONAHUE	U OF MICHIGAN
CI - M.B.	MCELROY	HARVARD U
CI - M.J.S.	BELTON	KITT PEAK NATL OBS
CI - D.F.	STROBEL	US NAVAL RESEARCH LAB
CI - H.W.	MOOS	JOHNS HOPKINS U
CI - J.E.	BLAMONT	CNRS-SA
CI - J.L.	BERTAUX	CNRS-SA
CI - S.K.	ATREYA	U OF MICHIGAN
CI - B.R.	SANDEL	U OF SOUTHERN CALIF
CI - D.E.	SHEMANSKY	U OF SOUTHERN CALIF

BRIEF DESCRIPTION
The UV spectrometer was designed to measure atmospheric properties and measured radiation in the wavelength range 0.04 to 0.16 micrometer (400 to 1600 A). Two modes of instrument operation were planned: airglow and occultation. In the airglow mode, the atmospheric radiation was measured. This radiation is predominantly resonance-scattered solar radiation, where the scattering is by the molecular or atomic atmospheric constituents, such as hydrogen (1216 A) or helium (584 A). In the occultation mode, sunlight was reflected into the spectrometer, and the solar spectrum was recorded. As the atmosphere moved between the spacecraft and the sun, the absorption characteristics of the atmosphere were obtained over the measured wavelength region. The absorption spectrum was used to identify the absorber as well as to measure its abundance in the line of sight to the sun. In addition, the atmosphere's thermal structure could be inferred.

INFRARED

------- VOYAGER 1, HANEL----------

INVESTIGATION NAME- INFRARED SPECTROSCOPY AND RADIOMETRY

NSSDC ID- 77-084A-03

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY ATMOSPHERES

PERSONNEL

PI - R.A.	HANEL	NASA-GSFC
CI - V.G.	KUNDE	NASA-GSFC
CI - D.P.	CRUIKSHANK	U OF HAWAII
CI - W.C.	MAGUIRE	NASA-GSFC
CI - J.C.	PEARL	NASA-GSFC
CI - J.A.	PIRRAGLIA	NASA-GSFC
CI - R.E.	SAMUELSON	NASA-GSFC
CI - P.J.	GIERASCH	CORNELL U
CI - C.A.	PONNAMPERUMA	U OF MARYLAND
CI - D.	GAUTIER	PARIS OBSERVATORY
CI - F.M.	FLASAR	NASA-GSFC
CI - S.	KUMAR	U OF SOUTHERN CALIF
CI - B.J.	CONRATH	NASA-GSFC

BRIEF DESCRIPTION
This investigation was carried out using an infrared radiometer and an interferometer-spectrometer similar in design to the Mariner 9 IRIS, combined into a single instrument. The investigation studied both global and local energy balance, using infrared spectral measurements in conjunction with broad-band measurements of reflected solar energy. Atmospheric composition was also investigated, including determination of the H2/He ratio, and the abundance of CH2 and NH3. Vertical temperature profiles were obtained on the planets and satellites with atmospheres. Studies of the composition, thermal properties, and size of particles in Saturn's rings were conducted. The interferometer had a spectral range of 200 to 4000 1/cm, while the radiometer range covered 5000 to 33,000 1/cm. The instrument used a single primary mirror 51 cm in diameter with a field of view of 0.25 deg.

------- VOYAGER 2, HANEL----------

INVESTIGATION NAME- INFRARED SPECTROSCOPY AND RADIOMETRY

NSSDC ID- 77-076A-03

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETARY ATMOSPHERES

PERSONNEL

PI - R.A. HANEL		NASA-GSFC
CI - C.A. PONNAMPERUMA		U OF MARYLAND
CI - P.J. GIERASCH		CORNELL U
CI - J.A. PIRRAGLIA		NASA-GSFC
CI - R.E. SAMUELSON		NASA-GSFC
CI - W.C. MAGUIRE		NASA-GSFC
CI - J.C. PEARL		NASA-GSFC
CI - V.G. KUNDE		NASA-GSFC
CI - D.P. CRUIKSHANK		U OF HAWAII
CI - B.J. CONRATH		NASA-GSFC
CI - D. GAUTIER		PARIS OBSERVATORY
CI - F.M. FLASAR		NASA-GSFC
CI - S. KUMAR		U OF SOUTHERN CALIF

BRIEF DESCRIPTION

This investigation was carried out using an infrared radiometer and an interferometer spectrometer similar in design to the Mariner 9 IRIS, combined into a single instrument. The investigation studied both global and local energy balance, using infrared spectral measurererts in conjunction with broad-band measurements of reflected solar energy. Atmospheric composition was also investigated, including determination of the H2/He ratio and the abundance of CH2 and NH3. Vertical temperature profiles were obtained on the planets and satellites with atmospheres. Studies of the composition, thermal properties, and size of particles in Saturn's rings were conducted. The interferometer had a spectral range of 200 to 4000 1/cm, while the radiometer range covered 5000 to 33,000 1/cm. The instrument used a single primary mirror 51 cm in diameter with a field of view of 0.25 deg.

RADIO SCIENCE AND CELESTIAL MECHANICS

------- PIONEER 10, ANDERSON----------

INVESTIGATION NAME- CELESTIAL MECHANICS

NSSDC ID- 72-012A-09

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
ASTRONOMY
PLANETOLOGY
CELESTIAL MECHANICS

PERSONNEL

PI - J.D. ANDERSON		NASA-JPL
OI - G.W. NULL		NASA-JPL

BRIEF DESCRIPTION

In this investigation, carried on both Pioneers 10 and 11, two-way Doppler tracking of the spacecraft was used to make more precise determinations of planetary masses, the heliocentric orbit of Jupiter, and the gravitational fields of the sun, Jupiter, and the Galilean satellites.

------- PIONEER 11, ANDERSON----------

INVESTIGATION NAME- CELESTIAL MECHANICS

NSSDC ID- 73-019A-09

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETOLOGY
ASTRONOMY
CELESTIAL MECHANICS

PERSONNEL

PI - J.D. ANDERSON		NASA-JPL
OI - G.W. NULL		NASA-JPL

BRIEF DESCRIPTION

In this investigation, two-way Doppler tracking of the spacecraft was used to make more precise determinations of planetary masses, the heliocentric orbits of Jupiter and Saturn, and the gravitational fields of the Sun, Jupiter, Saturn, and the Galilean and Saturnian satellites.

------- VOYAGER 1, TYLER----------

INVESTIGATION NAME- RADIO SCIENCE TEAM

NSSDC ID- 77-084A-02

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
ATMOSPHERIC PHYSICS
CELESTIAL MECHANICS
IONOSPHERES AND RADIO PHYSICS

PERSONNEL

TL - G.L. TYLER		STANFORD U
TM - V.R. ESHLEMAN		STANFORD U
TM - J.D. ANDERSON		NASA-JPL
TM - T.A. CROFT		SRI INTERNATIONAL
TM - G.F. LINDAL		NASA-JPL
TM - G.S. LEVY		NASA-JPL
TM - G.E. WOOD		NASA-JPL

BRIEF DESCRIPTION

The Radio Science Team used the telecommunications system of the Voyager spacecraft to perform its studies. The system was a coherent S- and X-band downlink and S-band uplink. The science objectives of the radio science investigation were (1) to determine the physical properties of planetary and satellite ionospheres and atmospheres by examining the propagation effects on a dual-frequency radio signal during immersion and emersion of spacecraft occultation by the subject body, (2) to determine planetary and satellite masses, gravity fields, and densities by precise tracking of a dual-frequency radio signal from the spacecraft during the encounter period, and (3) to determine the amount and size distribution of material in Saturn's rings and the ring dimensions by examining the propagation effects on a dual-frequency radio signal that passed through each ring in succession, and through the gap between the C ring and Saturn's surface.

------- VOYAGER 2, TYLER----------

INVESTIGATION NAME- RADIO SCIENCE TEAM

NSSDC ID- 77-076A-02

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
ATMOSPHERIC PHYSICS
CELESTIAL MECHANICS
IONOSPHERES AND RADIO PHYSICS

PERSONNEL

TL - G.L. TYLER		STANFORD U
TM - G.F. LINDAL		NASA-JPL
TM - G.S. LEVY		NASA-JPL
TM - T.A. CROFT		SRI INTERNATIONAL
TM - V.R. ESHLEMAN		STANFORD U
TM - J.D. ANDERSON		NASA-JPL
TM - G.E. WOOD		NASA-JPL

BRIEF DESCRIPTION

The Radio Science Team used the telecommunications systems of the Voyager spacecraft to perform their studies. The system was a coherent S- and X-band downlink and S-band uplink. The science objectives of the radio science investigation were (1) to determine the physical properties of planetary and satellite ionospheres and atmospheres by examining the propagation effects on a dual-frequency radio signal during immersion of spacecraft occultation by the subject body, (2) to determine planetary and satellite masses, gravity fields and densities by precise tracking of a dual-frequency radio signal from the spacecraft during the encounter period, and (3) to determine the amount and size distributions of material in the rings of Saturn and the ring dimensions by examining the propagation effects on a dual-frequency radio signal that passes through each ring in succession and through the gap between the C ring and the surface of Saturn.

------- PIONEER 10, KLIORE----------

INVESTIGATION NAME- S-BAND OCCULTATION

NSSDC ID- 72-012A-10

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
IONOSPHERES AND RADIO PHYSICS
PLANETARY ATMOSPHERES

PERSONNEL

PI - A.J. KLIORE		NASA-JPL
OI - G. FJELDBO(NLA)		NASA-JPL
OI - D.L. CAIN		NASA-JPL
OI - B.L. SEIDEL		NASA-JPL
OI - S.I. RASOOL(NLA)		IBM-PARIS

BRIEF DESCRIPTION

This experiment, carried on both Pioneers 10 and 11, utilized the S-band (2292 MHz, 8 W) spacecraft radio transmitter signal characteristics to obtain information about the ionospheres and atmospheres of Jupiter and its satellite Io. Entrance into and exit from Jupiter and Io occultation provided changes in the signal characteristics from which atmospheric temperature, pressure, and electron density profiles could be calculated. Temperature and pressure profiles were limited to levels above the pressure of one earth atmosphere. Signal occultation also provided a determination of the planetary diameter.

------- PIONEER 11, KLIORE----------

INVESTIGATION NAME- S-BAND OCCULTATION

NSSDC ID- 73-019A-10

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
IONOSPHERES AND RADIO PHYSICS
PLANETARY ATMOSPHERES

PERSONNEL

PI - A.J.	KLIORE	NASA-JPL
OI - G.	FJELDBO(NLA)	NASA-JPL
OI - D.L.	CAIN	NASA-JPL
OI - B.L.	SEIDEL	NASA-JPL
OI - S.I.	RASOOL	IBM-PARIS

BRIEF DESCRIPTION

This experiment utilized the S-band (2292-MHz, 8-4) spacecraft radio transmitter signal characteristics to obtain information about the ionospheres and atmospheres of Jupiter and its satellite Io, and Saturn. Ertrance into and exit from Jupiter and Io occultation provided changes in the signal characteristics from which atmospheric temperature, pressure, and electron density profiles could be calculated. Temperature and pressure profiles were limited to levels above the pressure of one earth atmosphere. Signal occultation also provided a determination of the planetary diameter.

------- VOYAGER 1, WARWICK----------

INVESTIGATION NAME- PLANETARY RADIO ASTRONOMY

NSSDC ID- 77-084A-10

INVESTIGATIVE PROGRAM
CODE EL-4/CO-OP, SCIENCE

INVESTIGATION DISCIPLINE(S)
MAGNETOSPHERIC PHYSICS
SPACE PLASMAS

PERSONNEL

PI - J.W.	WARWICK	RADIOPHYSICS, INC
CI - J.K.	ALEXANDER, JR.	NASA-GSFC
CI - T.D.	CARR	U OF FLORIDA
CI - F.T.	HADDOCK	U OF MICHIGAN
CI - D.H.	STAELIN	MASS INST OF TECH
CI - A.	BOISCHOT	PARIS OBSERVATORY
CI - C.C.	HARVEY	PARIS OBSERVATORY
CI - Y.	LEBLANC	PARIS OBSERVATORY
CI - W.E.	BROWN, JR.	NASA-JPL
CI - S.	GULKIS	NASA-JPL
CI - R.	PHILLIPS	NASA-JPL
CI - J.B.	PEARCE	RADIOPHYSICS, INC
CI - A.C.	RIDDLE	U OF COLORADO
CI - R.G.	PELTZER	MARTIN-MARIETTA AEROSP
CI - M.L.	KAISER	NASA-GSFC

BRIEF DESCRIPTION

This experiment consisted of a sweep-frequency radio receiver operating in both polarization states, between 20 kHz and 40.5 MHz. The signal was received by a pair of orthogonal 10-m monopole anterras. Study of the radio-emission signals from Jupiter and Saturn over this range of frequencies yielded data concerning the physics of magnetospheric plasma resonances and nonthermal radio emissions from these planetary regions.

------- VOYAGER 2, WARWICK----------

INVESTIGATION NAME- PLANETARY RADIO ASTRONOMY

NSSDC ID- 77-076A-10

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
MAGNETOSPHERIC PHYSICS
SPACE PLASMAS

PERSONNEL

PI - J.W.	WARWICK	RADIOPHYSICS, INC
CI - W.E.	BROWN, JR.	NASA-JPL
CI - S.	GULKIS	NASA-JPL
CI - C.C.	HARVEY	PARIS OBSERVATORY
CI - Y.	LEBLANC	PARIS OBSERVATORY
CI - D.H.	STAELIN	MASS INST OF TECH
CI - A.	BOISCHOT	PARIS OBSERVATORY
CI - T.D.	CARR	U OF FLORIDA
CI - F.T.	HADDOCK	U OF MICHIGAN
CI - J.K.	ALEXANDER, JR.	NASA-GSFC
CI - R.	PHILLIPS	NASA-JPL
CI - R.G.	PELTZER	MARTIN-MARIETTA AEROSP
CI - J.B.	PEARCE	RADIOPHYSICS, INC
CI - A.C.	RIDDLE	U OF COLORADO
CI - M.L.	KAISER	NASA-GSFC

BRIEF DESCRIPTION

This experiment consisted of a sweep-frequency radio receiver operating in both polarization states, between 20 kHz and 40.5 MHz. The signal was received by a pair of orthogonal 10-m monopole antennas. The physics of magnetospheric plasma resonances and nonthermal radio emissions from these planetary regions was studied by investigation of the radio emission signals from Jupiter and Saturn over this range of frequencies, and will do likewise at Uranus and Neptune.

ATMOSPHERE

------- PIONEER 10, GEHRELS----------

INVESTIGATION NAME- IMAGING PHOTOPOLARIMETER (IPP)

NSSDC ID- 72-012A-07

SEE THIS EXPERIMENT UNDER IMAGING

------- PIONEER 11, GEHRELS----------

INVESTIGATION NAME- IMAGING PHOTOPOLARIMETER (IPP)

NSSDC ID- 73-019A-07

SEE THIS EXPERIMENT UNDER IMAGING

------- VOYAGER 2, LANE----------

INVESTIGATION NAME- MULTIFILTER PHOTOPOLARIMETER, 2200-7300 A

NSSDC ID- 77-076A-11

INVESTIGATIVE PROGRAM
CODE EL-4/CO-OP, SCIENCE

INVESTIGATION DISCIPLINE(S)
INTERPLANETARY DUST
PLANETARY ATMOSPHERES

PERSONNEL

PI - A.L.	LANE	NASA-JPL
CI - K.D.	PANG	NASA-JPL
CI - J.E.	HANSEN	NASA-GISS
CI - D.L.	COFFEEN	NASA-GISS
CI - L.W.	ESPOSITO	U OF COLORADO
CI - M.	SATO(NLA)	NASA-GISS
CI - R.A.	WEST	U OF COLORADO
CI - C.W.	HORD	U OF COLORADO

BRIEF DESCRIPTION

This experiment consisted of an 8-in. (20-cm) f/1.1 telescope that sent radiation through a polarizer and a filter for one of eight bands in the 2200- to 7300-A spectral region, then on to a photomultipler tube. By study of these emission intensity data, information on surface texture and composition of Jupiter, Saturn, Uranus, and Neptune could be obtained, along with information of size distribution and composition of Saturn's and Uranus' rings and information on atmospheric scattering properties and density for all planets. Molecular scale heights for these planets could also be determined from these data.

FOLARIZATION

------- PIONEER 10, GEHRELS----------

INVESTIGATION NAME- IMAGING PHOTOPOLARIMETER (IPP)

NSSDC ID- 72-012A-07

SEE THIS EXPERIMENT UNDER IMAGING

------- PIONEER 11, GEHRELS----------

INVESTIGATION NAME- IMAGING PHOTOPOLARIMETER (IPP)

NSSDC ID- 73-019A-07

SEE THIS EXPERIMENT UNDER IMAGING

------- VOYAGER 2, LANE----------

INVESTIGATION NAME- MULTIFILTER PHOTOPOLARIMETER, 2200-7300 A

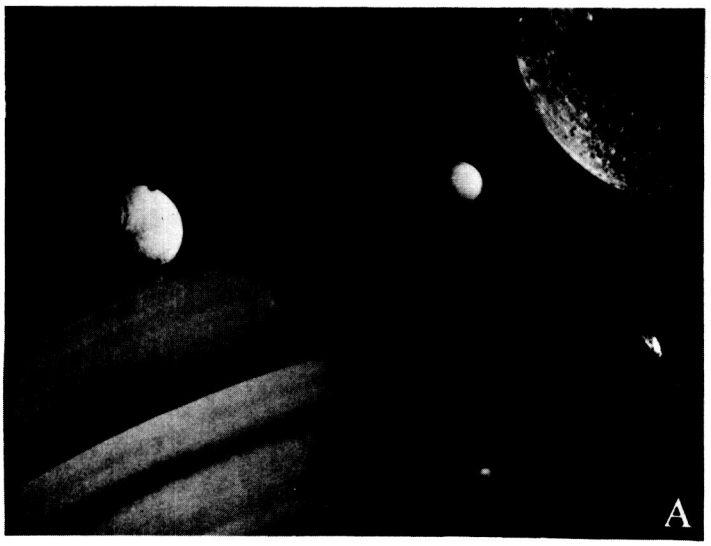
NSSDC ID- 77-076A-11

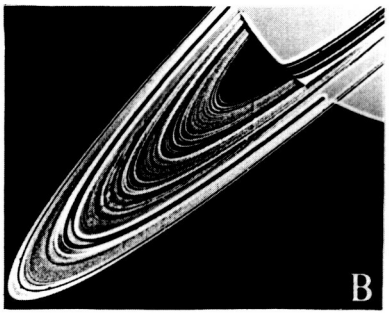
SEE THIS EXPERIMENT UNDER ATMOSPHERE

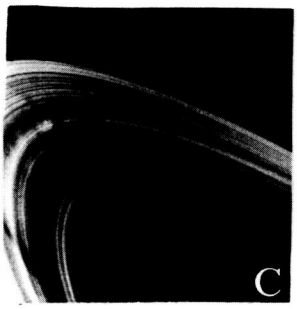
Saturn

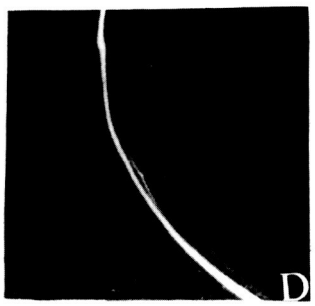
SATURN

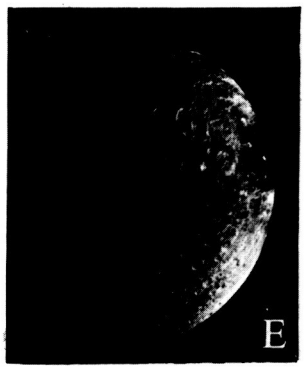
Plate 5. This is a collection of press release photographs from Voyagers 1 and 2 missions. (A) P23400 is a Voyager 1 montage of Saturn and some of its 23 known moons. (B) P23068 is a Voyager 2 photo showing that the rings are composed of myriads of ringlets (over a thousand in number, of which about 100 can be detected in this photo,) making it look like a playing record. (C) P23925 is a Voyager 2 photo of part of Saturn's rings showing many ringlets and the radial bands on the B-ring, discovered on Voyager 1. (D) P23099 is a Voyager 1 photo of the F-ring appearing to consist of twisted or braided rings discovered on this mission. Voyager 2 photos showed a single ring composed of at least 9 ringlets, (but not braided or twisted). (E) P23113 is a Voyager 1 photo of Dione (1120 km diameter) showing a highly cratered surface. (F) P23094 is a Voyager 2 photo of Dione showing an entirely different surface for its other hemisphere from that in (E). Here it is less cratered and splashed with light ray-like material with little relief. (G) P23956 is a Voyager 2 photo of Enceladus (500 km diameter) showing an area of smooth, craterless terrain with ridges bordering it, indicating surface movement in the past to present. (H) P23200 is a Voyager 2 photo of Mimas (390 km diameter) with an enormous deep crater with a high central peak, making its resemblance to the Death Star in *Star Wars* remarkable. (I) P23915 is a Voyager 2 photo of part of the atmospheric surface of Saturn showing bands, belts and vortices. These features are somewhat similar to Jupiter's though smaller in size and appearing more subdued because of a high-altitude haze on Saturn not present on Jupiter.

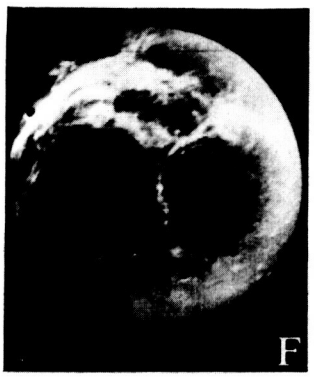


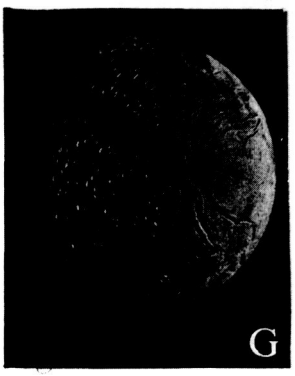


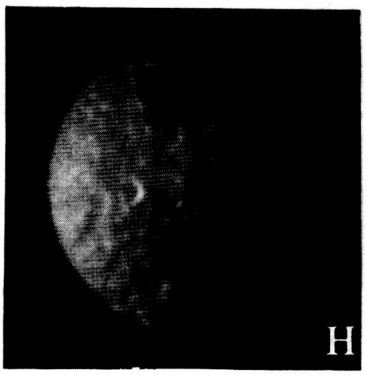












INTRODUCTION

The planet farthest from the sun that has been visited and measured by planetary missions is Saturn. It has been visited by three U.S. spacecraft: Pioneer 11 and Voyagers 1 and 2. Voyager 2 is now on its way to Uranus and is expected to arrive at Uranus in January 1986. Although all investigations on these missions that flew by Jupiter obtained data also on Saturn, these data are still being reduced and analyzed and these data are anticipated for deposit in NSSDC. There are nine investigations for which NSSDC has data archived and these data cover the five categories: (1) Imaging, (2) Particles and Fields, (3) Radio Science and Celestial Mechanics, (4) Atmosphere, and (5) Polarization. Again, as in the case of Jupiter, data for the Atmosphere and Polarization categories come from the photopolarimeter investigation and are described under Imaging. Tables 1 and 2 and Appendix A give more detail on these investigations.

SPACECRAFT

********** PIONEER 11**********

SPACECRAFT COMMON NAME- PIONEER 11
ALTERNATE NAMES- PIONEER-G, PL-733C
6421

NSSDC ID- 73-019A

LAUNCH DATE- 04/06/73 WEIGHT- 231. KG
LAUNCH SITE- CAPE CANAVERAL, UNITED STATES
LAUNCH VEHICLE- ATLAS

SPONSORING COUNTRY/AGENCY
UNITED STATES NASA-OSSA

INITIAL ORBIT PARAMETERS
ORBIT TYPE- SATURN FLYBY

PERSONNEL
PM - C.F. HALL(NLA) NASA-ARC
PS - P. DYAL NASA-ARC

BRIEF DESCRIPTION
This was the second mission to investigate Jupiter and the outer solar system. Pioneer 11, like Pioneer 10, used Jupiter's gravitational field to alter its trajectory radically. It passed close to Saturn and then it followed an escape trajectory from the solar system . The spacecraft was 2.9 m (9.5 ft) long and contained a 2.74-m (9-ft) diameter high-gain antenna of aluminum honeycomb sandwich material whose feed was topped with a medium-gain antenna. A low-gain, omnidirectional antenna was mounted below the high-gain dish. It contained two nuclear electric-power generators, which generated 144 W at Jupiter, but decreased to 100 W at Saturn. There were three reference sensors: a star (Canopus) sensor, and two sun sensors. Attitude position could be calculated from the reference direction to the earth and the sun, with the known direction to Canopus as backup. Pioneer 11's star sensor gain and threshold settings were modified, based on experience gained from the settings used on Pioneer 10. Three pairs of rocket thrusters provided spin-axis control (at 4.8 rpm) and change of the spacecraft velocity. The thrusters could be either fired steadily or pulsed, by command. Communications were maintained via the omnidirectional and medium-gain antennas, which operated together, connected to one receiver, while the high-gain antenna was connected to the other receiver. The receivers could be interchanged by command. Two radio transmitters, coupled to two traveling wave tube amplifiers, produced 8 W power each in S-band. Communication uplink (earth to spacecraft) operated at 2110 MHz, and downlink (spacecraft to earth) at 2292 MHz. At Jupiter's distance, round-trip communication time took 92 min. Data were received at the Deep Space Network (DSN). The spacecraft was temperature-controlled to between -23 and +38 deg C (-10 to +100 deg F). An additional experiment, a low-sensitivity fluxgate magnetometer, was added to the Pioneer 11 payload. Instruments studied the interplanetary and planetary magnetic fields; solar wind properties; cosmic rays; transition region of the heliosphere; neutral hydrogen abundance; distribution, size, mass, flux, and velocity of dust particles; Jovian aurorae; Jovian radio waves; the atmospheres of planets and satellites; and the surfaces of Jupiter, Saturn, and some of their satellites. Instruments carried for these experiments were magnetometer, plasma analyzer (for solar wind), charged-particle detector, ionizing detector, non-imaging telescopes with overlapping fields of view to detect sunlight reflected from passing meteoroids, sealed pressurized cells of argon and nitrogen gas for measuring penetration of meteoroids, UV photometer, IR radiometer, and an imaging photopolarimeter, which produced photographs and measured the polarization. Further scientific information was obtained from celestial mechanics and occultation phenomena. This spacecraft, like Pioneer 10, contains a plaque that has a drawing depicting man, woman, and the location of the sun and earth in the galaxy. Pioneer 11 was 36,800 km from Jupiter during its closest approach, December 4, 1974, to within 43,000 km of its cloud tops. It passed by Saturn on Aug. 5, 1979 at a distance of 21,400 km from Saturn's cloud tops.

********** VOYAGER 1**********

SPACECRAFT COMMON NAME- VOYAGER 1
ALTERNATE NAMES- MARINER JUPITER/SATURN A, OUTER PLANETS A
MARINER 77A, MJS 77A
10321

NSSDC ID- 77-084A

LAUNCH DATE- 09/05/77 WEIGHT- 700. KG
LAUNCH SITE- CAPE CANAVERAL, UNITED STATES
LAUNCH VEHICLE- TITAN

SPONSORING COUNTRY/AGENCY
UNITED STATES NASA-OSSA

INITIAL ORBIT PARAMETERS
ORBIT TYPE- SATURN FLYBY

PERSONNEL
PM - J.R. CASANI(NLA) NASA-JPL
PS - E.C. STONE CALIF INST OF TECH

BRIEF DESCRIPTION
The overall objectives of Voyager were to conduct exploratory investigations of the planetary systems of Jupiter and Saturn and of the interplanetary medium out to Saturn. Primary emphasis was placed on comparative studies of these two planetary systems by obtaining (1) measurements of the environment, atmosphere, and body characteristics of the planets and the satellites of each planet, (2) studies of the nature of the rings of Saturn, and (3) exploration of the interplanetary (or interstellar) medium at increasing distances from the sun. These objectives were attained by using a variety of instruments and methods including imaging, a coherent S- and X-band RF receiver, an infrared interferometer and radiometer, UV spectrometer, fluxgate magnetometers, Faraday cups, a charged-particle analyzer, plasma detector, plasma-wave radio receiver, cosmic-ray telescopes, photopolarimeter, and a sweep-frequency radio receiver. Voyager 1 had its closest encounter with Jupiter on March 5, 1979, and with Saturn on November 12, 1980.

********** VOYAGER 2**********

SPACECRAFT COMMON NAME- VOYAGER 2
ALTERNATE NAMES- MARINER JUPITER/SATURN B, OUTER PLANETS B
MARINER 77B, MJS 77B
10271

NSSDC ID- 77-076A

LAUNCH DATE- 08/20/77 WEIGHT- 700. KG
LAUNCH SITE- CAPE CANAVERAL, UNITED STATES
LAUNCH VEHICLE- TITAN

SPONSORING COUNTRY/AGENCY
UNITED STATES NASA-OSSA

INITIAL ORBIT PARAMETERS
ORBIT TYPE- SATURN FLYBY

PERSONNEL
PM - J.R. CASANI(NLA) NASA-JPL
PS - E.C. STONE CALIF INST OF TECH

BRIEF DESCRIPTION
The overall objectives of Voyager 2 were to conduct exploratory investigations of the planetary systems of Jupiter, Saturn, Uranus, and Neptune, and of the interplanetary medium. Primary emphasis was placed on comparative studies of these planetary systems by obtaining (1) measurements of the environment, atmosphere, and body characteristics of the planets and one or more of the satellites of each planet, (2) studies of the nature of the rings of Saturn and Uranus, and (3) exploration of the interplanetary (or interstellar) medium at increasing distances from the sun. These objectives were met using a variety of instruments and methods including imaging, a coherent S- and X-band RF receiver, an IR interferometer and radiometer, a UV spectrometer, fluxgate magnetometers, Faraday cups, a charged-particle analyzer, plasma detector, plasma-wave radio receiver, cosmic-ray telescopes, photopolarimeter, and a sweep-frequency radio receiver. Jupiter close encounter was achieved on July 9, 1979, and Saturn on August 5, 1981.

INVESTIGATIONS

IMAGING

------- PIONEER 11, GEHRELS----------

INVESTIGATION NAME- IMAGING PHOTOPOLARIMETER (IPP)

NSSDC ID- 73-019A-07 INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
ASTRONOMY
PLANETARY ATMOSPHERES
PLANETOLOGY

PERSONNEL
PI - T. GEHRELS U OF ARIZONA
OI - D.L. COFFEEN NASA-GISS
OI - J. HAMEEN-ANTTILA U OF ARIZONA
OI - C.E. KENKNIGHT U OF ARIZONA
OI - R.F. HUMMER SANTA BARBARA RES CTR
OI - M.G. TOMASKO U OF ARIZONA
OI - W. SWINDELL U OF ARIZONA

BRIEF DESCRIPTION

The Imaging Photopolarimeter (IPP) experiment used during Jovian and Saturnian encounter made simultaneous, two-color (blue - 3900 to 4900 A, red - 5800 to 7000 A) polarimetric and radiometric measurements, and moderate-resolution (about 200 km at best) spin-scan images of Jupiter and the Jovian satellites and Saturn and some of its satellites. The polarimetric and radiometric work was performed using an 8- by 8-mrad field-stop aperture, while the spin-scan imaging used a 0.5- by 0.5-mrad aperture stop. Relative radiometric calibration was derived using an internal tungsten lamp. Long-term absolute calibration of the instrument was accomplished by means of a sunlight diffusor/attenuator element located in the spacecraft antenna structure. Primary radiometric calibration was obtained throughout the mission by periodically commanding the telescope to view this diffuse backlighted (sunlight) source. The experimental train for the IPP package consisted of the following elements: (1) a near-diffraction-limited 2.54-cm Maksutov telescope of focal ratio f/3.4, (2) a focal-plane wheel containing field-of-view (FOV) apertures, depolarizers, calibration source, etc., (3) a Wollaston prism to split the light into two orthogonally polarized beams, (4) a 45-deg dichromatic mirror that reflected wavelengths of less than 5500 A (blue beam) and transmitted all light of longer wavelength (red beam), (5) a filtering-coated relay lens and folding mirrors for each spectral beam (the two polarizations were separated), and (6) two Bendix channeltron (blue - bialkali S-11, red - S-20) photocathodes for each spectral beam to register the intensity in each polarization component. Polarization data include the interplanetary region.

------- VOYAGER 1, SMITH----------

INVESTIGATION NAME- IMAGING

NSSDC ID- 77-084A-01

INVESTIGATIVE PROGRAM
CODE EL-4/CO-OP, SCIENCE

INVESTIGATION DISCIPLINE(S)
METEOROLOGY
PLANETARY ATMOSPHERES
PLANETOLOGY
ATMOSPHERIC PHYSICS

PERSONNEL

TL - B.A.	SMITH	U OF ARIZONA
DT - L.A.	SODERBLOM	US GEOLOGICAL SURVEY
TM - G.A.	BRIGGS	NASA HEADQUARTERS
TM - A.F.	COOK	SAO
TM - G.E.	DANIELSON	CALIF INST OF TECH
TM - M.E.	DAVIES	RAND CORP
TM - G.E.	HUNT	U COLLEGE LONDON
TM - T.	OWEN	STATE U OF NEW YORK
TM - C.	SAGAN	CORNELL U
TM - V.E.	SUOMI	U OF WISCONSIN
TM - T.V.	JOHNSON	NASA-JPL
TM - H.	MASURSKY	US GEOLOGICAL SURVEY

BRIEF DESCRIPTION

The photographic experiment used a two-camera system, based on the Mariner 10 system. This system included one narrow-angle, long-focal-length camera and one wide-angle, short-focal-length camera. The maximum resolution achievable depended on the actual trajectory on this multi-encounter mission, but the resolution was as high as 0.5 to 1.0 km on the closest approaches to some objects. At Jupiter and Saturn, the resolution was better than 20 km and 5 km, respectively. The objectives of the experiment were to photograph global motions and cloud distributions on Jupiter and Saturn, gross dynamical properties, zonal rotation, orientation of spin axis, zonal shear, vertical shear, flow instabilities, spots, and spectrum of scale of atmospheric motions in time and space. Additional objectives included the study of the mode of release of internal energy flux (search for convection cells and rolls), study of growth, dissipation, morphology, and vertical structure of cloud complexes, gross optical properties, global and localized scattering function in the visible spectrum, polarimetry, nature of chromophores (their structure and development), and high resolution of the Great Red Spot. The objectives of the satellite encounters included the following: (1) gross characteristics (size, shape, rotation, spin axis, cartography, improved ephemerides and masses,) (2) geology (major physiographic provinces, impact and volcanic features, lineaments, polar caps, erosion processes, and low- and high-density satellite comparative studies, detection of atmospheres, frosts, and limb stratification of aerosols,) (3) surface properties (colorimetry, scattering function, nature of brightness variation, and search for new satellites.) Studies of Saturn's rings included: (1) resolution of individual ring components or clumps of material, (2) vertical and radial distribution of material at very high resolution, (3) scattering function, (4) coarse polarimetry, (5) occultation - optical depth, and (6) distinguishing different types of material in the rings. Other objectives were to search for new comets, asteroids, and targets of opportunity.

------- VOYAGER 2, SMITH----------

INVESTIGATION NAME- IMAGING

NSSDC ID- 77-076A-01

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
METEOROLOGY
PLANETARY ATMOSPHERES
PLANETOLOGY

PERSONNEL

TL - B.A.	SMITH	U OF ARIZONA
DT - L.A.	SODERBLOM	US GEOLOGICAL SURVEY
TM - G.A.	BRIGGS	NASA HEADQUARTERS
TM - A.F.	COOK	SAO
TM - G.E.	DANIELSON	CALIF INST OF TECH
TM - M.E.	DAVIES	RAND CORP
TM - G.E.	HUNT	U COLLEGE LONDON
TM - T.	OWEN	STATE U OF NEW YORK
TM - C.	SAGAN	CORNELL U
TM - V.E.	SUOMI	U OF WISCONSIN
TM - T.V.	JOHNSON	NASA-JPL
TM - H.	MASURSKY	US GEOLOGICAL SURVEY

BRIEF DESCRIPTION

The photographic experiment used a two-camera system, based on the Mariner 10 system. This system included one narrow-angle, long-focal-length camera and one wide-angle, short-focal-length camera. The maximum resolution achievable depended greatly on the actual trajectory on this multi-encounter mission, but was as high as 0.5 to 1.0 km on the closest approaches to some objects. At Jupiter and Saturn, the resolution that was achieved was better than 20 km and 5 km, respectively. The objectives of the experiment were to photograph global motions and cloud distributions on Jupiter, Saturn, Uranus, and Neptune, gross dynamical properties, zonal rotation, orientation of spin axis, zonal shear, vertical shear, flow instabilities, spots, and spectrum of scale of atmospheric motions in time and space. Additional objectives included the study of the mode of release of internal energy flux (search for convection cells and rolls), study of growth, dissipation, morphology, and vertical structure of cloud complexes, gross optical properties, global and localized scattering function in the visible spectrum, polarimetry, nature of chromophores (their structure and development), and high resolution of the Great Red Spot. The objectives of the satellite encounters included (1) gross characteristics (size, shape, rotation, spin axis, cartography, improved ephemerides and masses;) (2) geology (major physiographic provinces, impact and volcanic features, lineaments, polar caps, erosion processes, and low- and high-density satellite comparative studies, detection of atmospheres, frosts, and limb stratification of aerosols;) and (3) surface properties (colorimetry, scattering function, nature of brightness variation, and search for new satellites.) Studies of Saturn's rings were carried out and will be for Uranus' rings. Objectives included (1) resolution of individual ring components of clumps of material; (2) vertical and radial distribution of material at very high resolution; (3) scattering function; (4) coarse polarimetry; (5) occultation - optical depth; and (6) distinguishing different types of material in the rings. Other objectives were to search for new comets, asteroids, and targets of opportunity.

PARTICLES AND FIELDS

------- PIONEER 11, WOLFE----------

INVESTIGATION NAME- PLASMA

NSSDC ID- 73-019A-13

INVESTIGATIVE PROGRAM
CODE EL-4/CO-OP, SCIENCE

INVESTIGATION DISCIPLINE(S)
SPACE PLASMAS
PARTICLES AND FIELDS

PERSONNEL

PI - J.H.	WOLFE	NASA-ARC
OI - L.A.	FRANK	U OF IOWA
OI - R.	LUST	MPI-HEADQUARTERS
OI - D.S.	INTRILIGATOR	U OF SOUTHERN CALIF
OI - V.T.	ZAVIENTSEFF(NLA)	NASA-ARC
OI - Z.A.	SMITH	NOAA-SEL
OI - F.L.	SCARF	TRW SYSTEMS GROUP
CI - H.R.	COLLARD	NASA-ARC
OI - W.C.	FELDMAN	LOS ALAMOS NAT LAB
OI - D.D.	MCKIBBIN	NASA-ARC

BRIEF DESCRIPTION

The instrument consisted of qual 90-deg quadrispherical electrostatic analyzers, one with 26 individual particle detectors anc the other with 5 current collectors. The system was capable of measuring incident plasma distribution parameters over the energy range 0.1 to 18 keV for protons and approximately 1-500 eV for electrons. The high-resolution analyzer with a constant of 9 keV/Q per kV applied to the plates, had a mean plate radius of 9 cm and separation of 0.5 cm. This analyzer was used to measure ions only, and had 26 channeltrons mounted on the semicircular exit to the analyzer. The aperture pointed through a wide slit in the back of the spacecraft high-gain antenna reflector and pointed along the

spin axis toward the earth (and therefore the sun). The edges of the antenna reflector limited the viewing of the instrument to 73 deg with respect to the spin axis. The channeltrons covered a range of plus or minus 51 deg. Each channeltron near the center covered 3 deg and approximately 8 deg near the edges of the analyzer. The angular width perpendicular to the long angular width was about 2 deg. In half the pin period the whole cone of half-angle 51 deg centered on the sun was swept out. A medium-energy analyzer with a mean radius of 12 cm and a 1 cm plate separation (constant of 6 keV/Q per kV applied) was used to detect both ions and electrons. The detectors were five flat-surface current collectors. The three center collectors each covered 15 deg and covered the angular range of plus or minus 22.5 deg from the spin axis. The two outside collectors had an angular width of 47.5 deg and were located at plus or minus 46.25 deg from the center of the analyzer. There was a variety of possible operating modes for the experiment; however, the principal mode utilized during the encounter phase was one in which the analyzer plate potential was stepped through its range every one-half revolution of the spacecraft, and all current collectors or channeltrons were read out at the peak flux roll angle. The high and medium resolution analyzers operated independently, so a cross check between these analyzers was possible. The dynamic range for the particle fluxes was from 1.0E+2 to 3.0E+9/sq cm s and the proton temperature down to 2.0E+3 deg K could be ascertained. Data include the interplanetary region.

------- PIONEER 11, ACUNA----------

INVESTIGATION NAME- JOVIAN MAGNETIC FIELD

NSSDC ID- 73-019A-14

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
MAGNETOSPHERIC PHYSICS
PLANETARY MAGNETIC FIELD

PERSONNEL
PI - M.H. ACUNA NASA-GSFC
OI - N.F. NESS NASA-GSFC

BRIEF DESCRIPTION
This instrument, designed to measure the Jovian and Saturnian magnetic field, consisted of a single-range triaxial fluxgate magnetometer sensor and associated electronics capable of measuring fields from 1.E-6 to 1.E-3 T (0.01 to 10 gauss) along each orthogonal axis. Use of a 10-bit A-to-D converter yielded a quantization step size of minus to plus 600 nT for fields less than 2.E-4 T. Instantaneous vector measurements were made once every three revolutions of the spacecraft (36 s) and transmitted to the ground with no further onboard processing. More instrumental details are given in Sp. Sci. Instrum., v. 1, p. 177, 1975. Principal Jovian scientific results can be found in J. Geophys. Res., v. 81, p. 2917, 1976.

------- PIONEER 11, VAN ALLEN----------

INVESTIGATION NAME- JOVIAN CHARGED PARTICLES

NSSDC ID- 73-019A-11

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS
MAGNETOSPHERIC PHYSICS

PERSONNEL
PI - J.A. VAN ALLEN U OF IOWA

BRIEF DESCRIPTION
This experiment used seven miniature Geiger tubes in three arrays to measure proton and electron fluxes near Jupiter and Saturn. Detector groupings were as follows: (1) a three-element (A, B, and C) differentially shielded telescope. Tube C was shielded omnidirectionally and was used for background subtraction to provide rates such as A-C (5 to 21 MeV electrons and 30 to 77.5 MeV protons) and B-C (0.55 to 21 MeV electrons and 6.6 to 77.5 MeV protons); (2) a three-element triangular array, each element responding to electrons above 31 MeV and protons above 77.5 MeV; and (3) a thin-window tube (G) with a gold-plated elbow as the entrance aperture to admit scattered electrons above 0.06 MeV while discriminating strongly against protons. For a description of the similar experiment on Pioneer 10, see Van Allen et al., J. Geophys. Res., v. 79, p. 3395, 1974. Early results are given in Science, v. 188, p. 459, 1975. Data include the interplanetary region.

------- PIONEER 11, MCDONALD----------

INVESTIGATION NAME- COSMIC-RAY SPECTRA

NSSDC ID- 73-019A-12

INVESTIGATIVE PROGRAM
CODE EL-4/CO-OP, SCIENCE

INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS
COSMIC RAYS

PERSONNEL
PI - F.B. MCDONALD NASA-GSFC
OI - K.G. MCCRACKEN CSIRO
OI - W.R. WEBBER U OF NEW HAMPSHIRE
OI - E.C. ROELOF APPLIED PHYSICS LAB
OI - B.J. TEEGARDEN NASA-GSFC
OI - J.H. TRAINOR NASA-GSFC

BRIEF DESCRIPTION
This experiment consisted of three 3-element telescopes, all looking normal to the spacecraft spin axis. A bidirectional telescope measured 20- to 800-MeV/nucleon particles with 5 to 10% energy resolution. Another telescope measured 3- to 22-MeV/nucleon particles with 5% resolution. These two telescopes measured particles with Z values between 1 and 8. The third telescope measured 50-keV to 1-MeV electrons and 50-keV to 20-MeV protons with 20% resolution. Data include the interplanetary region.

------- PIONEER 11, FILLIUS----------

INVESTIGATION NAME- JOVIAN TRAPPED RADIATION

NSSDC ID- 73-019A-05

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS
MAGNETOSPHERIC PHYSICS
PLANETOLOGY

PERSONNEL
PI - R.W. FILLIUS U OF CALIF, SAN DIEGO
OI - C.E. MCILWAIN U OF CALIF, SAN DIEGO

BRIEF DESCRIPTION
This experiment consisted of an array of five particle detectors with electron thresholds in the range .01 to 35 MeV and proton thresholds in the range 0.15 to 80 MeV. A Cerenkov counter (C) had four output channels (C1, C2, C3, and CDC) sensitive to electrons having energies above 5, 8, 12, and 1 MeV, respectively. An electron scatter counter (E) had three output channels (E1, E2, and E3) sensitive to electrons above .16, .26, and .46 MeV. A minimum ionization counter (M) had three output channels: M1, sensitive to electrons having energies greater than 35 MeV; M2, measuring background; and M3, sensitive to protons having energies greater than 80 MeV. The last two sensors were scintillator detectors (SP and SE), both of which had energy thresholds of 10 keV for electrons and 150 keV for protons. The sensitivity of the SE detector to protons was about a factor of 10 lower than its sensitivity to electrons. Thus, the SEDC channel effectively measured the electron flux, which could then be subtracted from the SPDC channel response to obtain the proton flux. Several other channels listed above required corrections to obtain the fluxes of the species indicated. The detector channels could be programmed for readout in any one of four patterns at each of the eight spacecraft bit-rate modes. During encounter when the spacecraft was operating in the highest bit-rate mode, the minimum time to sample one channel was 1.5 s and the time to obtain a complete scan through all channels was 108 s. Since the directional detectors pointed perpendicularly to the spin axis and the spin rate was 5 rpm, pitch-angle measurements were obtained. Although this experiment was primarily designed for encounter studies, some data were obtained at low rates in interplanetary space. A description of the instrumentation and initial Pioneer 10 results was published in J. Geophys. Res., v. 79, p. 3589, 1974.

RADIO SCIENCE AND CELESTIAL MECHANICS

------- PIONEER 11, ANDERSON----------

INVESTIGATION NAME- CELESTIAL MECHANICS

NSSDC ID- 73-019A-09

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PLANETOLOGY
ASTRONOMY
CELESTIAL MECHANICS

PERSONNEL
PI - J.D. ANDERSON NASA-JPL
OI - G.W. NULL NASA-JPL

BRIEF DESCRIPTION
In this investigation, two-way Doppler tracking of the spacecraft was used to make more precise determinations of planetary masses, the heliocentric orbits of Jupiter and Saturn, and the gravitational fields of the Sun, Jupiter, Saturn, and the Galilean and Saturnian satellites.

ATMOSPHERE

------- PIONEER 11, GEHRELS----------

INVESTIGATION NAME- IMAGING PHOTOPOLARIMETER (IPP)

NSSDC ID- 73-019A-07

SEE THIS EXPERIMENT UNDER IMAGING

POLARIZATION

------- PIONEER 11, GEHRELS----------

INVESTIGATION NAME- IMAGING PHOTOPOLARIMETER (IPP)

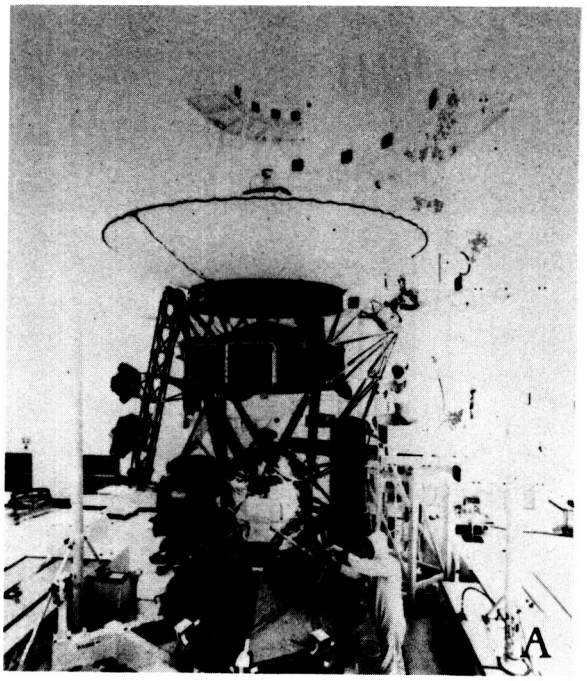
NSSDC ID- 73-019A-E7

SEE THIS EXPERIMENT UNDER IMAGING

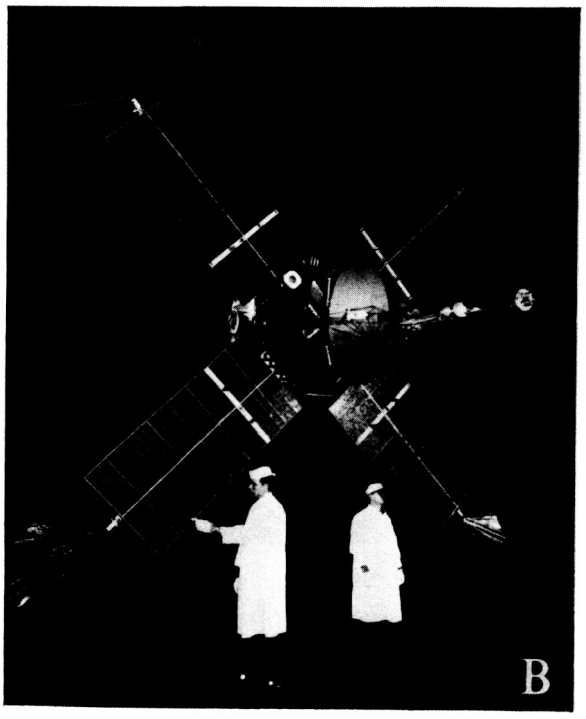
Interplanetary Investigations by Planetary Probes

INTERPLANETARY INVESTIGATIONS BY PLANETARY PROBES

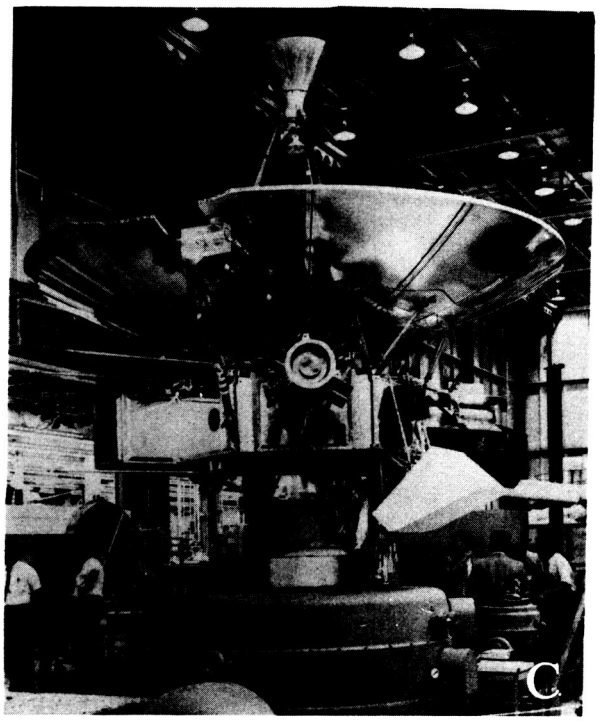
Plate 6. This is a collection of press release images of typical planetary spacecraft that conducted investigations in interplanetary space. (A) Mariner 4 was one of the first spacecraft to conduct planetary (Mars) and interplanetary exploration. (B) Pioneer 10 investigated the interplanetary medium, the nature of the asteroid belt, and conducted exploration of Jupiter and its environment. (C) Voyager 1 was designed to conduct investigations of the Jupiter and Saturn systems and to study interplanetary space.



Mariner 4



Pioneer 10



Voyager 1

INTERPLANETARY INVESTIGATIONS BY PLANETARY PROBES

INTRODUCTION

Six planetary probes carried instruments specifically to make investigations in interplanetary space. These were Mariners 4 and 5, Pioneers 10 and 11, and Voyagers 1 and 2. There were 11 investigations for which NSSDC has data or knows the sources for obtaining data. These cover three categories which are (1) Particles and Fields, (2) Ultraviolet, and (3) Interplanetary Particles. Table 1 and Appendix B show the investigations in more detail.

********** MARINER 4**********

SPACECRAFT COMMON NAME- MARINER 4
ALTERNATE NAMES- 00942

NSSDC ID- 64-077A

LAUNCH DATE- 11/28/64 WEIGHT- 262. KG
LAUNCH SITE- CAPE CANAVERAL, UNITED STATES
LAUNCH VEHICLE- ATLAS

SPONSORING COUNTRY/AGENCY
UNITED STATES NASA-OSSA

INITIAL ORBIT PARAMETERS
ORBIT TYPE- MARS FLYBY

PERSONNEL
PM - J.N. JAMES NASA-JPL
PS - R.K. SLOAN(NLA) NASA-JPL

BRIEF DESCRIPTION
Mariner 4 was the fourth in a series of spacecraft used for planetary exploration in a flyby mode. It was designed to conduct closeup scientific observations of the planet Mars and to transmit these observations to earth. Other mission objectives were to perform field and particle measurements in interplanetary space in the vicinity of Mars and to provide experience in and knowledge of the engineering capabilities for interplanetary flights of long duration. After 7.5 months of flight, the spacecraft flew by Mars on July 14, 1965, and returned 21 pictures plus 21 lines of picture 22. The closest approach was 9,846 km from the Martian surface. The spacecraft performed all programmed activities successfully at the proper times and returned useful data from launch until October 1965, when the distance from earth and its antenna orientation temporarily halted the signal acquisition. Data acquisition resumed in late 1967 and continued until December 20, 1967.

********** MARINER 5**********

SPACECRAFT COMMON NAME- MARINER 5
ALTERNATE NAMES- MARINER VENUS 67, 02845
VENUS-67

NSSDC ID- 67-060A

LAUNCH DATE- 06/14/67 WEIGHT- 245. KG
LAUNCH SITE- CAPE CANAVERAL, UNITED STATES
LAUNCH VEHICLE- ATLAS

SPONSORING COUNTRY/AGENCY
UNITED STATES NASA-OSSA

PERSONNEL
PM - D. SCHNEIDERMAN NASA-JPL
PM - T.H. PARKER(NLA) NASA-JPL
PM - G.A. REIFF(NLA) NASA HEADQUARTERS
PS - C.W. SNYDER NASA-JPL

BRIEF DESCRIPTION
The Mariner 5 spacecraft was the fifth in a series of spacecraft used for planetary exploration in the flyby mode. Mariner 5 was a refurbished backup spacecraft for the Mariner 4 mission and was converted from a Mars mission to a Venus mission. The spacecraft was fully attitude stabilized, using the sun and Canopus as references. A central computer and sequencer subsystem supplied timing sequences and computing services for other spacecraft subsystems. The spacecraft passed 4,000 km from Venus on October 19, 1967. The spacecraft instruments measured both interplanetary and Venusian magnetic fields, charged particles, and plasmas, as well as the radio refractivity and UV emissions of the Venusian atmosphere. The mission was termed a success.

********** PIONEER 10**********

SPACECRAFT COMMON NAME- PIONEER 10
ALTERNATE NAMES- PIONEER-F, PL-723D
05860

NSSDC ID- 72-012A

LAUNCH DATE- 03/03/72 WEIGHT- 231. KG
LAUNCH SITE- CAPE CANAVERAL, UNITED STATES
LAUNCH VEHICLE- ATLAS

SPONSORING COUNTRY/AGENCY
UNITED STATES NASA-OSSA

INITIAL ORBIT PARAMETERS
ORBIT TYPE- JUPITER FLYBY

PERSONNEL
PM - C.F. HALL(NLA) NASA-ARC
PS - P. DYAL NASA-ARC

BRIEF DESCRIPTION
This mission was the first to be sent to the outer solar system, and after encountering the planet Jupiter it assumed an escape trajectory from the solar system. The spacecraft body was mounted behind a 2.74-m-diameter parabolic dish antenna that was 46 cm deep. The spacecraft structure was a 36-cm-deep flat equipment compartment, the top and bottom being regular hexagons. Its sides were 71 cm long. One side joined a smaller compartment that carried the scientific experiments. The high-gain antenna feed was situated on three struts, which projected forward about 1.2 m. This feed was topped with a medium-gain antenna. A low-gain omnidirectional antenna extended about 0.76 m behind the equipment compartment and was mounted below the high-gain antenna. Power for the spacecraft was obtained by four SNAP-19 radioisotope thermonuclear generators (RTG), which were held about 3 m from the center of the spacecraft by two three-rod trusses 120 deg apart. A third boom extended 6.6 m from the experiment compartment to hold the magnetometer away from the spacecraft. The four RTG's generated about 155 watts at launch and decayed to approximately 140 watts by the time the spacecraft reached Jupiter on December 3, 1973, 21 months after launch. There were three reference sensors: a star sensor for Canopus, and two sun sensors. Attitude position could be calculated from the reference directions to the earth and the sun, with the known direction to Canopus as a backup. Three pairs of rocket thrusters provided spin-rate control (maintained at 4.8 rpm) and changed the velocity of the spacecraft. These thrusters could be pulsed or fired steadily by command. Communications were maintained via the omnidirectional and medium-gain antennas, which operated together, connected to one receiver, while the high-gain antenna was connected to another receiver. These receivers could be interchanged by command to provide some redundancy. Two radio transmitters, coupled to two traveling-wave tube amplifiers, produced 8 watts at 2292 MHz each. Uplink was accomplished at 2110 MHz, while data transmission downlink was at 2292 MHz. The data were received by NASA's Deep Space Network. The spacecraft was temperature-controlled between minus 23 deg C and plus 38 deg C. Fifteen experiments were carried to study the interplanetary and planetary magnetic fields; solar wind parameters; cosmic rays; transition region of the heliosphere; neutral hydrogen abundance; distribution, size, mass, flux, and velocity of dust particles; Jovian aurorae; Jovian radio waves; atmosphere of Jupiter and some of its satellites, particularly Io; and to photograph Jupiter and its satellites. Instruments carried for these experiments were magnetometer, plasma analyzer, charged particle detector, ionizing detector, non-imaging telescopes with overlapping fields of view to detect sunlight reflected from passing meteoroids, sealed pressurized cells of argon and nitrogen gas for measuring the penetration of meteoroids, UV photometer, IR radiometer, and an imaging photopolarimeter, which produced photographs and measured polarization. Further scientific information was obtained from the tracking and occultation data. The spacecraft achieved its closest approach on December 3, 1973, when it reached approximately three Jovian radii (about 210,000 km). The spacecraft contains plaques that have drawings depicting a man, a woman, and the location of the sun and the earth in our galaxy. It is leaving the solar system and passing into interstellar space.

********** PIONEER 11**********

SPACECRAFT COMMON NAME- PIONEER 11
ALTERNATE NAMES- PIONEER-G, PL-733C
6421

NSSDC ID- 73-019A

LAUNCH DATE- 04/06/73 WEIGHT- 231. KG
LAUNCH SITE- CAPE CANAVERAL, UNITED STATES
LAUNCH VEHICLE- ATLAS

SPONSORING COUNTRY/AGENCY
UNITED STATES NASA-OSSA

INITIAL ORBIT PARAMETERS
ORBIT TYPE- SATURN FLYBY

PERSONNEL
PM - C.F. HALL(NLA) NASA-ARC
PS - P. DYAL NASA-ARC

BRIEF DESCRIPTION
This was the second mission to investigate Jupiter and the outer solar system. Pioneer 11, like Pioneer 10, used Jupiter's gravitational field to alter its trajectory radically. It passed close to Saturn and then it followed an escape trajectory from the solar system. The spacecraft was 2.9 m (9.5 ft) long and contained a 2.74-m (9-ft) diameter high-gain antenna of aluminum honeycomb sandwich material whose feed was topped with a medium-gain antenna. A low-gain, omnidirectional antenna was mounted below the high-gain dish. It contained two nuclear electric-power generators, which generated 144 W at Jupiter, but decreased to 100 W at Saturn. There were three reference sensors: a star (Canopus) sensor, and two sun sensors. Attitude position could be calculated from the reference direction to the earth and the sun, with the

known direction to Canopus as backup. Pioneer 11's star sensor gain and threshold settings were modified, based on experience gained from the settings used on Pioneer 10. Three pairs of rocket thrusters provided spin-axis control (at 4.8 rpm) and change of the spacecraft velocity. The thrusters could be either fired steadily or pulsed, by command. Communications were maintained via the omnidirectional and medium-gain antennas, which operated together, connected to one receiver, while the high-gain antenna was connected to the other receiver. The receivers could be interchanged by command. Two radio transmitters, coupled to two traveling wave tube amplifiers, produced 8 W power each in S-band. Communication uplink (earth to spacecraft) operated at 2110 MHz, and downlink (spacecraft to earth) at 2292 MHz. At Jupiter's distance, round-trip communication time took 92 min. Data were received at the Deep Space Network (DSN). The spacecraft was temperature-controlled to between -23 and +38 deg C (-10 to +100 deg F). An additional experiment, a low-sensitivity fluxgate magnetometer, was added to the Pioneer 11 payload. Instruments studied the interplanetary and planetary magnetic fields; solar wind properties; cosmic rays; transition region of the heliosphere; neutral hydrogen abundance; distribution, size, mass, flux, and velocity of dust particles; Jovian aurorae; Jovian radio waves; the atmospheres of planets and satellites; and the surfaces of Jupiter, Saturn, and some of their satellites. Instruments carried for these experiments were magnetometer, plasma analyzer (for solar wind), charged-particle detector, ionizing detector, non-imaging telescopes with overlapping fields of view to detect sunlight reflected from passing meteoroids, sealed pressurized cells of argon and nitrogen gas for measuring penetration of meteoroids, UV photometer, IR radiometer, and an imaging photopolarimeter, which produced photographs and measured the polarization. Further scientific information was obtained from celestial mechanics and occultation phenomena. This spacecraft, like Pioneer 10, contains a plaque that has a drawing depicting man, woman, and the location of the sun and earth in the galaxy. Pioneer 11 was 36,800 km from Jupiter during its closest approach, December 4, 1974, to within 43,000 km of its cloud tops. It passed by Saturn on Aug. 5, 1979 at a distance of 21,400 km from Saturn's cloud tops.

********** VOYAGER 1**********

SPACECRAFT COMMON NAME- VOYAGER 1
ALTERNATE NAMES- MARINER JUPITER/SATURN A, OUTER PLANETS A
MARINER 77A, MJS 77A
10321

NSSDC ID- 77-084A

LAUNCH DATE- 09/05/77 WEIGHT- 700. KG
LAUNCH SITE- CAPE CANAVERAL, UNITED STATES
LAUNCH VEHICLE- TITAN

SPONSORING COUNTRY/AGENCY
UNITED STATES NASA-OSSA

INITIAL ORBIT PARAMETERS
ORBIT TYPE- SATURN FLYBY

PERSONNEL
PM - J.R. CASANI(NLA) NASA-JPL
PS - E.C. STONE CALIF INST OF TECH

BRIEF DESCRIPTION
The overall objectives of Voyager were to conduct exploratory investigations of the planetary systems of Jupiter and Saturn and of the interplanetary medium out to Saturn. Primary emphasis was placed on comparative studies of these two planetary systems by obtaining (1) measurements of the environment, atmosphere, and body characteristics of the planets and the satellites of each planet, (2) studies of the nature of the rings of Saturn, and (3) exploration of the interplanetary (or interstellar) medium at increasing distances from the sun. These objectives were attained by using a variety of instruments and methods including imaging, a coherent S- and X-band RF receiver, an infrared interferometer and radiometer, UV spectrometer, fluxgate magnetometers, Faraday cups, a charged-particle analyzer, plasma detector, plasma-wave radio receiver, cosmic-ray telescopes, photopolarimeter, and a sweep-frequency radio receiver. Voyager 1 had its closest encounter with Jupiter on March 5, 1979, and with Saturn on November 12, 1980.

********** VOYAGER 2**********

SPACECRAFT COMMON NAME- VOYAGER 2
ALTERNATE NAMES- MARINER JUPITER/SATURN B, OUTER PLANETS B
MARINER 77B, MJS 77B
10271

NSSDC ID- 77-076A

LAUNCH DATE- 08/20/77 WEIGHT- 700. KG
LAUNCH SITE- CAPE CANAVERAL, UNITED STATES
LAUNCH VEHICLE- TITAN

SPONSORING COUNTRY/AGENCY
UNITED STATES NASA-OSSA

INITIAL ORBIT PARAMETERS
ORBIT TYPE- SATURN FLYBY

PERSONNEL
PM - J.R. CASANI(NLA) NASA-JPL
PS - E.C. STONE CALIF INST OF TECH

BRIEF DESCRIPTION
The overall objectives of Voyager 2 were to conduct exploratory investigations of the planetary systems of Jupiter, Saturn, Uranus, and Neptune, and of the interplanetary medium. Primary emphasis was placed on comparative studies of these planetary systems by obtaining (1) measurements of the environment, atmosphere, and body characteristics of the planets and one or more of the satellites of each planet, (2) studies of the nature of the rings of Saturn and Uranus, and (3) exploration of the interplanetary (or interstellar) medium at increasing distances from the sun. These objectives were met using a variety of instruments and methods including imaging, a coherent S- and X-band RF receiver, an IR interferometer and radiometer, a UV spectrometer, fluxgate magnetometers, Faraday cups, a charged-particle analyzer, plasma detector, plasma-wave radio receiver, cosmic-ray telescopes, photopolarimeter, and a sweep-frequency radio receiver. Jupiter close encounter was achieved on July 9, 1979, and Saturn on August 5, 1981.

INVESTIGATIONS

PARTICLES AND FIELDS

------- MARINER 5, BRIDGE-------

INVESTIGATION NAME- INTERPLANETARY ION PLASMA PROBE FOR E/Q OF 40 TO 9400 VOLTS

NSSDC ID- 67-060A-03 INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS
INTERPLANETARY PHYSICS

PERSONNEL
PI - H.S. BRIDGE MASS INST OF TECH
OI - C.W. SYNDER NASA-JPL

BRIEF DESCRIPTION
This three-sectional-collector modulated-grid Faraday cup measured positive ions from 40 to 9400 eV/Q in eight approximately logarithmically equispaced energy windows. As the instrument always pointed toward the sun, vector data were obtained by comparing the relative signals from the three 120-deg pie-shaped collector sections. During each telemetry sequence, the instrument was stepped forward and backward through the eight windows to measure the sum of the currents from the three plates. Then it was stepped forward and backward to measure, for each voltage setting, the currents to the three plates in succession. The entire 32 steps in voltage window per telemetry sequence produced 64 current measurements. These measurements were repeated every 5 min. The instrument operated nominally throughout its mission.

------- MARINER 4, SIMPSON-------

INVESTIGATION NAME- COSMIC-RAY TELESCOPE

NSSDC ID- 64-077A-04 INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
COSMIC RAYS

PERSONNEL
PI - J.A. SIMPSON U OF CHICAGO
OI - J.J. O'GALLAGHER U OF MARYLAND

BRIEF DESCRIPTION
A set of three silicon surface barrier detectors was used in the form of a dE/dx vs range telescope to determine the flux of protons in the energy intervals 15 to 70 MeV and 70 to 170 MeV, alpha particles in the energy ranges 15 to 70 MeV/nucleon and above 70 MeV/nucleon, and protons and alpha particles in the energy interval 1.2 to 15 MeV/nucleon. The detector was mounted on the spacecraft so as to point always in the antisolar direction. A 128-channel pulse-height analyzer was used to sample the energy loss in the top detector element of the telescope. It was possible to pulse-height analyze protons and alpha particles from 15 to 70 MeV/nucleon, protons from 70 to 170 MeV, and alpha particles with energies above 70 MeV/nucleon. Two count rates and two pulse height analyses were obtained every 72 or 18 s according to whether the spacecraft transmission rate was 8-1/3 or 33-1/3 bps. The experiment performed normally from launch until October 1965, when the spacecraft was turned off to conserve power. When the spacecraft was turned on again at a later time, the detector did not respond. For further details, see O'Gallagher, Ap. J., v. 150, p. 675, 1967.

------- VOYAGER 1, VOGT----------

INVESTIGATION NAME- HIGH- AND MODERATELY LOW-ENERGY COSMIC-RAY TELESCOPE

NSSDC ID- 77-084A-08

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
COSMIC RAYS
MAGNETOSPHERIC PHYSICS

PERSONNEL

PI - R.E.	VOGT	CALIF INST OF TECH
CI - J.R.	JOKIPII	U OF ARIZONA
CI - E.C.	STONE	CALIF INST OF TECH
CI - F.B.	MCDONALD	NASA-GSFC
CI - J.H.	TRAINOR	NASA-GSFC
CI - W.R.	WEBBER	U OF NEW HAMPSHIRE
CI - A.W.	SCHARDT	NASA-GSFC

BRIEF DESCRIPTION
This investigation studied the origin and acceleration process, life history, and dynamic contribution of interstellar cosmic rays, the nucleosynthesis of elements in cosmic-ray sources, the behavior of cosmic rays in the interplanetary medium, and the trapped planetary energetic-particle environment. The instrumentation included a High-Energy Telescope System (HETS) and a Low-Energy Telescope System (LETS). The HETS covered an energy range between 6 and 500 MeV/nucleon for nuclei ranging in atomic numbers from 1 through 30. In addition, electrons in the energy range between 3 and 100 MeV/nucleon were measured by this telescope and an electron telescope (TET). The LETS measured the energy and determined the identity of nuclei for energies between 30. The instruments also measured the anisotropies of electrons and nuclei. In addition, electrons in the energy range between 3 and 100 MeV/nucleon were measured by an electron telescope.

------- VOYAGER 2, VOGT----------

INVESTIGATION NAME- HIGH- AND MODERATELY LOW-ENERGY COSMIC-RAY TELESCOPE

NSSDC ID- 77-076A-08

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
COSMIC RAYS
MAGNETOSPHERIC PHYSICS

PERSONNEL

PI - R.E.	VOGT	CALIF INST OF TECH
CI - J.R.	JOKIPII	U OF ARIZONA
CI - E.C.	STONE	CALIF INST OF TECH
CI - F.B.	MCDONALD	NASA-GSFC
CI - J.H.	TRAINOR	NASA-GSFC
CI - W.R.	WEBBER	U OF NEW HAMPSHIRE
CI - A.W.	SCHARDT	NASA-GSFC

BRIEF DESCRIPTION
This investigation studied the origin and acceleration process, life history, and dynamic contribution of interstellar cosmic rays, the nucleosynthesis of elements in cosmic-ray sources, the behavior of cosmic rays in the interplanetary medium, and the trapped planetary energetic particle environment. The instrumentation included a High-Energy Telescope System (HETS) and a Low-Energy Telescope System (LETS). The HETS covered an energy range between 6 and 500 MeV/nucleon for nuclei ranging in atomic numbers from 1 through 30. In addition, electrons in the energy range between 3 and 100 MeV were measured by this telescope and an electron telescope (TET). The LETS measured the energy and determined the identity of nuclei for energies between .15 and 30 MeV/nucleon and atomic numbers from 1 to 30. The instruments also measured the anisotropies of electrons and nuclei. In addition, electrons in the energy range between 3 and 100 MeV were measured by an electron telescope.

ULTRAVIOLET

------- PIONEER 10, JUDGE----------

INVESTIGATION NAME- ULTRAVIOLET PHOTOMETRY

NSSDC ID- 72-012A-06

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
ASTRONOMY
PLANETARY ATMOSPHERES

PERSONNEL

PI - D.L.	JUDGE	U OF SOUTHERN CALIF
OI - R.W.	CARLSON	NASA-JPL

BRIEF DESCRIPTION
This experiment (on both Pioneers 10 and 11) consisted of a broadband photometer sensitive between 200 and 800 A. During the cruise phase of the mission, this experiment was used to search for the supersonic-to-subsonic transition region in the solar wind. During the Jovian encounter, this experiment was used to look for evidence of an auroral oval on the Jovian dayside, to find the ratio of hydrogen to helium in the Jovian atmosphere, and to find the temperature of the outer portion of the Jovian atmosphere. Evidence of helium was found in the interplanetary region indicating interactions between charged particles and neutral hydrogen.

------- PIONEER 11, JUDGE----------

INVESTIGATION NAME- ULTRAVIOLET PHOTOMETRY

NSSDC ID- 73-019A-06

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
ASTRONOMY
PLANETARY ATMOSPHERES
PLANETOLOGY
PARTICLES AND FIELDS

PERSONNEL

PI - D.L.	JUDGE	U OF SOUTHERN CALIF
OI - R.W.	CARLSON	NASA-JPL

BRIEF DESCRIPTION
This experiment consisted of a broadband photometer, sensitive between 200 and 800 A. During the cruise phase of the mission, this experiment was used to search for the supersonic-to-subsonic transition region in the solar wind. During the Jovian encounter, this experiment was used to look for evidence of an auroral oval on the Jovian dayside, to find the ratio of hydrogen to helium in the Jovian atmosphere, and to find the temperature of the outer portion of the Jovian atmosphere. Evidence of helium was found in the interplanetary region, indicating interactions between charged particles and neutral hydrogen.

INTERPLANETARY PARTICLES

------- PIONEER 10, SOBERMAN----------

INVESTIGATION NAME- ASTEROID/METEOROID ASTRONOMY

NSSDC ID- 72-012A-03

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
ASTRONOMY
INTERPLANETARY DUST

PERSONNEL

PI - R.K.	SOBERMAN	GENERAL ELECTRIC CO
OI - H.A.	ZOOK	NASA-JSC

BRIEF DESCRIPTION
The overall objective of this experiment (also carried on Pioneer 11) was to investigate dust particles and meteoroids in interplanetary space. It was essentially two experiments, using two different techniques. One method was to detect particles by the reflection of light from them, and the other method was to detect them by their impacts. The objectives were to determine distance, trajectory, velocity, relative size, and flux of particles ranging in size from minute particles a few meters from the telescope to distant asteroids. The equipment for the detection of reflection consisted of four non-imaging Ritchey-Chretien telescopes with primary mirrors of 20-cm (8 in.) diameter, and 25-cm (10 in.) focal length, fields of view (FOV) of 0.2 rad (8 deg) each, secondary optics, and a photomultiplier tube. The latter detects the reflected light collected by the telescope. An event was recorded when at least three of the four telescopes saw the object. Entry and departure times of the light enabled determination of range and velocity. The equipment for the impact mode consisted of 13 panels each containing 18 sealed cells, pressurized with argon and nitrogen gas, covering 0.65 sq m (6.9 sq ft) of the back of the main antenna dish. Penetration by a particle resulted in loss of gas at a rate proportional to the size of the hole, which would be related to the particle mass and velocity. Penetrations were registered from particles as small as 1.E-8 g.

------- PIONEER 11, SOBERMAN----------

INVESTIGATION NAME- ASTEROID/METEOROID ASTRONOMY

NSSDC ID- 73-019A-03

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
ASTRONOMY
INTERPLANETARY DUST

PERSONNEL

PI - R.K.	SOBERMAN	GENERAL ELECTRIC CO
OI - H.A.	ZOOK	NASA-JSC

BRIEF DESCRIPTION

The overall objective of this experiment was to investigate dust particles and meteoroids in interplanetary space. It was essentially two experiments, using two different techniques. One method was to detect particles by the reflection of light from them, and the other method was to detect them by their impacts. The objectives were to determine distance, trajectory, velocity, relative size, and flux of particles ranging in size from minute particles a few meters from the telescope to distant asteroids. The equipment for the detection of reflection consisted of four non-imaging Ritchey-Chretien telescopes with primary mirrors of 20-cm (8 in.) diameter, 25-cm (10 in.) focal length, fields of view (FOV) of 0.2 rad (8 deg) each, secondary optics, and a photomultiplier tube. The latter detects the reflected light collected by the telescopes. An event was recorded when three of the four telescopes saw the object. Entry and departure times of the light enabled determination of range and velocity. The equipment for the impact mode consisted of 13 panels containing 18 sealed cells, pressurized with argon and nitrogen gas, covering 0.65 sq m (6.9 sq ft) of the back of the main antenna dish. Penetration by a particle resulted in loss of gas at a rate proportional to the hole, which would be related to its mass and velocity. This experiment is similar to one on Pioneer 10. Since the cells on Pioneer 11 were slightly thicker than Pioneer 10, the minimum mass particles detected were of slightly greater mass.

------- PIONEER 10, KINARD----------

INVESTIGATION NAME- METEOROID DETECTORS

NSSDC ID- 72-012A-04

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
ASTRONOMY
INTERPLANETARY DUST

PERSONNEL

PI - W.H.	KINARD	NASA-LARC
OI - R.E.	TURNER	NASA-MSFC
OI - J.M.	ALVAREZ	NASA-LARC
OI - D.H.	HUMES	NASA-LARC
OI - R.L.	O'NEAL	NASA-LARC

BRIEF DESCRIPTION

This experiment was designed to measure the number of meteoroid impacts on the Pioneer 10 spacecraft (and a similar one was on Pioneer 11), by means of 12 panels, each containing 18 pressurized cells, mounted on the back of the antenna disk. The total exposed area was 0.465 sq m. Each panel of gas-filled cells consisted of a 2.54E-5 m (1-mil) thick and a 5.08E-5 m (2-mil) thick sheet of stainless steel welded together in such a way that many small pockets of gas were left between them. Whenever a pocket was punctured, the gas escaped and a cold cathode device detected the loss. The rate of pressure loss indicated the size of the hole made, and thus the particle's mass and incident energy could be determined. The combination of these data with trajectory data provided an indication of the spatial density of the particles. The 2.54E-5 m thick side of the gas panel was exposed to the interplanetary medium, and penetrations of the cells from that side indicated encounters with particles having masses of 1 nanogram or more.

------- PIONEER 11, KINARD----------

INVESTIGATION NAME- METEOROID DETECTORS

NSSDC ID- 73-019A-04

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
ASTRONOMY
INTERPLANETARY DUST

PERSONNEL

PI - W.H.	KINARD	NASA-LARC
OI - J.M.	ALVAREZ	NASA-LARC
OI - D.H.	HUMES	NASA-LARC

BRIEF DESCRIPTION

The Pioneer 11 meteoroid detection experiment attempted to detect the distribution in interplanetary space of meteoroids too small to be seen by light-scattering techniques. Twelve panels, each containing 18 pressurized cells, were mounted on the back of the spacecraft antenna dish. The pressurized cells consisted of a 5.08e-5 m thick stainless steel outer layer welded to a 2.54e-5 m thick stainless steel inner layer, with a large number of small pockets of gas trapped between them. Loss of gas pressure from any of the cells indicated a hit, and the rate of gas loss indicated the size of the hole made. Thus, the mass and incident energy of each meteoroid particle could be obtained, and when combined with the trajectory data, allowed the spatial density of the meteoroids to be determined. The panels detected impacts of particles having a mass of greater than 1.E-6 g. The panels covered 0.46 sq m of exposed area on Pioneer 11. Results from this experiment were combined with those from a similar experiment flown on Pioneer 10 to determine the range in mass of small particles on both the inner and outer boundaries and within the asteroid belt.

------- PIONEER 10, WEINBERG----------

INVESTIGATION NAME- ZODIACAL-LIGHT TWO-COLOR PHOTOPOLARIMETRY

NSSDC ID- 72-012A-14

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
ASTRONOMY
PLANETARY ATMOSPHERES
ZODIACAL LIGHT

PERSONNEL

PI - J.L.	WEINBERG	U OF FLORIDA
OI - M.S.	HANNER	NASA-JPL

BRIEF DESCRIPTION

The Imaging Photopolarimeter (IPP) experiment (also carried on Pioneer 11) was used to obtain maps of the zodiacal light distribution in two colors, blue (3900 to 4900 A) and red (5800 to 7000 A). In each color, the maps were constructed out of the integrated-detector-response (1/64 of a roll period), spin-scan point-imaging data obtained by viewing through a 40 by 40-mrad field-stop aperture. This work was performed during the cruise portion of the mission. Detailed simultaneous radiometric and polarimetric maps of both sky colors were made as the spacecraft swept out a 360-deg clock angle swath, and the telescope and optics were stepped in cone angle (the angle between spacecraft spin axis and the telescope optical axis). At each discrete cone angle, a 20-roll measurement cycle occurred, consisting of 10 rolls for the accumulation of the data and for calibration, alternated with 10-roll periods used for the telemetry of the data. During a data roll, the signals from four detectors (2/color) were integrated over a time interval equal to 1/64 of the roll period. The four channels provided simultaneous measurements at two orthogonal polarization azimuths in the two spectral bands. The polarization was sampled parallel and perpendicular to the plane containing the spacecraft spin axis and the optical axis of the telescope. Radioactive calibration was provided by a radioisotope-activated phosphor source. All such data were formatted to produce a sky map, 360 deg in clock angle by 141 deg in cone angle. The experimental train for the IPP package consisted of the following elements: (1) a near-diffraction-limited 2.54-cm Maksutov catadioptric telescope (f/3.4), (2) a focal plane wheel containing field-of-view apertures, depolarizers, calibration source, etc., (3) a Wollaston prism to split light into two orthogonally polarized beams, (4) a 45-deg dichromatic mirror that reflected wavelengths less than 5500 A (blue beam) and transmitted all light of greater wavelength (red beam), (5) for each spectral beam (two polarizations), a filtering coated relay lens and folding mirrors, and (6) for each spectral beam, two Bendix channeltron detectors (blue, bialkali S-11 photocathodes; red, S-20 photocathodes) to register the intensity in each polarization component.

------- PIONEER 11, WEINBERG----------

INVESTIGATION NAME- ZODIACAL-LIGHT TWO-COLOR PHOTOPOLARIMETRY

NSSDC ID- 73-019A-15

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
ZODIACAL LIGHT
PLANETARY ATMOSPHERES
ASTRONOMY

PERSONNEL

PI - J.L.	WEINBERG	SPACE ASTRONOMY LAB
OI - M.S.	HANNER	NASA-JPL

BRIEF DESCRIPTION

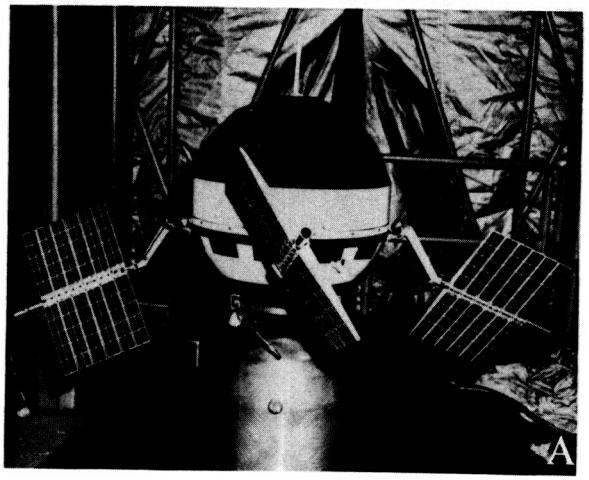
The Imaging Photopolarimeter (IPP) experiment was used to obtain maps of the zodiacal light distribution in two colors, blue (3900 to 4900 A) and red (5800 to 7000 A). In each color, the maps were constructed out of the integrated-detector-response (1/64 of a roll period), spin-scan point-imaging data obtained by viewing through a 40- by 40-mrad field-stop aperture. This work was performed during the cruise portion of the mission. In detail, simultaneous radiometric and polarimetric maps of the sky in both colors were made as the spacecraft swept out a 360-deg clock angle swath, and the telescope and optics were stepped in cone angle (the angle between spacecraft spin axis and the telescope optical axis). At each discrete cone angle, a 20-roll measurement cycle occurred, consisting of 10 rolls for the accumulation of the data and for calibration, alternated with 10-roll periods used for the telemetry of the data. During a data roll, the signals from four detectors (2/color) were integrated over a time interval equal to 1/64 of the roll period. The four channels provided simultaneous measurements at two orthogonal polarization azimuths in the two spectral bands. The polarization was sampled parallel and perpendicular to the plane containing the spacecraft spin axis and the optical axis of the telescope. Radioactive calibration was provided by a radioisotope-activated phosphor source. All such data were

formatted to produce a sky map, 360 deg in clock angle by 141 deg in cone angle. The experimental train for the IPP package consisted of the following elements: (1) a near-diffraction-limited 2.54-cm Maksutov catadioptric telescope (f/3.4); (2) a focal plane wheel containing field-of-view apertures, depolarizers, calibration source, etc.; (3) a Wollaston prism to split the light into two orthogonally polarized beams, (4) a 45-deg dichromatic mirror that reflected wavelengths less than 5500 A (blue beam) and transmitted all light of greater wavelength (red beam), (5) for each spectral beam (two polarizations) a filtering, coated relay lens and folding mirrors, and (6) for each spectral beam, two Bendix channeltron detectors (blue - bialkali S-11 photocathodes, red - S-20 photocathodes) to register the intensity in each polarization component. (Note: a similar experiment was also aboard Pioneer 10.) Data include the interplanetary region.

Interplanetary Investigations

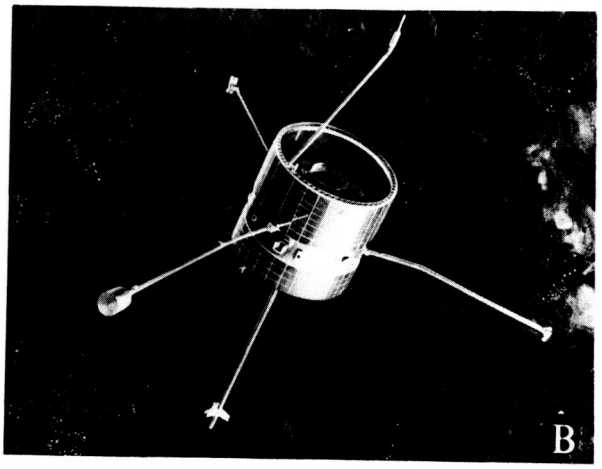
INTERPLANETARY

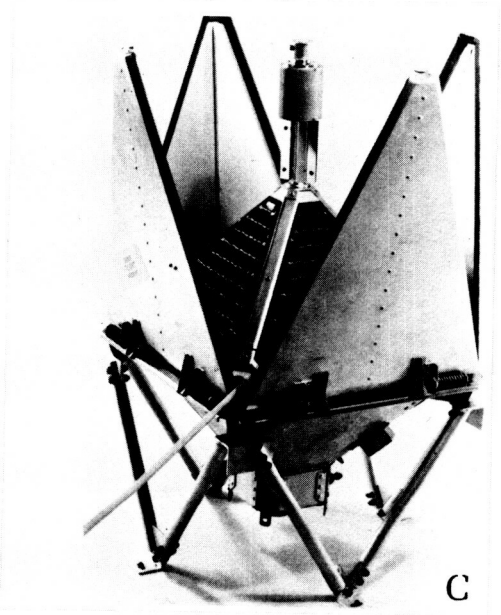
Plate 7. This is a collection of press release images of typical spacecraft designed solely to conduct investigations in interplanetary space. (A) Pioneer 5 investigated particles and fields in ciscytherean space, including solar flares and the solar wind. (B) Pioneer 6 investigated interplanetary phenomena in ciscytherean space to within about 0.814 AU of the sun. (C) Pioneer 9 collected scientific data on the electromagnetic and plasma properties of the interplanetary medium. (D) Helios-A investigated the properties and processes in interplanetary space in the direction of and close to the sun.



Pioneer 5

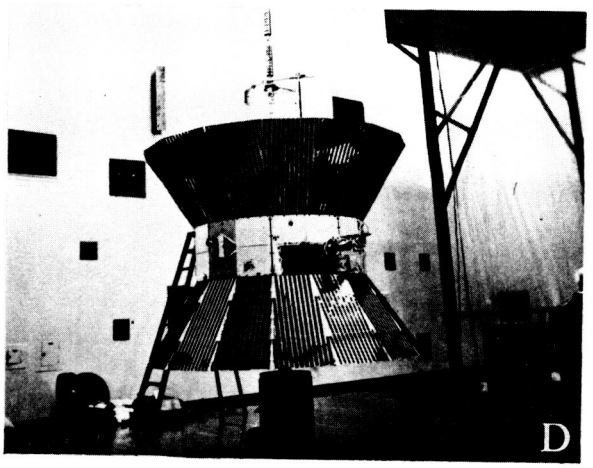
Pioneer 6





Pioneer 9

Helios A



INTERPLANETARY INVESTIGATIONS

INTRODUCTION

There were seven missions which were designed solely to make investigations in interplanetary space. These were Pioneers 5, 6, 7, 8, and 9, and Helios-A and -B. There were 54 investigations for which NSSDC has data or sources for obtaining data. These cover three categories which are (1) Particles and Fields, (2) Radio Science and Celestial Mechanics, and (3) Interplanetary Particles. Table 1 and Appendix C show the investigations in more detail.

********** PIONEER 5**********

SPACECRAFT COMMON NAME- PIONEER 5
ALTERNATE NAMES- 1960 ALPHA 1, 00027

NSSDC ID- 60-001A

LAUNCH DATE- 03/11/60 WEIGHT- 43. KG
LAUNCH SITE- CAPE CANAVERAL, UNITED STATES
LAUNCH VEHICLE- THOR

SPONSORING COUNTRY/AGENCY
UNITED STATES NASA-OSSA
UNITED STATES DOD-USAF

INITIAL ORBIT PARAMETERS
ORBIT TYPE- HELIOCENTRIC EPOCH DATE- 03/11/60
ORBIT PERIOD- 311.6 DAYS INCLINATION- 3.35 DEG
PERIAPSIS- 0.7061 AU RAD APOAPSIS- 0.9931 AU RAD

PERSONNEL
PM - C.F. HALL(NLA) NASA-ARC

BRIEF DESCRIPTION
Pioneer 5 (1960 alpha 1) was a spin-stabilized space probe used to investigate interplanetary space between the orbits of earth and Venus. The spacecraft measured magnetic field phenomena, solar flare particles, and ionization in the interplanetary region. The digital data were transmitted at 1, 8, and 64 bps, depending on the distance of the spacecraft from the earth and the size of the receiving antenna. Weight limitations on the solar cells prevented continuous operation of the telemetry transmitters. About four operations of 25-min duration were scheduled per day with occasional increases during times of special interest. A total of 138.9 h of operation was completed, and over 3 million binary bits of data were received. The major portion of the data was received at the Manchester and Hawaii tracking stations because their antennas provided gric reception. Pioneer 5 performed normally until April 30, 1960, after which telemetry transmission became too infrequent for any significant addition to the data. The spacecraft established a communications link with the earth from a record distance of 22.5 million miles on June 26, 1960, which was the last day of transmission.

********** PIONEER 6**********

SPACECRAFT COMMON NAME- PIONEER 6
ALTERNATE NAMES- PIONEER-A, 01841

NSSDC ID- 65-105A

LAUNCH DATE- 12/16/65 WEIGHT- 146. KG
LAUNCH SITE- CAPE CANAVERAL, UNITED STATES
LAUNCH VEHICLE- DELTA

SPONSORING COUNTRY/AGENCY
UNITED STATES NASA-OSSA

ORBIT PARAMETERS
ORBIT TYPE- HELICCENTRIC EPOCH DATE- 07/15/75
ORBIT PERIOD- 311.1 DAYS INCLINATION- 0.168 DEG
PERIAPSIS- 0.813 AU RAD APOAPSIS- 0.983 AU RAD

PERSONNEL
PM - C.F. HALL(NLA) NASA-ARC
PS - P. DYAL NASA-ARC

BRIEF DESCRIPTION
Pioneer 6 was the first in a series of solar-orbiting, spin-stabilized, solar-cell and battery-powered satellites designed to obtain measurements on a continuing basis of interplanetary phenomena from widely separated points in space. Its experiments studied the positive ions and electrons in the solar wind, the interplanetary electron density (radio propagation experiment), solar and galactic cosmic rays, and the interplanetary magnetic field. Its main antenna was a high-gain directional antenna. The spacecraft was spin-stabilized at about 60 rpm, and the spin axis was perpendicular to the ecliptic plane and pointed toward the south ecliptic pole. By ground command, one of five bit rates, one of four data formats, and one of four operating modes could be selected. The five bit rates were 512, 256, 64, 16, and 8 bps. Three of the four data formats contained primarily scientific data and consisted of 32 seven-bit words per frame. One scientific data format was for use at the two highest bit rates. Another was for use at the three lowest bit rates. The third contained data from only the radio propagation experiment. The fourth data format contained mainly engineering data. The four operating modes were real time, telemetry store, duty cycle store, and memory readout. In the real-time mode, data were sampled and transmitted directly (without storage) as specified by the data format and bit rate selected. In the telemetry store mode, data were stored and transmitted simultaneously in the format and at the bit rate selected. In the duty-cycle store mode, a single frame of scientific data was collected and stored at a rate of 512 bps. The time interval between the collection and storage of successive frames could be varied by ground command between 2 and 17 min to provide partial data coverage for periods up to 19 h, as limited by the bit storage capacity. In the memory readout mode, data were read out at whatever bit rate was appropriate to the satellite distance from the earth.

********** PIONEER 7**********

SPACECRAFT COMMON NAME- PIONEER 7
ALTERNATE NAMES- PIONEER-B, 02398

NSSDC ID- 66-075A

LAUNCH DATE- 08/17/66 WEIGHT- 138. KG
LAUNCH SITE- CAPE CANAVERAL, UNITED STATES
LAUNCH VEHICLE- DELTA

SPONSORING COUNTRY/AGENCY
UNITED STATES NASA-OSSA

ORBIT PARAMETERS
ORBIT TYPE- HELIOCENTRIC EPOCH DATE- 02/12/76
ORBIT PERIOD- 402.9 DAYS INCLINATION- 0.098 DEG
PERIAPSIS- 1.009 AU RAD APOAPSIS- 1.125 AU RAD

PERSONNEL
PM - C.F. HALL(NLA) NASA-ARC
PS - J.H. WOLFE NASA-ARC

BRIEF DESCRIPTION
Pioneer 7 was the second in a series of solar-orbiting, spin-stabilized, solar-cell and battery-powered satellites designed to obtain measurements of interplanetary phenomena from widely separated points in space on a continuing basis. The spacecraft carried experiments to study positive ions and electrons in the solar wind, the interplanetary electron density (radio propagation experiment), solar and galactic cosmic rays, and the interplanetary magnetic field. Its main antenna was a high-gain directional antenna. The spacecraft was spin-stabilized at about 60 rpm, and the spin axis was perpendicular to the ecliptic plane and pointed approximately toward the south ecliptic pole. By ground command, one of five bit rates, one of four data formats, and one of four operating modes could be selected. The five bit rates were 512, 256, 64, 16, and 8 bps. Three of the four data formats contained primarily scientific data and consisted of 32 seven-bit words per frame. One scientific data format was used for the two highest bit rates. Another was used for the three lowest bit rates. The third contained data from only the radio propagation experiment. The fourth data format contained mainly engineering data. The four operating modes were (1) real time, (2) telemetry store, (3) duty cycle store, and (4) memory readout. In the real-time mode, data were sampled and transmitted directly (without storage) as specified by the data format and bit rate selected. In the telemetry store mode, data were stored and transmitted simultaneously in the format and at the bit rate selected. In the duty cycle store mode, a single frame of scientific data was collected and stored at a rate of 512 bps. The time period between which successive frames were collected and stored could be varied by ground command between 2 and 17 min to provide partial data coverage for periods up to 19 h, as limited by the bit storage capacity. In the memory readout mode, data were read out at whatever bit rate was appropriate to the satellite distance from the earth.

********** PIONEER 8**********

SPACECRAFT COMMON NAME- PIONEER 8
ALTERNATE NAMES- PIONEER-C, 03066

NSSDC ID- 67-123A

LAUNCH DATE- 12/13/67 WEIGHT- 146. KG
LAUNCH SITE- CAPE CANAVERAL, UNITED STATES
LAUNCH VEHICLE- DELTA

SPONSORING COUNTRY/AGENCY
UNITED STATES NASA-OSSA

ORBIT PARAMETERS
ORBIT TYPE- HELIOCENTRIC EPOCH DATE- 09/17/75
ORBIT PERIOD- 387.5 DAYS INCLINATION- 0.057 DEG
PERIAPSIS- 0.992 AU RAD APOAPSIS- 1.088 AU RAD

PERSONNEL
PM - C.F. HALL(NLA) NASA-ARC
PS - J.H. WOLFE NASA-ARC

BRIEF DESCRIPTION
Pioneer 8 was the third in a series of solar-orbiting, spin-stabilized, solar-cell and battery-powered satellites designed to obtain measurements of interplanetary phenomena from widely separated points in space on a continuing basis. The spacecraft carried experiments to study the positive ions and electrons in the solar wind, the interplanetary electron density (radio propagation experiment), solar and galactic cosmic rays, the interplanetary magnetic field, cosmic dust, and electric fields. Its main antenna was a high-gain directional antenna. The spacecraft was spin-stabilized at about 60 rpm, and the spin axis was perpendicular to the ecliptic plane and pointed toward the south ecliptic pole. By ground command, one of five bit rates, one of four data formats, and one of four operating modes could be selected. The five bit rates were 512, 256, 64, 16, and 8 bps. Three of the four data formats were used primarily for scientific data and consisted of 32 seven-bit words per frame. One scientific

data format was used at the two highest bit rates. Another was used at the three lowest bit rates. The third was used for data from only the radio propagation experiment. The fourth data format was used mainly for engineering data. The four operating modes were (1) real time, (2) telemetry store, (3) duty cycle store, and (4) memory readout. In the real-time mode, data were sampled and transmitted directly (without storage) as specified by the data format and bit rate selected. In the telemetry store mode, data were stored and transmitted simultaneously in the format and at the bit rate selected. In the duty cycle store mode, a single frame of scientific data was collected and stored at a rate of 512 bps. The time interval between the collection and storage of successive frames could be varied by ground command between 2 and 17 min to provide partial data coverage for periods up to 19 h, as limited by the bit storage capacity. In the memory readout mode, data were read out at whatever bit rate was appropriate to the satellite distance from the earth.

********** PIONEER 9**********

SPACECRAFT COMMON NAME- PIONEER 9
ALTERNATE NAMES- PIONEER-D, PL-684K
03533

NSSDC ID- 68-100A

LAUNCH DATE- 11/08/68 WEIGHT- 147. KG
LAUNCH SITE- CAPE CANAVERAL, UNITED STATES
LAUNCH VEHICLE- DELTA

SPONSORING COUNTRY/AGENCY
UNITED STATES NASA-OSSA

ORBIT PARAMETERS
ORBIT TYPE- HELIOCENTRIC EPOCH DATE- 02/27/76
ORBIT PERIOD- 297.6 DAYS INCLINATION- 0.086 DEG
PERIAPSIS- 0.754 AU RAD APOAPSIS- 0.990 AU RAD

PERSONNEL
PM - C.F. HALL(NLA) NASA-ARC
PS - P. DYAL NASA-ARC

BRIEF DESCRIPTION
Pioneer 9 was the fourth in a series of solar-orbiting, spin-stabilized, and solar-cell and battery-powered satellites designed to obtain measurements of interplanetary phenomena from widely separated points in space on a continuing basis. The spacecraft carried experiments to study the positive ions and electrons in the solar wind, the interplanetary electron density (radio propagation experiment), solar and galactic cosmic rays, the interplanetary magnetic field, cosmic dust, and electric fields. Also, a new coding process was implemented for Pioneer 9. Its main antenna was a high-gain directional one. The spacecraft was spin-stabilized at about 60 rpm, and the spin axis was perpendicular to the ecliptic plane and pointed toward the south ecliptic pole. By ground command, one of five bit rates, one of four data formats, and one of four operating modes could be selected. The five bit rates were 512, 256, 64, 16, and 8 bps. Three of the four data formats contained primarily scientific data and consisted of 32 seven-bit words per frame. One scientific data format was used at the two highest bit rates, another was used at the three lowest bit rates, and the third contained data from only the radio-propagation experiment. The fourth data format contained mainly engineering data. The four operating modes were real-time, telemetry-store, duty-cycle store, and memory readout. In the real-time mode, data were sampled and transmitted directly (without storage) as specified by the data format and bit rate selected. In the telemetry-store mode, data were stored and transmitted simultaneously in the format and at the bit rate selected. In the duty-cycle store mode, a single frame of scientific data was collected and stored at a rate of 512 bps. The time period between collection and storage of successive frames could be varied by ground command between 2 and 17 min to provide partial data coverage for periods of up to 19 h, as limited by the bit-storage capacity. In the memory readout mode, data were read out at whatever bit rate was appropriate to the satellite distance from the earth.

********** HELIOS-A**********

SPACECRAFT COMMON NAME- HELIOS-A
ALTERNATE NAMES- HELIO-A, PL-741A
HELIOS 1

NSSDC ID- 74-097A

LAUNCH DATE- 12/10/74 WEIGHT- 371.2 KG
LAUNCH SITE- CAPE CANAVERAL, UNITED STATES
LAUNCH VEHICLE- TITAN

SPONSORING COUNTRY/AGENCY
FED REP OF GERMANY BMWF
UNITED STATES NASA-OSSA

ORBIT PARAMETERS
ORBIT TYPE- HELIOCENTRIC EPOCH DATE- 01/16/75
ORBIT PERIOD- 190.15 DAYS INCLINATION- 0.02 DEG
PERIAPSIS- 0.3095 AU RAD APOAPSIS- 0.985 AU RAD

PERSONNEL
PM - A. KUTZER GES FUR WELTRAUMFORSCH
PM - G.W. OUSLEY NASA-GSFC
PS - H. PORSCHE DFVLR
PS - J.H. TRAINOR NASA-GSFC

BRIEF DESCRIPTION
This spacecraft was one of a pair of deep space probes developed by the Federal Republic of Germany (FRG) in a cooperative program with NASA. Experiments were provided by scientists from both FRG and the U.S. NASA supplied the Titan/Centaur launch vehicle. The spacecraft was equipped with two booms and a 32-m electric dipole. The payload consisted of a fluxgate magnetometer; electric and magnetic wave experiments, which covered various bands in the frequency range 6 Hz to 3 MHz; charged-particle experiments, which covered various energy ranges starting with solar wind thermal energies and extending to 1 GeV; a zodiacal-light experiment; and a micrometeoroid experiment. The purpose of the mission was to make pioneering measurements of the interplanetary medium from the vicinity of the earth's orbit to 0.3 AU. The spin axis was normal to the ecliptic, and the nominal spin rate was 1 rps. The outer spacecraft surface was dielectric, effectively (because of the sheath potential) raising the low-energy threshold for the solar wind plasma experiment to as high as 100 eV. Also, sheath-related coupling caused by the spacecraft antennae produced interference with the wave experiments. The spacecraft was capable of being operated at bit rates from 4096 to 8 bps, variable by factors of two. While the spacecraft was moving to perihelion, it was generally operated from 64 to 256 bps; and near 0.3 AU, it was operated at the highest bit rate. Because of a deployment failure of one axis of the 32-m, tip-to-tip, dipole antenna, one axis was shorted, causing the antenna to function as a monopole. The major effect of this anomaly was to increase the effective instrument thresholds, and to introduce additional uncertainties in the effective antenna length. Instrument descriptions written by the experimenters were published (some in German, some in English) in the journal Raumfahrtforschung, v. 19, n. 5, 1975.

********** HELIOS-B**********

SPACECRAFT COMMON NAME- HELIOS-B
ALTERNATE NAMES- HELIO-B, PL-751A
HELIOS 2

NSSDC ID- 76-003A

LAUNCH DATE- 01/15/76 WEIGHT- 371.2 KG
LAUNCH SITE- CAPE CANAVERAL, UNITED STATES
LAUNCH VEHICLE- TITAN

SPONSORING COUNTRY/AGENCY
FED REP OF GERMANY BMWF
UNITED STATES NASA-OSSA

INITIAL ORBIT PARAMETERS
ORBIT TYPE- HELIOCENTRIC EPOCH DATE- 07/21/76
ORBIT PERIOD- 185.6 DAYS INCLINATION- 0. DEG
PERIAPSIS- 0.289 AU RAD APOAPSIS- 0.983 AU RAD

PERSONNEL
PM - A. KUTZER GES FUR WELTRAUMFORSCH
PM - G.W. OUSLEY NASA-GSFC
PS - H. PORSCHE DFVLR
PS - J.H. TRAINOR NASA-GSFC

BRIEF DESCRIPTION
This spacecraft was one of a pair of deep-space probes developed by the Federal Republic of Germany (FRG) in a cooperative program with NASA. Experiments were provided by scientists from both FRG and the U.S. NASA supplied the Titan/Centaur launch vehicle. The spacecraft was equipped with two booms and a 32-m electric dipole. The payload consisted of a fluxgate magnetometer; electric and magnetic wave experiments, which covered various bands in the frequency range 6 Hz to 3 MHz; charged particle experiments, which covered various energy ranges starting with solar wind thermal energies and extending to 1 GeV; a zodiacal light experiment; and a micrometeoroid experiment. The purpose of the mission was to make pioneering measurements of the interplanetary medium from the vicinity of the earth's orbit to 0.3 AU. The spacecraft was spin stabilized with the spin axis normal to the ecliptic, and a nominal spin rate of 1 rps. The outer surface was coated with a conductive material, resulting in a plasma-sheath potential of typically 5 eV. Sheath-related coupling caused by the spacecraft antennae produced interference with the wave experiments, but the character of the interference was different from that observed on the Helios-A spacecraft. The spacecraft was capable of being operated at bit rates of from 4096 to 8 bps, variable by factors of two. While the spacecraft was moving to perihelion, it was generally operated from 64 to 256 bps; near 0.3 AU, it was operated at higher bit rates. Because of difficulty encountered with the high-gain antenna, and scheduling conflicts with Viking, relatively fewer high-bit-rate data were obtained from Helios-B than were available from Helios-A. Instrument descriptions written by the experiments are published (some in German, some in English)

in the journal Raumfahrtforschung, v. 19, n. 5, 1975.

INVESTIGATIONS

PARTICLES AND FIELDS

------- PIONEER 6, BRIDGE----------

INVESTIGATION NAME- SOLAR WIND PLASMA FARADAY CUP

NSSDC ID- 65-105A-02
INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS
SPACE PLASMAS

PERSONNEL
PI - H.S. BRIDGE — MASS INST OF TECH
OI - A.J. LAZARUS — MASS INST OF TECH
OI - F. SCHERB — U OF WISCONSIN

BRIEF DESCRIPTION
A multigrid Faraday cup with two semicircular, coplanar collectors was used to study solar wind ions and electrons. The instrument had 14 contiguous, energy-per-charge (E/Q) channels between 75 and 9485 V for positive ions, and four energy-per-charge channels between 90 and 1580 V for electrons. The instrument view axis was perpendicular to the spacecraft spin axis and parallel to the ecliptic plane. The line separating the two collectors lay in the ecliptic plane, enabling a rough determination of solar wind bulk flow perpendicular to the ecliptic plane. During every second spacecraft rotation and at one voltage level, the sum of the currents from the collectors was obtained in 28 contiguous 11.25-deg angular sectors (from -45 deg to 270 deg, with 0 deg being the spacecraft-sun line). The eight measurements about the sun-earth line (-45 deg to +45 deg) were telemetered, but only the largest measurement in each succeeding 45-deg interval (45 deg to 270 deg) was telemetered. In addition, during this rotation, the current from one of the collectors was measured in all twenty-eight 11.25-deg sectors, and the largest was identified and telemetered (both magnitude and sector). A complete set of positive ion measurements and one energy channel of electron measurements were completed every 32 s. The time between each 32-s group of measurements varied with the bit rate. For a more complete description, see J. Geophys. Res., v. 71, p. 3787-3791, August 1966.

------- PIONEER 7, BRIDGE----------

INVESTIGATION NAME- SOLAR WIND PLASMA FARADAY CUP

NSSDC ID- 66-075A-02
INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS

PERSONNEL
PI - H.S. BRIDGE — MASS INST OF TECH

BRIEF DESCRIPTION
A multigrid Faraday cup with two semicircular, coplanar collectors was used to study solar wind ions and electrons. The instrument had 14 contiguous energy-per-charge channels between 75 and 9485 V for positive ions and four energy-per-charge channels between 115 and 1600 V for electrons. The instrument view axis was perpendicular to the spacecraft spin axis and parallel to the ecliptic plane. The line separating the two collectors lay in the ecliptic plane, enabling a rough determination of solar wind bulk flow perpendicular to the ecliptic plane. During every second spacecraft rotation and at one voltage level, the sum of the currents from the collectors was obtained in 28 contiguous 11.25-deg angular sectors (from -45 deg to 270 deg, with 0 deg being the spacecraft-sun line). The eight measurements about the sun-earth line (-45 deg to +45 deg) were telemetered, but only the largest measurement in each succeeding 45-deg interval (45 deg to 270 deg) was telemetered. In addition, during this rotation the current from one of the collectors was measured in all twenty-eight 11.25-deg sectors, and the largest was identified and telemetered (both magnitude and sector). A complete set of positive ion measurements and one electron measurement were completed every 32 s. The time between each 32-s group of measurements varied with the bit rate. The experiment worked well from launch until it became inoperable in November 1972. For more complete information, see J. Geophys. Res., v. 71, pp. 3787-3791, August 1966.

------- PIONEER 6, LEVY----------

INVESTIGATION NAME- SUPERIOR CONJUNCTION FARADAY ROTATION

NSSDC ID- 65-105A-08
INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
HIGH ENERGY ASTROPHYSICS

PERSONNEL
PI - G.S. LEVY — NASA-JPL

BRIEF DESCRIPTION
This experiment utilized measurements of the polarization of the spacecraft telemetry signal to obtain measurements of the relative faraday rotation due to the interplanetary medium and the earth's ionosphere.

------- PIONEER 7, LEVY----------

INVESTIGATION NAME- SUPERIOR CONJUNCTION FARADAY ROTATION

NSSDC ID- 66-075A-08
INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
HIGH ENERGY ASTROPHYSICS

PERSONNEL
PI - G.S. LEVY — NASA-JPL

BRIEF DESCRIPTION
This experiment utilized measurements of the polarization of the spacecraft telemetry signal to obtain measurements of the relative faraday rotation due to the interplanetary medium and the earth's ionosphere.

------- PIONEER 9, WOLFE----------

INVESTIGATION NAME- SOLAR PLASMA DETECTOR

NSSDC ID- 68-100A-02
INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
SPACE PLASMAS
PARTICLES AND FIELDS

PERSONNEL
PI - J.H. WOLFE — NASA-ARC
OI - D.D. MCKIBBIN — NASA-ARC

BRIEF DESCRIPTION
A truncated hemispherical electrostatic analyzer (120-deg total parallel-plate curvature) with three contiguous current collectors was used to study the directional intensity of the electrons and positive ions in the solar wind. Ions were detected in 30 logarithmically equispaced energy per unit charge (E/Q) steps from 150 to 15,000 V. There was an electron mode of operation in which electrons were measured in 14 logarithmically equispaced E/Q steps ranging from 12 to 1000 V. There was also a zero E/Q, or background, step. The three collectors measured particles incident from three different contiguous angular intervals relative to the spacecraft equatorial plane (same as the ecliptic plane). Two collectors measured flux from 10 to 85 deg on either side of the spacecraft equatorial plane, and the third measured flux in a 20-deg interval centered on the spacecraft equatorial plane. As the spacecraft was spinning, fluxes were measured in 23 possible 2-13/16-deg-wide azimuthal angular sectors. Seventeen of these sectors were contiguous and bracketed the solar direction. The remaining six sectors were widely spaced. The instrument had three modes of data collection: polar scan, azimuthal scan, and maximum flux. At the two highest bit rates (512 and 256 bps), the polar-scan mode was alternated with the azimuthal scan mode at each E/Q step. In the polar-scan mode, all three collectors were observed, and the peak flux obtained and the azimuthal direction (to 2-13/16 deg) of the observation were reported for each collector. In the azimuthal scan mode, the peak flux observed in the 23 azimuthal sectors was recorded for the central collector at each E/Q step. At the low bit rates (64, 16, and 8 bps), the maximum flux mode was used at each E/Q step followed by either (1) for ions, a polar scan and an azimuthal scan at that E/Q step where the peak flux measurement during the maximum flux mode was obtained, or (2) for electrons, a polar scan and an azimuthal scan at E/Q = 100 V. In the maximum flux mode, only the central collector was observed, and the peak flux obtained and the azimuthal direction (to 2-13/16 deg) of the observation were reported. A complete set of measurements consisted of seven sets of ion measurements (at each E/Q step) and one set of electron measurements (at each E/Q step). At the high bit rates (512 and 256 bps) one set of ion measurements took 62 s and one set of electron measurements, 38 s. At the low bit rates (64, 16, and 8 bps), one set of ion measurements took 37 s and one set of electron measurements, 28 s. At 64 bps, a complete set of measurements (seven ions plus one electron) was taken and telemetered every 402.5 s. At 16 bps, it took 1610 s, and, at 8 bps, it took 3220 s.

------- HELIOS-A, ROSENBAUER----------

INVESTIGATION NAME- PLASMA DETECTORS

NSSDC ID- 74-097A-09
INVESTIGATIVE PROGRAM
CODE EL-4/CO-OP, SCIENCE

INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS
SPACE PLASMAS

PERSONNEL

PI - H.R.	ROSENBAUER	MPI-AERONOMY
OI - H.	PELLKOFER	MPI-EXTRATERR PHYS
OI - J.H.	WOLFE	NASA-ARC

BRIEF DESCRIPTION

This experiment (E1) employed three plasma analyzers for positive ions and one for electrons. All detectors were mounted normal to the spin axis. Positive ions with energy per charge within the range 0.155 to 15.32 keV/Q were measured in two angular dimensions using a combination of a hemispherical, a quadrispherical, and a sinusoidally shaped electrostatic analyzer. Electrons with energy from 0.5 to 1660 eV were measured with a hemispherical electrostatic analyzer in one dimension. The experiment operated in several modes, with differing time resolution depending in detail on telemetry format and satellite bit rate. Typical time resolution was on the order of a minute. Also, whenever the special shock alarm mode was triggered by experiments -04 or -01, high-time-resolution plasma data for a period before and after the event was recorded into spacecraft memory for later transmission. Because the spacecraft body was dielectric, sheath potentials of up to 100 eV degraded the usefulness of data taken in the lower electron-energy channels. This phenomenon was judged to have minimal effects on the usefulness of the ion data. For more detailed information see p. 226 of Raumfahrtforschung, v. 19, n. 5, 1975.

------- HELIOS-B, ROSENBAUER----------

INVESTIGATION NAME- PLASMA DETECTORS

NSSDC ID- 76-003A-09

INVESTIGATIVE PROGRAM
CODE EL-4/CO-OP, SCIENCE

INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS

PERSONNEL

PI - H.R.	ROSENBAUER	MPI-AERONOMY
OI - H.	PELLKOFER	MPI-EXTRATERR PHYS
OI - J.H.	WOLFE	NASA-ARC

BRIEF DESCRIPTION

This experiment (E1) employed three plasma analyzers for positive ions and one for electrons. All detectors were mounted normal to the spin axis. Positive ions with energy per charge within the range 0.155 to 15.32 keV/Q were measured in two angular dimensions using a combination of a hemispherical, a quadrispherical, and a sinusoidally-shaped electrostatic analyzer. Electrons with energy from 0.5 to 1660 eV were measured with a hemispherical electrostatic analyzer in one dimension. The experiment operated in several modes with differing time resolution depending in detail on telemetry format and satellite bit rate. Typical time resolution was on the order of a minute. Also, whenever the special shock alarm mode was triggered by experiments -04 or -01, high-time-resolution plasma data for a period starting before and ending after the event were recorded into spacecraft memory for later transmission. Because the spacecraft body was coated with a conductive coating, the sheath potentials were about 5 eV, causing far less degradation in the usefulness of data taken in the lower electron energy channels than on the Helios-A spacecraft, and almost no effect on the ion data. For more detailed information see p. 226 of Raumfahrtforschung, v. 19, n. 5, 1975.

------- HELIOS-A, GURNETT----------

INVESTIGATION NAME- SOLAR WIND PLASMA WAVE

NSSDC ID- 74-097A-04

INVESTIGATIVE PROGRAM
CODE EL-4/CO-OP, SCIENCE

INVESTIGATION DISCIPLINE(S)
IONOSPHERES AND RADIO PHYSICS
PARTICLES AND FIELDS

PERSONNEL

PI - D.A.	GURNETT	U OF IOWA
OI - P.J.	KELLOGG	U OF MINNESOTA
OI - S.J.	BAUER	GRAZ U
OI - R.G.	STONE	NASA-GSFC

BRIEF DESCRIPTION

This experiment (E5a) shared the 32 m, tip-to-tip electric antenna with experiments -05 and -06. The instrument consisted of a 16-channel spectrum analyzer with approximately logarithmically equispaced center frequencies, 16 log compressors, 16 R-C integrators for averaging the log compressed electric field amplitude between readouts, and 16 peak detectors which were reset after readout. The 16 averages and 16 peak log values were sampled almost simultaneously. The channels covered the frequency range of about 20 Hz to 200 kHz, with four channels per decade of frequency. The log compressors had a dynamic range of 100 dB. Sampling rate depended in detail on the spacecraft bit rate and telemetry format. The fastest real-time telemetered rate was for 16 averages and 16 peak values to be sampled every 1.125 s. Whenever a very strong signal was detected in a pre-selected channel, the shock alarm data mode was initiated in which the electric field spectrum, magnetic field, and plasma data were recorded into spacecraft memory for a period starting before and terminating after the triggering signal time. The maximum sampling rate of the spectrum data in this mode was 14.2 samples per s for each channel. One half of the dipole antenna failed to extend properly and was short circuited to the spacecraft ground. The resultant configuration was that of a monopole which was calculated to have an effective length of approximately 8 m. The primary detrimental effects were the loss of 6 dB in E field sensitivity due to the shortened antenna and the increase in the 178 kHz channel by 25 dB. Solar cell and sheath effects caused interference in the lowest 6 channels (which was less severe with increasing channel frequency). For more details, see J. Geophys. Res., v. 82, p. 632, 1975, and p. 245-247 of Raumfahrtforschung, v. 19, n. 5, 1975.

------- HELIOS-B, GURNETT----------

INVESTIGATION NAME- SOLAR WIND PLASMA WAVE

NSSDC ID- 76-003A-04

INVESTIGATIVE PROGRAM
CODE EL-4/CO-OP, SCIENCE

INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS
IONOSPHERES AND RADIO PHYSICS

PERSONNEL

PI - D.A.	GURNETT	U OF IOWA
OI - P.J.	KELLOGG	U OF MINNESOTA
OI - S.J.	BAUER	GRAZ U
OI - R.G.	STONE	NASA-GSFC

BRIEF DESCRIPTION

This experiment (E5a) shared the 32-m, tip-to-tip, electric antenna with experiments -05 and -06. The instrument consisted of a 16-channel spectrum analyzer with approximately logarithmically equispaced center frequencies, 16 log compressors, 16 R-C integrators for averaging the log-compressed, electric field amplitude between readouts, and 16 peak detectors which were reset after readout. The 16 averages and 16 peak log values were sampled almost simultaneously. The channels covered the frequency range of about 20 Hz to 200 kHz, with four channels per decade of frequency. The log compressors had a dynamic range of 100 dB. Sampling rate depended in detail on the spacecraft bit rate and telemetry format. The fastest real-time telemetered rate was for 16 averages and 16 peak values to be sampled every 1.125 s. Whenever a very strong signal was detected in a pre-selected channel, the shock alarm data mode was initiated in which the electric field spectrum, magnetic field, and plasma data were recorded into spacecraft memory for a period starting before and terminating after the triggering signal time. The maximum sampling rate of the spectrum data in this mode was 14.2 samples per s for each channel. Interference, caused by solar cell noise, occurred primarily in the lowest six channels, and harmonics were related to the spin frequency and the spacecraft sheath. However, a combination of factors, including the proper deployment of the dipole antenna and the conductive spacecraft coating, resulted in data from this spacecraft being of higher quality than data from Helios-A. For further details, see pp. 245-247 of Raumfahrtforschung, v. 19, n. 5, 1975.

------- PIONEER 8, SCARF----------

INVESTIGATION NAME- PLASMA WAVE DETECTOR

NSSDC ID- 67-123A-07

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS

PERSONNEL

PI - F.L.	SCARF	TRW SYSTEMS GROUP
OI - I.M.	GREEN	TRW SYSTEMS GROUP

BRIEF DESCRIPTION

Electrostatic and electromagnetic plasma waves were measured in the solar wind near 1 AU using an unbalanced dipole antenna. The 423-MHz Stanford University antenna, which served as the sensor, was capacitively coupled to three channels. Channel 1 was a 15 % bandpass filter centered at 400 Hz, a typical interplanetary electron cyclotron frequency. Channel 2 was a 15 % bandpass filter centered at 22 kHz, a typical interplanetary electron plasma frequency. The broadband channel from 100 Hz to 100 kHz was fed into a count rate meter that measured the number of positive going pulses per unit time having amplitudes large enough to cross the present trigger level. The trigger level was varied in 16 steps per telemetry sequence. The trigger levels together with the count rate at each level gave a measure of the broadband power spectrum. Almost all of the time this measurement amounts to the power spectrum at near 100 Hz. At the highest telemetry rate of Pioneer 8, this sequence was repeated every 7.47 min.

------- PIONEER 9, SCARF----------

INVESTIGATION NAME- ELECTRIC FIELD DETECTOR

NSSDC ID- 68-100A-07 INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS
SPACE PLASMAS

PERSONNEL

PI - F.L.	SCARF	TRW SYSTEMS GROUP
OI - I.M.	GREEN	TRW SYSTEMS GROUP
OI - G.M.	CROOK	GAINES M. CROOK ASSOC
OI - R.W.	FREDERICKS	TRW SYSTEMS GROUP

BRIEF DESCRIPTION
Electrostatic and electromagnetic plasma waves were measured in the solar wind near 1 AU using an unbalanced electric dipole antenna. The 423-MHz Stanford University antenna, which served as the sensor, was capacitively coupled to three telemetry channels. Channel 1 was a 15 % bandpass filter centered at 400 Hz, and channel 2 was a 15 % bandpass filter centered at 30 kHz. These channels were each sampled 64 times per telemetry sequence. Channel 3 was a broadband 100-Hz to 100-kHz channel. The broadband channel was fed into a count-rate meter that measured the number of positive-going pulses per unit time having amplitudes large enough to cross the present trigger level. The trigger level was varied through eight steps, eight times per telemetry sequence. The trigger levels, together with the count rate at each level, gave a measure of the broadband power spectrum. Due to ambient conditions, these data usually represented the power at about 100 Hz. The telemetry sequence was repeated over time intervals from 7 min 28 s to 472 min 52 s.

------- PIONEER 6, WOLFE----------

INVESTIGATION NAME- ELECTROSTATIC ANALYZER

NSSDC ID- 65-105A-06 INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS

PERSONNEL

PI - J.H.	WOLFE	NASA-ARC

BRIEF DESCRIPTION
A quadrispherical electrostatic analyzer with eight contiguous current collectors was used to study the directional intensity of electrons and positive ions in the solar wind. Ions were detected in 16 logarithmically equispaced energy-per-charge (E/Q) steps from 200 to 10,000 V. There was an electron mode of operation in which electrons were measured in eight logarithmically equispaced E/Q steps ranging from 1 to 500 V. The eight collectors measured particles incident from eight different contiguous angular intervals relative to the spacecraft equatorial plane (same as the ecliptic plane). There were four 15-deg intervals, two 20-deg intervals, and two 30-deg intervals. As the spacecraft was spinning, fluxes were measured in 15 azimuthal angular sectors. Eight of the these sectors were 5-5/8 deg wide, were contiguous, and bracketed the solar direction. The remaining seven sectors were 45 deg wide. Three different modes of data collection were used. At the highest bit rate (512 bps), the full scan mode was alternated with the maximum flux mode at each E/Q step. In the full scan mode, the maximum flux observed in each of the 15 azimuthal sectors as the spacecraft rotated was recorded for a given single collector at a given E/Q step. During 24 successive operations of the full scan mode (48 spacecraft revolutions), the 16 ion E/Q steps and eight electron E/Q steps were exercised for a given collector. During eight successive such periods, each of the eight collectors was exercised. The full cycle of full scan mode data required 400 spacecraft revolutions (about 400 s). Such cycles were repeated without interruption at the high bit rate. In the maximum flux mode, for the E/Q step used in the preceding revolution of full scan mode operation, all collectors were observed for one revolution, and the maximum flux observed was reported, along with the number of the collector that observed it and the angular direction (2-13/16-deg resolution) of the observation. At the next highest bit rate (256 bps), the short-scan mode was alternated every spacecraft revolution with the maximum-flux mode. The short-scan mode was the same as the full-scan mode, except that only the peak flux in each of the eight 5-5/8-deg-wide azimuthal sectors was recorded. Thus, this cycle also took 400 spacecraft revolutions. At the low bit rates (64, 16, and 8 bps), the maximum flux mode alone was used. Thus, no azimuthal distributions were measured. At the low bit rates, it took 32 s for a complete set of ion measurements and 16 s for a complete set of electron measurements. At 64 bps, the ion and electron measurements were taken and telemetered every 84 s. At 16 bps, they were taken and telemetered every 336 s. At 8 bps, they were taken and telemetered every 672 s.

------- PIONEER 7, WOLFE----------

INVESTIGATION NAME- ELECTROSTATIC ANALYZER

NSSDC ID- 66-075A-03 INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS
SPACE PLASMAS

PERSONNEL

PI - J.H.	WOLFE	NASA-ARC
OI - R.W.	SILVA	TRW SYSTEMS GROUP

BRIEF DESCRIPTION
A quadrispherical electrostatic analyzer with eight contiguous current collectors was used to study the directional intensity of the electrons and positive ions in the solar wind. Ions were detected in 16 logarithmically equispaced energy per unit charge (E/Q) steps from 200 to 10,000 V. There was an electron mode of operation in which electrons were measured in eight logarithmically equispaced energy per charge steps ranging from 0 to 500 V. The eight collectors measured particles incident from eight different contiguous angular intervals relative to the spacecraft equatorial plane (same as the ecliptic plane). There were four 15-deg intervals, two 20-deg intervals, and two 30-deg intervals. As the spacecraft was spinning, fluxes were measured in 15 azimuthal angular sectors. Eight of the these sectors were 5-5/8 deg wide, were contiguous, and bracketed the solar direction. The remaining seven sectors were 45 deg wide. Three different modes of data collection were used. At the highest bit rate (512 bps), the full scan mode was alternated with the maximum flux mode at each E/Q step. In the full scan mode, the maximum flux observed in each of the 15 azimuthal sectors as the spacecraft rotated was recorded for a given single collector at a given E/Q step. During 24 successive operations of the full scan mode (48 spacecraft revolutions), the 16 ion E/Q steps and eight electron E/Q steps were exercised for a given collector. During eight successive such periods, each of the eight collectors was exercised. The full cycle of full scan mode data required 400 spacecraft revolutions (about 400 s). Such cycles were repeated without interruption at the high bit rate. In the maximum flux mode, for the E/Q step used in the preceding revolution of full scan mode operation, all collectors were observed for one revolution, and the maximum flux observed was reported along with the number of the collector that observed it and the angular direction (2-13/16-deg resolution) of the observation. At the next highest bit rate (256 bps), the short scan mode was alternated every spacecraft revolution with the maximum flux mode. The short scan mode was the same as the full scan, except that only the peak flux in each of the eight 5-5/8-deg-wide azimuthal sectors was recorded, thus, this cycle also took 400 spacecraft revolutions. At the low bit rates (64, 16, and 8 bps), the maximum flux mode alone was used. Thus, no azimuthal distributions were measured. At the low bit rates, it took 32 s for a complete set of ion measurements and 16 s for a complete set of electron measurements. At 64 bps, the ion and electron measurements were taken and telemetered every 84 s. At 16 bps, they were taken and telemetered every 336 s. At 8 bps, they were taken and telemetered every 672 s.

------- PIONEER 8, WOLFE----------

INVESTIGATION NAME- ELECTROSTATIC ANALYZER

NSSDC ID- 67-123A-02 INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS
SPACE PLASMAS

PERSONNEL

PI - J.H.	WOLFE	NASA-ARC
OI - D.D.	MCKIBBIN	NASA-ARC

BRIEF DESCRIPTION
A truncated hemispherical electrostatic analyzer (120-deg total parallel plate curvature) with three contiguous current collectors was used to study the directional intensity of the electrons and positive ions in the solar wind. Ions were detected in 30 logarithmically equispaced energy per unit charge (E/Q) steps from 150 to 15,000 V. There was an electron mode of operation in which electrons were measured in 14 logarithmically equispaced E/Q steps ranging from 12 to 1000 V. There was also a zero E/Q, or background, step. The three collectors measured particles incident from three different contiguous angular intervals relative to the spacecraft equatorial plane (same as the ecliptic plane). Two collectors measured flux from 10 to 85 deg on either side of the spacecraft equatorial plane, and the third measured flux in a 20-deg interval centered on the spacecraft equatorial plane. As the spacecraft was spinning, fluxes were measured in 23 possible 2-13/16-deg wide azimuthal angular sectors. Seventeen of these sectors were contiguous and bracketed the solar direction. The remaining six sectors were widely spaced. The instrument had three modes of data collection; polar scan, azimuthal scan, and maximum flux. At the two highest bit rates (512 and 256 bps) the polar scan mode was alternated with the azimuthal scan mode at each E/Q step. In the polar scan mode, all three collectors were observed, and the peak flux obtained and the azimuthal direction (to 2-13/16 deg) of the observation were reported for each collector. In the azimuthal scan mode, the peak flux observed in the 23 azimuthal sectors was recorded for the central collector at each E/Q step. At the low bit

rates (64, 16, and 8 bps), the maximum flux mode was used at each E/Q step followed by either (1) for ions, a polar scan and an azimuthal scan at that E/Q step where the peak flux measurement during the maximum flux mode was obtained, or (2) for electrons, a polar scan and an azimuthal scar at E/Q = 100 V. In the maximum flux mode, only the central collector was observed, and the peak flux obtained and the azimuthal direction (to 2-13/16 deg) of the observation were reported. A complete set of measurements consisted of seven sets of ion measurements (at each E/Q step) and one set of electron measurements (at each E/Q step). At the high bit rates (512 and 256 bps) one set of ion measurements took 62 s and one set of electron measurements 38 s. At the low bit rates (64, 16, and 8 bps), one set of ion measurements took 37 s and one set of electron measurements 28 s. At 64 bps, a complete set of measurements (sever ions plus one electron) was taken and telemetered every 402.5 s. At 16 bps, it took 1610 s, and, at 8 bps, it took 3220 s.

------- HELIOS-A, KEPPLER----------

INVESTIGATION NAME- ENERGETIC ELECTRON AND PROTON DETECTOR

NSSDC ID- 74-097A-10
INVESTIGATIVE PROGRAM
CODE EL-4/CO-OP, SCIENCE

INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS

PERSONNEL
PI - E. KEPPLER — MPI-AERONOMY
OI - B. WILKEN — MPI-AERONOMY
OI - D.J. WILLIAMS — NOAA-ERL

BRIEF DESCRIPTION
The objective of the experiment (E8) was to study the origin and the distribution mechanism of low-energy electrons and protons. The instrument, a magnetic spectrometer, consisted of six semiconductor detectors with the field of view in the plane of the ecliptic. Species separation was achieved by an inhomogeneous magnetic field oriented perpendicular to the particle path. Four electron and two proton detectors measured electrons from 20 to 1000 keV and protons from 80 to 1000 keV. The proton measurements were made with a two-detector telescope employing coincidence and anticoincidence logic. Both particle species were measured in 16 energy channels through pulse-height analysis. For further information see pp. 261-263 of Raumfahrtforschung, v. 19, n. 5, 1975.

------- HELIOS-B, KEPPLER----------

INVESTIGATION NAME- ENERGETIC ELECTRON AND PROTON DETECTOR

NSSDC ID- 76-003A-10
INVESTIGATIVE PROGRAM
CODE EL-4/CO-OP, SCIENCE

INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS

PERSONNEL
PI - E. KEPPLER — MPI-AERONOMY
OI - B. WILKEN — MPI-AERONOMY
OI - D.J. WILLIAMS — NOAA-ERL

BRIEF DESCRIPTION
The objective of the experiment (E8) was to study the origin and the distribution mechanism of low-energy electrons and protons. The instrument, a magnetic spectrometer, consisted of six semiconductor detectors with the field of view in the plane of the ecliptic. Species separation was achieved by an inhomogeneous magnetic field oriented perpendicular to the particle path. Four electron and two proton detectors measured electrons from 20 to 1000 keV and protons from 80 to 1000 keV. The proton measurements were made with a two-detector telescope employing coincidence and anticoincidence logics. Both particle species were measured in 16 energy channels through pulse height analysis. For further information see pp. 261-263 of Raumfahrtforschung, v. 19, n. 5, 1975.

------- PIONEER 6, NESS----------

INVESTIGATION NAME- UNIAXIAL FLUXGATE MAGNETOMETER

NSSDC ID- 65-105A-01
INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS

PERSONNEL
PI - N.F. NESS — NASA-GSFC

BRIEF DESCRIPTION
A single, boom-mounted uniaxial fluxgate magnetometer, with a dynamic range of plus or minus 64 nT and plus or minus 0.25-nT resolution, obtained a complete vector magnetic field measurement by means of three measurements taken at equal time intervals during each spacecraft spin period (approximately 1 s). At telemetry bit rates less than or equal to 16 bps, averages were computed on board for transmission to earth. The instrument worked well from launch to July 6, 1970. No useful data were obtainec after that date. For further details, see Ness et al., J. Geophys. Res., v. 71, p. 3305, 1966. NSSDC has all the useful data that exist from this investigation. The erratic coverage after September 1967 resulted in no useful data being reduced after that period.

------- PIONEER 7, NESS----------

INVESTIGATION NAME- SINGLE-AXIS MAGNETOMETER

NSSDC ID- 66-075A-01
INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS

PERSONNEL
PI - N.F. NESS — NASA-GSFC

BRIEF DESCRIPTION
A single, boom-mounted, uniaxial fluxgate magnetometer, with a dynamic range of plus or minus 32 nT and plus or minus 0.125-nT resolution, obtained a vector magnetic field measurement by means of three scalar measurements taken at equal time intervals during each spacecraft spin period (approximately 1 s). At telemetry bit rates less than or equal to 16 bps, time-averaged field data were returned from the spacecraft. The detector performed well until February 1969, after which no further data were obtained. For further details see Mariani et al, J. Geophys. Res., v. 75, p. 6037, 1970. NSSDC has all the useful data that exist from this investigation.

------- PIONEER 8, NESS----------

INVESTIGATION NAME- SINGLE-AXIS MAGNETOMETER

NSSDC ID- 67-123A-01
INVESTIGATIVE PROGRAM
CODE EL-4/CO-OP, SCIENCE

INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS

PERSONNEL
PI - N.F. NESS — NASA-GSFC
OI - S.C. CANTARANO — CNR, SPACE PLASMA LAB
OI - F. MARIANI — U OF ROME

BRIEF DESCRIPTION
A single, boom-mounted uniaxial fluxgate magnetometer, with mode-dependent ranges of plus or minus 32 nT and plus or minus 96 nT and corresponding resolutions of plus or minus 0.125 nT and plus or minus 0.375 nT, obtained a vector magnetic field measurement by means of three measurements taken at equal time intervals during each spacecraft spin period (approximately 1 s). At telemetry bit rates less than or equal to 16 bps, averages were computed on board for transmission to earth. For further details, see Mariani and Ness, J. Geophys. Res., v. 74, p. 5633, 1969. NSSDC has all the useful data that exist from this investigation.

------- PIONEER 9, SONETT----------

INVESTIGATION NAME- TRIAXIAL MAGNETOMETER

NSSDC ID- 68-100A-01
INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS

PERSONNEL
PI - C.P. SONETT — U OF ARIZONA
OI - D.S. COLBURN — NASA-ARC

BRIEF DESCRIPTION
A boom-mounted, triaxial fluxgate magnetometer was used to study the interplanetary magnetic field and its fluctuations. The sensors were orthogonally mounted with one axis parallel to the spacecraft spin axis. Upon command, a motor interchanged a sensor in the spin plane with the sensor along the spin axis, enabling inflight determination of zero levels. Every 24 hours, the instrument was commanded into a self-calibrate sequence, and this was often repeated after the sensors were flipped. The instrument, which had a dynamic range of plus or minus 200 nT with a resolution of plus or minus 0.2 nT, was capable of inflight demodulation of the signals received from the two sensors in the spin plane. Each magnetic field component was digitized into a 10-bit telemetry word. Nine magnetic field components, comprising three magnetic field vectors, were transmitted in each spacecraft telemetry frame.

------- HELIOS-A, NESS----------

INVESTIGATION NAME- FLUXGATE MAGNETOMETER FOR AVERAGE FIELDS

NSSDC ID- 74-097A-02
INVESTIGATIVE PROGRAM
CODE EL-4/CO-OP, SCIENCE

INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS

PERSONNEL

PI - N.F. NESS		NASA-GSFC
OI - F. MARIANI		U OF ROME
OI - L.F. BURLAGA		NASA-GSFC
OI - S.C. CANTARANO		CNR, SPACE PLASMA LAB

BRIEF DESCRIPTION

This experiment (E3) consisted of a boom-mounted, triaxial-fluxgate magnetometer. An automatic inflight range switch system selected the optimum of four ranges that were minus to plus 16, 48, 144, and 432 nT per sensor. These had corresponding digitization resolutions of minus to plus 0.03, 0.09, 0.28, and 0.84 nT. A sensor flipper was actuated every 36 h to assist in sensor zero level determination. For telemetry bit rates above 256 bps, vector measurements were made at rates between 1 and 16 per s, depending on bit rates. At lower bit rates, averages and variances were computed on board for transmission to earth.

------- HELIOS-B, NESS----------

INVESTIGATION NAME- FLUXGATE MAGNETOMETER FOR AVERAGE FIELDS

NSSDC ID- 76-003A-02

INVESTIGATIVE PROGRAM
CODE EL-4/CO-OP, SCIENCE

INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS

PERSONNEL

PI - N.F. NESS		NASA-GSFC
OI - F. MARIANI		U OF ROME
OI - L.F. BURLAGA		NASA-GSFC
OI - S.C. CANTARANO		CNR, SPACE PLASMA LAB

BRIEF DESCRIPTION

This experiment (E3) consisted of a boom-mounted triaxial-fluxgate magnetometer. An automatic inflight range switch system selected the optimum of four ranges: minus to plus 16, 48, 144, and 432 nT per sensor. These had corresponding digitization resolutions of minus to plus 0.03, 0.09, 0.28, and 0.84 nT. A sensor flipper was actuated every 36 h to assist in sensor zero level determination. For telemetry bit rates above 256 bps, vector measurements were made at rates between 1 and 16 per s, depending on bit rates. At lower bit rates, averages and variances were computed on board for transmission to earth. For further details, see pp. 237-240 of Raumfahrtforschung, v. 19, n. 5, 1975.

------- HELIOS-A, NEUBAUER----------

INVESTIGATION NAME- FLUXGATE MAGNETOMETER FOR FIELD FLUCTUATIONS

NSSDC ID- 74-097A-01

INVESTIGATIVE PROGRAM
CODE EL-4/CO-OP, SCIENCE

INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS

PERSONNEL

PI - F.M. NEUBAUER		U OF KÖLN
OI - A. MAIER		BRAUNSCHWEIG TECH U

BRIEF DESCRIPTION

The instrument (E2) consisted of a triaxial fluxgate magnetometer mounted on a 2.75-m boom to make magnetic field measurements up to 4 Hz. Data from each axis were first sent through a low-pass filter with the 3 dB attenuation point at 4 Hz. Depending on the telemetry format and bit rate, the data were fed either into a time-averaging computer or directly connected to telemetry. A shock identification computer triggered the storage of rapid-rate data in the spacecraft memory when there were discontinuities in the variations of the ambient magnetic field. Two measurement ranges were used, plus or minus 100 and 400 nT with resolutions of plus or minus 0.2 and 0.8 nT, respectively. The instrument was equipped with a flipper mechanism, which reoriented each sensor by 90 deg periodically. For detailed information, see p. 232 of Raumfahrtforschung, v. 19, n. 5, 1975.

------- HELIOS-B, NEUBAUER----------

INVESTIGATION NAME- FLUXGATE MAGNETOMETER FOR FIELD FLUCTUATIONS

NSSDC ID- 76-003A-01

INVESTIGATIVE PROGRAM
CODE EL-4/CO-OP, SCIENCE

INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS

PERSONNEL

PI - F.M. NEUBAUER		U OF KÖLN
OI - A. MAIER		BRAUNSCHWEIG TECH U

BRIEF DESCRIPTION

The instrument (E2) consisted of a triaxial fluxgate magnetometer mounted on a 2.75-m boom to make magnetic field measurements up to 4 Hz. Data from each axis were first sent through a low-pass filter with the 3 dB attenuation point at 4 Hz. Depending on the telemetry format and bit rate, the data were fed either into a time-averaging computer or directly connected to telemetry. When there were discontinuities in the variations of the ambient magnetic field, a shock-identification computer triggered the storage of rapid-rate data in the spacecraft memory. Two measurement ranges were used, plus or minus 100 and 400 nT with resolutions of plus or minus 0.2 and 0.8 nT, respectively. The instrument was equipped with a flipper mechanism, which re-oriented each sensor by 90 deg periodically. For detailed information, see p. 232 of Raumfahrtforschung, v. 19, n. 5, 1975.

------- PIONEER 5, GREENSTADT----------

INVESTIGATION NAME- SEARCH-COIL MAGNETOMETER

NSSDC ID- 60-001A-02

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS

PERSONNEL

PI - E.W. GREENSTADT		TRW SYSTEMS GROUP
OI - D.L. JUDGE		U OF SOUTHERN CALIF
OI - C.P. SONETT		U OF ARIZONA

BRIEF DESCRIPTION

This search coil magnetometer, which was similar to those flown on Pioneer 1 and Explorer 6, was designed to study the interplanetary magnetic field. The detector consisted of a single search coil that was mounted on the spacecraft so that it measured the magnetic field perpendicular to the spacecraft spin axis. The magnetometer could measure fields from 1 microgauss tc 12 milligauss. No inflight calibration was provided for. The experiment had both digital and analog outputs. The magnetometer amplitude and phase were sampled continuously for analog transmission and intermittently (every 96, 12, and 1.5 s, depending on satellite bit rate) for digital transmission. Approximately 21,000 digital readings of the magnetic field amplitude were obtained. The last data were taken on May 6, 1960. However, no information was obtained on the phase angle of the field about the spin axis. See Coleman, J. Geophys. Res., v. 69, p. 3051, 1964, for further details.

------- HELIOS-A, NEUBAUER----------

INVESTIGATION NAME- SEARCH COIL MAGNETOMETER

NSSDC ID- 74-097A-03

INVESTIGATIVE PROGRAM
CODE EL-4/CO-OP, SCIENCE

INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS

PERSONNEL

PI - F.M. NEUBAUER		U OF KÖLN
OI - G. DEHMEL		BRAUNSCHWEIG TECH U

BRIEF DESCRIPTION

This experiment (E4) was designed to investigate the magnetic component of electromagnetic waves in the solar wind from 0.3 to 1.0 AU. By means of its waveform channel (WFC) the rapid variations of the magnetic field were measured up from plus or minus 8.75 nT to plus or minus 275 nT in three orthogonal directions from 4 to 128 Hz. A spectrum analyzer observed the field components in the ecliptic plane and perpendicular to it, to obtain the power spectral density and peak values for eight logarithmically spaced channels in the range from 4.7 to 2200 Hz. Because of the large amount of data produced by this experiment, an adaptive data reduction was applied. For interesting time intervals selected by the fluxgate magnetometer (74-097A-01, Neubauer) or Gurnett (-04), waveform data could be read into an on-board memory at a rapid rate to be transmitted slowly afterwards. For more detailed information see p. 241 in Raumfahrtforschung, v. 19, n. 5, 1975.

------- HELIOS-B, NEUBAUER----------

INVESTIGATION NAME- SEARCH COIL MAGNETOMETER

NSSDC ID- 76-003A-03

INVESTIGATIVE PROGRAM
CODE EL-4/CO-OP, SCIENCE

INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS

PERSONNEL

PI - F.M. NEUBAUER		U OF KÖLN
OI - G. DEHMEL		BRAUNSCHWEIG TECH U

BRIEF DESCRIPTION

This experiment (E4) was designed to investigate the magnetic component of electromagnetic waves in the solar wind from 0.3 to 1.0 AU. By means of its waveform channel (WFC), the rapid variations of the magnetic field were measured up from plus or minus 8.75 nT to plus or minus 275 nT in three orthogonal directions from 4 to 128 Hz. A spectrum analyzer observed the field components in the ecliptic plane and perpendicular to it, to obtain the power spectral density and peak values for eight logarithmically spaced channels in the range from 4.7 to 2200 Hz. Because of the large amount of data produced by this experiment, an adaptive data reduction was applied. For interesting time intervals selected by the fluxgate magnetometer (Neubauer) 76-003A-01, or Gurnett (-04), waveform data could be read into an onboard memory at a rapid

rate to be transmitted slowly afterwards. For more detailed information see p. 241 in Raumfahrtforschung, v. 19, n. 5, 1975.

------- PIONEER 5, WINCKLER----------

INVESTIGATION NAME- ION CHAMBER AND GM TUBE

NSSDC ID- 60-001A-03
INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS

PERSONNEL

PI - J.R.	WINCKLER	U OF MINNESOTA
OI - R.L.	ARNOLDY	U OF NEW HAMPSHIRE
OI - R.A.	HOFFMAN	NASA-GSFC

BRIEF DESCRIPTION
This experiment consisted of a Neher-type integrating ionization chamber and an Anton 302 Geiger counter. The Geiger counter was mounted normal to the spacecraft spin axis. Due to the complex, nonuniform shielding of the detectors, the ion chamber responded quasi-omnidirectionally to protons greater than about 25 MeV while the Geiger counter responded quasi-omnidirectionally to protons greater than about 35 MeV. Energy thresholds for quasi-omnidirectional responses to electrons were approximately 1.6 and 2.9 MeV for the ion chamber and Geiger counter, respectively. Counts from the Geiger counter and pulses from the ion chamber were accumulated in separate registers and telemetered by both analog and digital systems. The experiment performed normally from launch through May 17, 1960. Telemetry noise limited the timespan of useful data to the period from launch through April 29, 1960.

------- PIONEER 5, SIMPSON----------

INVESTIGATION NAME- PROPORTIONAL COUNTER TELESCOPE

NSSDC ID- 60-001A-01
INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
MAGNETOSPHERIC PHYSICS
PARTICLES AND FIELDS

PERSONNEL

PI - J.A.	SIMPSON	U OF CHICAGO
OI - C.Y.	FAN	U OF ARIZONA
OI - P.	MEYER	U OF CHICAGO

BRIEF DESCRIPTION
A triple coincidence omnidirectional proportional counter telescope was used to observe terrestrial trapped radiation and solar particles (protons E>75 MeV, electrons E>13 MeV). Measurements were obtained for about 2 months during which a week of quiescent magnetic field conditions followed by two geomagnetic storms closely spaced in time occurred. The date of transmission of the last useful information was May 16, 1960.

------- PIONEER 6, SIMPSON----------

INVESTIGATION NAME- COSMIC-RAY TELESCOPE

NSSDC ID- 65-105A-03
INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS
COSMIC RAYS

PERSONNEL

PI - J.A.	SIMPSON	U OF CHICAGO
OI - J.E.	LAMPORT	U OF CHICAGO

BRIEF DESCRIPTION
This experiment used a charged-particle telescope composed of four silicon solid-state detectors to study the anisotropy and fluctuations of solar protons and alpha particles. The proton energy ranges sampled were 0.6 to 13.9 MeV, 13.9 to 73.2 MeV, 73.2 to 175 MeV, and E>175 MeV. The alpha particle energy ranges sampled were 2.4 to 55.6 MeV, 55.6 to 293 MeV, and E>294 MeV. The time resolution ranged from about one measureeert per 0.4 s to about one measurement per 28 s depending on the telemetry bit rate. The detector was mounted so that it made a 360-deg scan in the ecliptic plane about once per s. Pulse-height analysis of detector D1 output (128 channel) and D3 output (32 channel) was accomplished for the last event prior to each telemetry readout for the experiment. For further details, see Fan et al., J. Geophys. Res., v. 73, p. 1555, 1968.

------- PIONEER 7, SIMPSON----------

INVESTIGATION NAME- COSMIC-RAY TELESCOPE

NSSDC ID- 66-075A-06
INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS
COSMIC RAYS

PERSONNEL

PI - J.A.	SIMPSON	U OF CHICAGO
OI - C.Y.	FAN	U OF ARIZONA
OI - J.E.	LAMPORT	U OF CHICAGO

BRIEF DESCRIPTION
This experiment used a charged particle telescope composed of four silicon solid-state detectors to study the anisotropy and fluctuations of solar protons and alpha particles. The proton energy ranges sampled were 0.6 to 12.7 MeV, 12.7 tc 73.0 MeV, 73.0 to 165 MeV, and E>165 MeV. The alpha particle energy ranges sampled were 2.5 to 52 MeV, 52 to 280 MeV, and E>280 MeV. The time resolution ranged from about one measurement per 0.4 s to about one measurement per 28 s depending on the telemetry bit rate. The detector was mounted so that it made a 360-deg scan in the ecliptic plane about once per second.

------- PIONEER 8, WEBBER----------

INVESTIGATION NAME- COSMIC-RAY GRADIENT DETECTOR

NSSDC ID- 67-123A-06
INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS
COSMIC RAYS

PERSONNEL

PI - W.R.	WEBBER	U OF NEW HAMPSHIRE

BRIEF DESCRIPTION
This experiment utilized a telescope comprised of five solid-state sensors, a Cerenkov detector, and an anticoincidence shield. The telescope axis was perpendicular to the spacecraft spin axis. As determined by two coincidence modes and electronic discrimination of sensor output pulses, particles measured were electrons in three contiguous energy intervals between 0.34 and 8.4 MeV, protons in six contiguous energy intervals between 3.49 and 64.3 MeV (one of five count rates was due to the sum of counts in two noncontiguous energy intervals), and alpha particles in four contiguous energy intervals between 6.64 and 64.1 MeV/nucleon (one of three count rates was due to the sum of counts in two noncontiguous energy intervals). A third coincidence mode measured the sum of counts due to electrons above 0.6 MeV and nuclei above 14 MeV/nucleon. A fourth coincidence mode measured the sum of nuclei above 42 MeV/nucleon and electrons above 5.1 MeV. Spacecraft spin-integrated directional fluxes were measured in the various modes. Accumulation times and readout intervals were dependent on the telemetry bit rate and were typically in tens of seconds. In all cases, they were longer than the spacecraft spin period. At low telemetry bit rates accumulator saturation rendered some counting modes to be of no value. For further details, see J. Geophys. Res., v. 76, p. 1605, 1971.

------- PIONEER 6, MCCRACKEN----------

INVESTIGATION NAME- COSMIC-RAY ANISOTROPY

NSSDC ID- 65-105A-05
INVESTIGATIVE PROGRAM
CODE EL-4/CO-OP, SCIENCE

INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS
COSMIC RAYS

PERSONNEL

PI - K.G.	MCCRACKEN	CSIRO
OI - W.C.	BARTLEY	DOE HEADQUARTERS
OI - U.R.	RAO	ISRO SATELLITE CENTER

BRIEF DESCRIPTION
This experiment was designed primarily to measure the directional characteristics of galactic and solar cosmic-ray fluxes. The particle detector was a CsI (Tl) scintillator crystal that was set into an anticoincidence plastic scintillator collimator cup. Separate photomultiplier tubes viewed the two scintillators. Pulses from the CsI crystal unaccompanied by pulses from the plastic scintillator were sorted by a three-window pulse-height analyzer, the windows corresponding to energy depositions of 7.4 to 44.0, 44.0 to 77.1, and 123.8 to 303.8 MeV. Counts in the two lower energy windows were due mainly to protons with the window energies, while only particles of Z greater than or equal to 2 contributed to the highest energy window count rate. (Protons above 90 MeV gave anticoincidence pulses.) For each energy window, counts were separately accumulated in each of four angular sectors as the spacecraft spun. Each angular sector was normally 89.5 deg in width, with the sun in the middle of one sector. However, when large fluxes were encountered, each angular sector was reduced to 11.2 deg, with the sun near the midpoint between two sectors. A spin-integrated (isotropic) mode, in which all particles depositing 7.4 MeV in the CsI crystal (no anticoincidence requirement) were counted, was also used. Accumulation times for each of the 12 directional modes

and for the omnidirectional mode varied between 14 s and 112 s (spacecraft spin period was about 1 s) depending on the telemetry bit rate. See Bartley et al., Rev. Sci. Instrum., v. 38, p. 266, 1967, for a more detailed experiment description.

------- PIONEER 7, MCCRACKEN----------

INVESTIGATION NAME- COSMIC-RAY ANISOTROPY

NSSDC ID- 66-075A-05
INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS
COSMIC RAYS

PERSONNEL
PI - K.G. MCCRACKEN — CSIRO
OI - W.C. BARTLEY — DOE HEADQUARTERS
OI - U.R. RAO — ISRO SATELLITE CENTER

BRIEF DESCRIPTION
This experiment was designed primarily to measure the directional characteristics of galactic and solar cosmic ray fluxes. The particle detector was a CsI (Tl) scintillator crystal that was set into an anticoincidence plastic scintillator collimator cup. Separate photomultiplier tubes viewed the two scintillators. Pulses from the CsI crystal that were not accompanied by pulses from the plastic scintillator were sorted by a three-window pulse-height analyzer, the windows corresponding to energy depositions of 7.2 to 47.4, 47.4 to 64.5, and 64.5 to 81.2 MeV. No positive species identification was made, although most of the counts in each window were usually due to protons with the window energies. For each energy window, counts were separately accumulated in each of four angular sectors as the spacecraft spun. Each angular sector was normally 89.5 deg in width, with the sun either near a sector boundary or in the middle of a sector, depending on the operating mode. However, when large fluxes were encountered, each angular sector was reduced to 11.2 deg, with the sun either in a sector or near the midpoint between two sectors. A spin-integrated (isotropic) mode, in which all particles depositing 7.2 MeV in the CsI crystal (no anticoincidence requirement) were counted, was also used. Accumulation times for each of the 12 directional modes and for the omnidirectional mode varied between 14 and 112 s (spacecraft spin period was about 1 s) depending on the telemetry bit rate. See Bartley et al., Rev. Sci. Instrum., v. 38, p. 266, 1967, for a more detailed experiment description.

------- PIONEER 9, MCCRACKEN----------

INVESTIGATION NAME- COSMIC-RAY ANISOTROPY

NSSDC ID- 68-100A-05
INVESTIGATIVE PROGRAM
CODE EL-4/CO-OP, SCIENCE

INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS
COSMIC RAYS

PERSONNEL
PI - K.G. MCCRACKEN — CSIRO
OI - U.R. RAO — ISRO SATELLITE CENTER
OI - W.C. BARTLEY — DOE HEADQUARTERS

BRIEF DESCRIPTION
This experiment consisted of a CsI scintillator and three solid-state telescopes. The CsI scirtillator was collimated by an anticoincidence plastic scintillator and had a conical aperture with a 38.2-deg half-angle. The scintillator look direction was centered in the ecliptic plane. Three solid-state detectors were oriented in a fan arrangement with respect to a fourth solid-state detector, such that each of the first three detectors formed a telescope with the fourth detector. Each of the three telescopes thus formed had an acceptance cone of 23-deg half-angle. The mean viewing directions of the telescopes were in the ecliptic plane and 48 deg above and below that plane, respectively. Two concurrent modes of counting were employed. In the first mode, counts were accumulated in eight separate 45-deg intervals during the spacecraft spin, while, in the second, spin-integrated counts were acquired. In the first mode, the scintillator separately measured particles with energies in the ranges 7.4 to 21.5 MeV/nucleon and 19.7 to 63.0 MeV/nucleon (no species discrimination) while each solid-state telescope separately measured protons in the energy ranges 3.3 to 3.6 MeV and 5.6 to 6.7 MeV. In the second mode, the scintillator separately measured particles in six contiguous energy intervals between 4.5 and 40 MeV/nucleon (interval lower limits at 4.5, 7.0, 9.6, 13, 21, and 28 MeV/nucleon), while each of the solid-state telescopes separately measured protons in the energy ranges 1 to 8, 1 to 5, 1 to 3, and 4 to 6 MeV, and alpha particles in the energy range 4 to 8 MeV. During each 224-bit main telemetry frame, two first-mode 9-bit accumulators and one second-mode 9-bit accumulator were read out. Inflight calibration of the scintillator and of some of the electronics was performed daily. See Bukata et al, IEEE Trans. Nuc. Sci., NS-17, pp. 18-24, 1970, for a more detailed experiment description.

------- PIONEER 8, WEBBER----------

INVESTIGATION NAME- COSMIC-RAY GRADIENT DETECTOR

NSSDC ID- 67-123A-06
INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS
COSMIC RAYS

PERSONNEL
PI - W.R. WEBBER — U OF NEW HAMPSHIRE

BRIEF DESCRIPTION
This experiment utilized a telescope comprised of five solid-state sensors, a Cerenkov detector, and an anticoincidence shield. The telescope axis was perpendicular to the spacecraft spin axis. As determined by two coincidence modes and electronic discrimination of sensor output pulses, particles measured were electrons in three contiguous energy intervals between 0.34 and 8.4 MeV, protons in six contiguous energy intervals between 3.49 and 64.3 MeV (one of five count rates was due to the sum of counts in two noncontiguous energy intervals), and alpha particles in four contiguous energy intervals between 6.64 and 64.1 MeV/nucleon (one of three count rates was due to the sum of counts in two noncontiguous energy intervals). A third coincidence mode measured the sum of counts due to electrons above 0.6 MeV and nuclei above 14 MeV/nucleon. A fourth coincidence mode measured the sum of nuclei above 42 MeV/nucleon and electrons above 5.1 MeV. Spacecraft spin-integrated directional fluxes were measured in the various modes. Accumulation times and readout intervals were dependent on the telemetry bit rate and were typically in tens of seconds. In all cases, they were longer than the spacecraft spin period. At low telemetry bit rates accumulator saturation rerdered some counting modes to be of no value. For further details, see J. Geophys. Res., v. 76, p. 1605, 1971.

------- PIONEER 9, WEBBER----------

INVESTIGATION NAME- COSMIC-RAY GRADIENT

NSSDC ID- 68-100A-06
INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS
COSMIC RAYS

PERSONNEL
PI - W.R. WEBBER — U OF NEW HAMPSHIRE

BRIEF DESCRIPTION
This experiment utilized a telescope comprised of five solid-state sensors, a Cerenkov detector, and an anticoincidence shield. The telescope axis was perpendicular to the spacecraft spin axis. As determined by two coincidence modes and electronic discrimination of sensor output pulses, particles measured were (1) electrons in three contiguous energy intervals between 0.31 and 5.1 MeV, (2) protons in five contiguous energy intervals between 2.2 and 42 MeV, and (3) alpha particles in contiguous energy intervals between 5.8 and 42 MeV/nucleon. A third coincidence mode measured the sum of counts due to electrons above 0.6 MeV and nuclei above 14 MeV/nucleon. A fourth coincidence mode measured the sum of nuclei above 42 MeV/nucleon and electrons above 5.1 MeV. Spacecraft spin-integrated directional fluxes were measured in the various modes. Accumulation times and readout intervals were dependent on the telemetry bit rate and were typically in tens of seconds. In all cases, they were longer than the spacecraft spin period.

------- HELIOS-A, TRAINOR----------

INVESTIGATION NAME- GALACTIC AND SOLAR COSMIC RAYS

NSSDC ID- 74-097A-08
INVESTIGATIVE PROGRAM
CODE EL-4/CO-OP, SCIENCE

INVESTIGATION DISCIPLINE(S)
COSMIC RAYS
PARTICLES AND FIELDS

PERSONNEL
PI - J.H. TRAINOR — NASA-GSFC
OI - E.C. ROELOF — APPLIED PHYSICS LAB
OI - B.J. TEEGARDEN — NASA-GSFC
OI - F.B. MCDONALD — NASA-GSFC
OI - K.G. MCCRACKEN — CSIRO

BRIEF DESCRIPTION
The detector complement of this experiment (E7) consisted of three separate delta E/delta x vs E telescopes and a proportional counter for monitoring solar X-rays in the range 2-8 keV. The high-energy telescope had a geometric factor of 0.22 sq cm-sr and measured electrons in three ranges between 2 and 8 MeV, and protons and alpha particles in three ranges between 20 and 56 MeV/n. Protons above 230 MeV are also measured. The first low-energy telescope (geometric factor was 0.155 sq cm-sr) measured protons and z >1 particles in three ranges between 3 and 21 MeV/n. The second low-energy telescope (geometric factor was 0.015 sq cm-sr) measured protons in several ranges between 0.12 and 2.1 MeV, alpha particles in the

ranges 0.6-2.1 and 6-21.2 MeV/n, and electrons in four ranges between 0.12 and 2 MeV. For a number of coincidence modes, counting-rate data sectored into eight 45-deg sectors were obtained. The data cycle time was dependent on the spacecraft telemetry rate (variable between 4096 and 8 bits/s) and format. Under optimum conditions, five events per second were pulse-height analyzed and the rate data cycle was of the order of 5 min. At the slowest combination of bit rate and format, a complete data cycle required about 2.5 h. See IEEE Trans. on Nuc. Sci., NS-22, p. 570, 1975, and Raumfahrtforschung, v. 19, n. 5, pp. 258-260, 1975, for further details.

------- HELIOS-B, TRAINOR----------

INVESTIGATION NAME- GALACTIC AND SOLAR COSMIC RAYS

NSSDC ID- 76-003A-08

INVESTIGATIVE PROGRAM
CODE EL-4/CO-OP, SCIENCE

INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS
COSMIC RAYS

PERSONNEL

PI - J.H.	TRAINOR	NASA-GSFC
OI - E.C.	ROELOF	APPLIED PHYSICS LAB
OI - B.J.	TEEGARDEN	NASA-GSFC
OI - F.B.	MCDONALD	NASA-GSFC
OI - K.G.	MCCRACKEN	CSIRO

BRIEF DESCRIPTION

The detector complement of this experiment (E7) consisted of three separate delta E/delta x vs E telescopes and a proportional counter for monitoring solar X rays in the range 2-8 keV. The high-energy telescope had a geometric factor of 0.22 sq cm-sr and measured electrons in three ranges between 2 and 8 MeV, and protons and alpha particles in three ranges between 20 and 56 MeV/n. Protons above 230 MeV were also measured. The first low-energy telescope (geometric factor was 0.155 sq cm-sr) measured protons and z >1 particles in three ranges between 3 and 21 MeV/n. The second low-energy telescope (geometric factor was 0.015 sq cm-sr) measured protons in several ranges between 0.12 and 2.1 MeV, alpha particles in the ranges 0.6-2.1 and 6-21.2 MeV/n, and electrons in four ranges between 0.12 and 2 MeV. For a number of coincidence modes, counting data sectored into eight 45-deg sectors were obtained. The data cycle time was dependent on the spacecraft telemetry (variable between 4096 and 8 bits/s) and format. Under optimum conditions, five events per s are pulse-height analyzed and the rate data cycle was on the order of 5 min. At the slowest combination of bit rate and format, a complete data cycle required about 2.5 h. For further details see IEEE Trans. on Nuc. Sci., NS-22, p. 570, 1975, and pp. 258-260 of Raumfahrtforschung, v. 19, n. 5, 1975.

------- HELIOS-A, KUNOW----------

INVESTIGATION NAME- COSMIC-RAY PARTICLES

NSSDC ID- 74-097A-07

INVESTIGATIVE PROGRAM
CODE EL-4/CO-OP, SCIENCE

INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS
COSMIC RAYS

PERSONNEL

PI - H.	KUNOW	U OF KIEL
OI - G.H.	WIBBERENZ	U OF KIEL
OI - G.	GREEN	U OF KIEL
OI - M.	MUELLER-MELLIN	U OF KIEL
OI - M.	WITTE	U OF KIEL
OI - H.	HEMPE	U OF KIEL

BRIEF DESCRIPTION

The objective of the experiment (E6) was to study high-energy, charged, cosmic-ray particles of solar, planetary, and galactic origin in interplanetary space. Protons and alpha particles with energies >1.3 MeV/nucleon, and electrons >0.3 MeV were measured within interplanetary space over the range from 0.3 to 1.0 AU. The instrument, a particle telescope with a 55-deg field of view, consisted of five semiconductor detectors, one sapphire Cerenkov counter, and one scintillation counter, all enclosed by an anticoincidence cylinder. The telescope was calibrated prior to launch using radioactive sources, particle accelerators, and ground-level muons. It measured protons and alpha particles in six channels (1.3-3.3, 3.3-13, 13-27, 27-37, 37-45, and >45 MeV/nucleon) and electrons in five energy channels (0.3-0.8, 0.8-2, 2-3, 3-4, and >4 MeV). For more detail see pp. 253-257 of Raumfahrtforschung, v. 19, n. 5, 1975.

------- HELIOS-B, KUNOW----------

INVESTIGATION NAME- COSMIC-RAY PARTICLES

NSSDC ID- 76-003A-07

INVESTIGATIVE PROGRAM
CODE EL-4/CO-OP, SCIENCE

INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS
COSMIC RAYS

PERSONNEL

PI - H.	KUNOW	U OF KIEL
OI - G.H.	WIBBERENZ	U OF KIEL
OI - G.	GREEN	U OF KIEL
OI - M.	MUELLER-MELLIN	U OF KIEL
OI - M.	WITTE	U OF KIEL
OI - H.	HEMPE	U OF KIEL

BRIEF DESCRIPTION

The objective of the experiment (E6) was to study high-energy, charged, cosmic-ray particles of solar, planetary, and galactic origin in interplanetary space. Protons and alpha particles with energies >1.3 MeV/nucleon, and electrons >0.3 MeV were measured within interplanetary space over the range from 0.3 to 1.0 AU. The instrument, a particle telescope with a 55-deg field of view, consisted of five semiconductor detectors, one sapphire Cerenkov counter, and one scintillation counter, all enclosed by an anticoincidence cylinder. The telescope was calibrated prior to launch using radioactive sources, particle accelerators, and ground-level muons. It measured protons and alpha particles in six channels (1.3-3.3, 3.3-13, 13-27, 27-37, 37-45, and >45 MeV/nucleon) and electrons in five energy channels (0.3-0.8, 0.8-2, 2-3, 3-4, and >4 MeV). For more details see pp. 253-257 of Raumfahrtforschung, v. 19, n. 5, 1975.

RADIO SCIENCE AND CELESTIAL MECHANICS

------- PIONEER 6, ANDERSON----------

INVESTIGATION NAME- CELESTIAL MECHANICS

NSSDC ID- 65-105A-07

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
CELESTIAL MECHANICS

PERSONNEL

PI - J.D.	ANDERSON	NASA-JPL

BRIEF DESCRIPTION

The purpose of this experiment was to use the tracking data from the mission to obtain primary determinations of the masses of the earth and moon, the astronomical unit, and the oscillating elements of the orbit of the earth. This was appropriate because of the absence of midcourse orbit corrections and near-planetary encounters. Also, solar radiation pressure effects were small. The experiment used the onboard receiver and transmitter equipment in conjunction with Deep Space Network station equipment to obtain Doppler measurements.

------- PIONEER 6, ESHLEMAN----------

INVESTIGATION NAME- TWO-FREQUENCY BEACON RECEIVER

NSSDC ID- 65-105A-04

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
IONOSPHERES AND RADIO PHYSICS
PARTICLES AND FIELDS

PERSONNEL

PI - V.R.	ESHLEMAN	STANFORD U
OI - T.A.	CROFT	SRI INTERNATIONAL
OI - R.L.	LEADABRAND	SRI INTERNATIONAL
OI - O.K.	GARRIOTT	NASA-JSC
OI - A.M.	PETERSON	STANFORD U

BRIEF DESCRIPTION

Both 423.3-MHz and its 2/17 subharmonic 49.8-MHz signals were transmitted from a 46-m steerable parabolic antenna at Stanford University to the two-frequency radio receiver on the spacecraft. The high-frequency signal served as a reference signal since its propagation time was not appreciably lengthened by electrons along the path. The low-frequency signal was delayed in proportion to the total electron content in the propagation path. On the spacecraft, a phase-locked receiver counted the beat frequency zero crossings of the received signals to obtain measurements of phase-path differences. Differential delay of the group velocity was also observed, and these values were telemetered to the ground station. From calculated total electron content values, the ionospheric effect (up to a selected altitude obtained from other experimental techniques) could be subtracted to produce data describing the interplanetary electron content of the solar wind and its variations. For similar experiments covering other time periods see 68-108A-03, 67-123A-03, 66-075A-04, and 67-060A-02. More detailed descriptions of the experiment can be found in J. Geophys. Res., v. 71, pp. 3325-3327, and in Radio Sci., v. 6, pp. 55-63.

------- PIONEER 7, ESHLEMAN----------

INVESTIGATION NAME- TWO-FREQUENCY BEACON RECEIVER

NSSDC ID- 66-075A-04

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
IONOSPHERES
PARTICLES AND FIELDS

PERSONNEL

PI -	V.R. ESHLEMAN	STANFORD U
OI -	T.A. CROFT	SRI INTERNATIONAL

BRIEF DESCRIPTION

Both 423.3-MHz and its 2/17 subharmonic 49.8-MHz signals were transmitted from a 4.6-m steerable parabolic antenna at Stanford University to the two-frequency radio receiver on the spacecraft. The high-frequency signal served as a reference signal since its propagation time was not appreciably delayed. The low-frequency signal was delayed in proportion to the total electron content in the propagation path. On the spacecraft, a phase locked receiver counted the beat frequency zero crossings of the received signals to obtain measurements of phase-path differences. Differential delay of the group velocity was also observed, and these values were telemetered to the grounc station. From calculated total electron content values, the ionospheric effect (up to a selected altitude obtained fror other experimental techniques) was subtracted to produce data describing the interplanetary electron content of the solar wind and its variations. The experiment operated nominally from launch to May 20, 1969. For similar experiments covering other time periods, see 68-100A-03, 67-123A-03, 65-105A-04, and 67-060A-02. More detailed descriptions of the experiment car be found in J. Geophys. Res., v. 71, p. 3325-3327, 1966, and in Radio Sci., v. 6, p. 55-63, 1971.

------- PIONEER 8, ESHLEMAN----------

INVESTIGATION NAME- TWO-FREQUENCY BEACON RECEIVER

NSSDC ID- 67-123A-03

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
IONOSPHERES AND RADIO PHYSICS
PLANETARY ATMOSPHERES
PARTICLES AND FIELDS
INTERPLANETARY DUST

PERSONNEL

PI -	V.R. ESHLEMAN	STANFORD U
OI -	T.A. CROFT	SRI INTERNATIONAL
OI -	H.T. HOWARD	STANFORD U
OI -	R.L. LEADABRAND	SRI INTERNATIONAL
OI -	R.A. LONG	SRI INTERNATIONAL
OI -	A.M. PETERSON	STANFORD U

BRIEF DESCRIPTION

Both 423.3-MHz and its 2/17 subharmonic 49.8-MHz signals were transmitted from a 46-m steerable parabolic antenna at Stanford University to the two-frequency radio receiver on the spacecraft. The high-frequency signal served as a reference signal since its propagation time was not appreciably delayed. The low-frequency signal was delayed in proportion to the total electron content in the propagation path. On the spacecraft, a phase-locked receiver counted the beat frequency zero crossirgs of the received signals to obtain measurements of phase-path differences. Differential delay of the group velocity was also observed, and these values were telemetered to the ground station. From calculated total electron contert values, the ionospheric effect (up to a selected altitude obtained from other experimental techniques) could be subtracted to produce data describing the interplanetary electron content of the solar wind and its variations. For similar experiments covering other time periods, see 68-100A-03, 66-075A-04, 65-105A-04, and 67-060A-02. A more detailed description of the experiment can be found in J. Geophys. Res., v. 17, p. 3325-3327, and in Radio Sci., v. 6, p. 55-63.

------- PIONEER 9, ESHLEMAN----------

INVESTIGATION NAME- TWO-FREQUENCY BEACON RECEIVER

NSSDC ID- 68-100A-03

INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS
IONOSPHERES AND RADIO PHYSICS

PERSONNEL

PI -	V.R. ESHLEMAN	STANFORD U
OI -	T.A. CROFT	SRI INTERNATIONAL
OI -	H.T. HOWARD	STANFORD U
OI -	R.L. LEADABRAND	SRI INTERNATIONAL
OI -	R.A. LONG	SRI INTERNATIONAL
OI -	A.M. PETERSON	STANFORD U

BRIEF DESCRIPTION

Both 423.3-MHz and its 2/17 subharmonic 49.8-MHz signals were transmitted from a 4.6-m steerable parabolic antenna at Stanford University to the two-frequency radio receiver on the spacecraft. The high-frequency signal served as a reference signal, since its propagation time was not appreciably delayed. The low-frequency signal was delayed in proportion to the total electron content in the propagation path. On the spacecraft, a phase-locked receiver counted the beat frequency zero crossings of the received signals to obtain measurements of phase-path differences. Differential delay of the group velocity was also observed, and these values were telemetered to the ground station and used to calculate the total electron content. The ionospheric contribution (up to a selected altitude obtained from other experimental techniques) could be subtracted to produce data describing the interplanetary electron content of the solar wind and its variations. More detailed descriptions of the experiment can be found in J. Geophys. Res., v. 71, pp. 3325-3327, and in Radio Sci., v. 6, pp. 55-63.

------- HELIOS-A, GURNETT----------

INVESTIGATION NAME- FINE FREQUENCY, COARSE TIME RESOLUTION SPECTRUM ANALYSIS

NSSDC ID- 74-097A-05

INVESTIGATIVE PROGRAM
CODE EL-4/CO-OP, SCIENCE

INVESTIGATION DISCIPLINE(S)
IONOSPHERES AND RADIO PHYSICS
PARTICLES AND FIELDS

PERSONNEL

PI -	D.A. GURNETT	U OF IOWA
OI -	P.J. KELLOGG	U OF MINNESOTA
OI -	S.J. BAUER	GRAZ U
OI -	R.G. STONE	NASA-GSFC

BRIEF DESCRIPTION

This experiment (E5b) shared the 32 m, tip-to-tip, electric dipole antenna with experiments -04 and -06. Instrumentation consisted of three tunable plasma wave receivers, a fixed-frequency wideband receiver, and a waveform sampler. The tunable receivers and wideband receiver provided data for direct telemetry to earth. Each of the tunable receivers covered a different frequency band in the range 1 Hz to 200 kHz. The high-frequency receiver had 96 frequency settings separated by about 4 %, and covered the frequency range 6.4 kHz to 205 kHz. The mid-range receiver had 48 frequency settings separated by about 8 %, and covered the range 208 Hz to 6.07 kHz. The low-frequency receiver had 24 settings with 15 % separation, and covered the range 11 Hz to 309 Hz. The response time of the low-frequency receiver was approximately 1 s, necessitating the inclusion of the wideband receiver to obtain information about the angular distribution of waves appearing in the low-frequency band. This receiver covered the frequency range 1 Hz to 200 Hz. The time resolution depended in detail on the spacecraft telemetry format, bit rate, and experiment operational mode. When the shock alarm mode became activated, data from the waveform sampler were read into spacecraft memory for a period starting before and ending after the triggering event. In this mode, the instantaneous voltage across the antenna was passed through a low-pass filter with corner frequency dependent on the sampling rate, and measured at discrete intervals, the most rapid being 2.2 ms. One half of the electric dipole failed to deploy properly, and became short-circuited to ground. The resulting configuration was that of a monopole with an operational effective length of about 8 m. This resulted in a 6-dB loss in sensitivity, and an increased receiver noise level, particularly at low frequencies. In addition, the high-gain telemetry antenna produced additional interference. For a more detailed discussion, see p. 248 of Raumfahrtforschung, v. 19, n. 5, 1975.

------- HELIOS-B, GURNETT----------

INVESTIGATION NAME- FINE FREQUENCY, COARSE TIME RESOLUTION SPECTRUM ANALYSIS

NSSDC ID- 76-003A-05

INVESTIGATIVE PROGRAM
CODE EL-4/CO-OP, SCIENCE

INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS
IONOSPHERES AND RADIO PHYSICS

PERSONNEL

PI -	D.A. GURNETT	U OF IOWA
OI -	P.J. KELLOGG	U OF MINNESOTA
OI -	S.J. BAUER	GRAZ U
OI -	R.G. STONE	NASA-GSFC

BRIEF DESCRIPTION

This experiment (E5b) shared the 32-m, tip-to-tip, electric dipole antenna with experiments -04 and -06. Instrumentation consisted of three tunable plasma-wave receivers, a fixed-frequency wideband receiver, and a waveform sampler. The tunable receivers and wideband receiver provided data for direct telemetry to earth. Each of the tunable receivers covered a different frequency band in the range 1 hz to 200 kHz. The high-frequency receiver had 96 frequency settings separated by about 4 %, and covered the frequency range 6.4 kHz to 205 kHz. The mid-range receiver had 48

frequency settings separated by about 8 percent and covered the range 208 Hz to 6.07 kHz. The low-frequency receiver had 24 settings with 15 %, separation and covered the range 11 Hz to 309 Hz. The response time of the low-frequency receiver was approximately 1 s, necessitating the inclusion of the wideband receiver to obtain information about the angular distribution of waves appearing in the low-frequency band. This receiver covered the frequency range 1 Hz to 200 Hz. The time resolution depended in detail on the spacecraft telemetry format, bit rate, and experiment operational mode. When the shock alarm mode became activated, data from the waveform sampler were read into spacecraft memory for a period starting before and ending after the triggering event. In this mode, the instantaneous voltage across the antenna was passed through a low-pass filter with corner frequency dependent on the sampling rate, and measured at discrete intervals, the most rapid being 2.2 ms. For a more detailed discussion see p. 248 of Raumfahrtforschung, v. 19, n. 5, 1975.

------- HELIOS-A, GURNETT----------

INVESTIGATION NAME- 26.5-KHZ TO 3-MHZ RADIO WAVE

NSSDC ID- 74-097A-06

INVESTIGATIVE PROGRAM
CODE EL-4/CO-OP, SCIENCE

INVESTIGATION DISCIPLINE(S)
RADIO PHYSICS
PARTICLES AND FIELDS
SOLAR PHYSICS

PERSONNEL

PI - D.A.	GURNETT	U OF IOWA
OI - P.J.	KELLOGG	U OF MINNESOTA
OI - R.R.	WEBER	NASA-GSFC
OI - R.G.	STONE	NASA-GSFC

BRIEF DESCRIPTION

This experiment (E5c) shared the 32-m, tip-to-tip, electric dipole antenna with experiments -04 and -05. A dual (redundant) 16-frequency channel radiometer, with approximately logarithmically spaced channels, was used to detect type III radio emissions associated with solar flare events in the frequency band 26.5 kHz to 3 MHz. The experiment sampling rate was synchronized such that each spacecraft revolution was divided into 32 sectors. The secuence and frequency of sampling depended on the instrument operational mode (one of four) and the spacecraft bit rate. The most rapid sampling possible for a single-frequency channel was once every 1/32 of a satellite spin period, or about .03 s. A typical sampling sequence was for one frequency channel to be sampled for 16 sectors (1/2 revolution), followed by the next. One-half of the 32-m dipole failed to extend properly during deployment, and was shorted to ground. The resulting antenna configuration was that of a monopole with an operational effective length of about 8 m. This shorter configuration resulted in increased radio-frequency interference (RFI) of from 3 to 30 dB above expected levels, and a loss of 6 dB in gain. Another problem was unexpected interference with the high-gain telemetry antenna. This added 60 dB RFI at 27.5 kHz, decreasing with increasing frequency, so that above 200 kHz it produced no detectable interference. For more details about the instrument and modes of operation, see p. 250 of Raumfahrtforschung, v. 19, n. 5, 1975.

------- HELIOS-B, GURNETT----------

INVESTIGATION NAME- 50-KHZ TO 2-MHZ RADIO WAVE

NSSDC ID- 76-003A-06

INVESTIGATIVE PROGRAM
CODE EL-4/CO-OP, SCIENCE

INVESTIGATION DISCIPLINE(S)
SOLAR PHYSICS
RADIO PHYSICS
PARTICLES AND FIELDS

PERSONNEL

PI - D.A.	GURNETT	U OF IOWA
OI - P.J.	KELLOGG	U OF MINNESOTA
OI - R.R.	WEBER	NASA-GSFC
OI - R.G.	STONE	NASA-GSFC

BRIEF DESCRIPTION

This experiment (E5c) shared the 32-m, tip-to-tip, electric dipole antenna with experiments -04 and -05. A dual (redundant) 16-frequency channel radiometer, with approximately logarithmically spaced channels, was used to detect type III radio emissions associated with solar-flare events in the frequency band 26.5 kHz to 3 MHz. The experiment sampling rate was synchronized such that each spacecraft revolution was divided into 32 sectors. The sequence and frequency of sampling depended on the instrument operational mode (one of four) and the spacecraft bit rate. The most rapid sampling possible for a single frequency channel was once every 1/32 of a satellite spin period, or about .03 s. A typical sampling sequence was for one frequency channel to be sampled for 16 sectors (1/2 revolution), followed by the next. For more details about the instrument and modes of operation, see p. 250 of Raumfahrtforschung, v. 19, n. 5, 1975.

------- HELIOS-A, FECHTIG----------

INVESTIGATION NAME- MICROMETEOROID DETECTOR AND ANALYZER

NSSDC ID- 74-097A-12

INVESTIGATIVE PROGRAM
CODE EL-4/CO-OP, SCIENCE

INVESTIGATION DISCIPLINE(S)
INTERPLANETARY PHYSICS
INTERPLANETARY DUST

PERSONNEL

PI - H.	FECHTIG	MPI-NUCLEAR PHYS
OI - J.	WEIHRAUCH	MPI-PHYS ASTROPHYS

BRIEF DESCRIPTION

The purpose of the experiment (E10) was to investigate some theories about the interplanetary dust including whether or not (1) the number of particles increases toward the sun, (2) the cutoff for small particles is dependent on the distance from the sun, because solar pressure increases nearer the sun, and (3) the number densities of particles change near the orbits of planets. The kinetic energy of dust particles hitting a target with high velocity (several km/s) caused the material to vaporize and become partially ionized. The generated plasma cloud was then separated by appropriate voltages into its negative (electron) part and into positive ions. The mass and the energy of the dust particles was determined from the impulse heights. A time-of-flight mass spectrometer in connection with the target allowed the small ion cloud to be analyzed. In this way, the investigation of the chemical composition of the dust particles became possible. The threshold for the detection of a particle was about 1.E-15 g. Mass and energy determination was possible for particles larger than about 1.E-14 g. For particles larger than 1.E-13 g, a mass spectrum was gathered. For further details, see pp. 268-269 of Raumfahrtforschung, v. 19, n. 5, 1975.

------- HELIOS-A, LEINERT----------

INVESTIGATION NAME- ZODIACAL LIGHT PHOTOMETER

NSSDC ID- 74-097A-11

INVESTIGATIVE PROGRAM
CODE EL-4/CO-OP, SCIENCE

INVESTIGATION DISCIPLINE(S)
INTERPLANETARY PHYSICS
ZODIACAL LIGHT

PERSONNEL

PI - C.	LEINERT	MPI-ASTRONOMIE
OI - E.	PITZ	MPI-ASTRONOMIE

BRIEF DESCRIPTION

This experiment (E9) consisted of three photometers looking at 15 deg, 30 deg, and 90 deg from the ecliptic. These photometers observed the intensity and polarization of the zodiacal light in UV, blue, and visual bands. The purpose of this experiment was to obtain information about the spatial distribution, size, and nature of interplanetary dust particles. For further details, see pp. 264-267 of Raumfahrtforschung, v. 19, n. 5, 1975.

------- HELIOS-B, LEINERT----------

INVESTIGATION NAME- ZODIACAL LIGHT PHOTOMETER

NSSDC ID- 76-003A-11

INVESTIGATIVE PROGRAM
CODE EL-4/CO-OP, SCIENCE

INVESTIGATION DISCIPLINE(S)
INTERPLANETARY PHYSICS
ZODIACAL LIGHT

PERSONNEL

PI - C.	LEINERT	MPI-ASTRONOMIE
OI - E.	PITZ	MPI-ASTRONOMIE

BRIEF DESCRIPTION

This experiment (E9) consisted of three photometers looking at 15 deg, 30 deg, and 90 deg from the ecliptic. These photometers observed the intensity and polarization of the zodiacal light in UV, blue, selected visual bands, and white light. The purpose of this experiment was to obtain information about the spatial distribution, size, and nature of interplanetary dust particles. For further details, see pp. 264-267 of Raumfahrtforschung, v. 19, n. 5, 1975.

Table 3. U.S. Lunar Mission Data

LEGEND

● All or partial data at NSSDC
X No data at NSSDC
◇ Experiment failed
□ Experiment aborted

PHOTOGRAPHY: Hasselblad through Far UV Camera/Spectrograph

Mission	Television	Hasselblad	Multispectral	Maurer	Closeup Stereoscopic	Hycon	Nikon	Contamination	TV Kinescope	Panoramic	Mapping Camera System (Mapping and Stellar)	Gegenschein	Far UV Camera/Spectrograph	Geologic Samples	Soil Mechanics
Ranger 7	●														
Ranger 8	●														
Ranger 9	●														
Surveyor 1	●*														X
Surveyor 3	●*														●
Surveyor 5	●*														X
Surveyor 6	●*														X
Surveyor 7	●*														●
Lunar Orbiter 1	●														
Lunar Orbiter 2	●														
Lunar Orbiter 3	●														
Lunar Orbiter 4	●														
Lunar Orbiter 5	●														
Apollo 8		●		●											
Apollo 10		●		●											
Apollo 11		●		●	●									●	●
Apollo 12		●	●†	●	●									●	●
Apollo 13		●		●	□	□								□	□
Apollo 14		●*		●	●	●						X		●	●
Apollo 15		●*		●			●		●	●	●	◇		●	●
Apollo 16		●		●			●	●	●	●	●	●§	●	●	●
Apollo 17		●		●			●		●	●	●	X		●	●

Mission	Alpha Particle Measurements	Radiation	Selenodesy	Meteoroids	Laser Altimeter	S-Band Transponder	Bistatic Radar	Gamma-Ray Spectrometer	X-Ray Fluorescence	Mass Spectrometer	Far UV Spectrometer	Lunar Sounder	IR Scanning Radiometer	Seismic Experiments	Laser Ranging Retroreflector
Ranger 7															
Ranger 8															
Ranger 9															
Surveyor 1															
Surveyor 3															
Surveyor 5	●														
Surveyor 6	●														
Surveyor 7	●														
Lunar Orbiter 1		X	●	●											
Lunar Orbiter 2		X	●	●											
Lunar Orbiter 3		X	●	●											
Lunar Orbiter 4		X	●	●											
Lunar Orbiter 5		X	●	●											
Apollo 8															
Apollo 10															
Apollo 11				X										●	●
Apollo 12				X		●								●	X
Apollo 13				□										□	
Apollo 14						●	●							●	●
Apollo 15	●		●		●	●	●	●	●	●				●	●
Apollo 16	●		●		●	●	●	X	●	●		●		●	
Apollo 17			●	X	●	●					●		X	●	

Mission	Magnetic Fields	Heat Flow	Traverse Gravimeter	Lunar Surface Gravimeter	Electrical Properties	Neutron Probe	Suprathermal Ions	Cold Cathode Ion Gage	Charged Particles	Atmospheric Composition	Solar Wind Experiments	Cosmic-Ray Experiments	Lunar Dust Detector	Particle Shadows/ Boundary Layer	Biaxial Fluxgate Magnetometer
Ranger 7															
Ranger 8															
Ranger 9															
Surveyor 1															
Surveyor 3															
Surveyor 5															
Surveyor 6															
Surveyor 7															
Lunar Orbiter 1															
Lunar Orbiter 2															
Lunar Orbiter 3															
Lunar Orbiter 4															
Lunar Orbiter 5															
Apollo 8															
Apollo 10															
Apollo 11											X		X		
Apollo 12	●						●	X			●		X		
Apollo 13		□						□	□				□		
Apollo 14	●						●	●	●		X		●		
Apollo 15	●	●					●	●			●		●	●	●
Apollo 16	●	◇								●		●		●	●
Apollo 17		●	●	◇	●	●						●			

*Mosaics also available.
†Included with Hasselblad data.
§Included with Maurer and Nikon data.

Appendixes

APPENDIX A

INDEX TO PLANETARY INVESTIGATIONS
WITH DATA AVAILABLE AT NSSDC

INVESTIGATION CATEGORY	ID	MISSION	BRIEF NAME	PRINCIPAL INVESTIGATOR	PAGE
		MERCURY			
Imaging	73-085A-01	Mariner 10	TV Photography	Murray	19
Particles and Fields	73-085A-03	Mariner 10	Scan. Elect. Analyzer	Bridge	19
	73-085A-07	Mariner 10	Energetic Particles	Simpson	20
	73-085A-04	Mariner 10	Flux. Magnetometer	Ness	19
Ultraviolet	73-085A-05	Mariner 10	EUV Spectrometer	Broadfoot	20
Infrared	73-085A-06	Mariner 10	IR Radiometer	Chase	20
Radio Science and Celestial Mechanics	73-085A-02	Mariner 10	Radio Science	Howard	20
		VENUS			
Imaging	73-085A-01	Mariner 10	TV Photography	Murray	29
	78-051A-06	Pioneer Venus 1-Orb.	Cloud Photopolarimeter	Hansen	30
	75-050D-01	Venera 9-Desc.	Pan. Telephotometer		30
	75-054D-01	Venera 10-Desc.	Pan. Telephotometer		30
	81-106D-01	Venera 13-Desc.	Pan. Telephotometer		30
	81-110D-01	Venera 14-Desc.	Pan. Telephotometer		30
Particles and Fields	62-041A-06	Mariner 2	Elect. Analyzer	Neugebauer	30
	73-085A-03	Mariner 10	Scan. Elect. Analyzer	Bridge	30
	78-051A-13	Pioneer Venus 1-Orb.	Electric Field Detector	Scarf	31
	62-041A-07	Mariner 2	Particle Detector	Van Allen	32
	73-085A-07	Mariner 10	Energetic Particle	Simpson	32
	78-078A-02	Pioneer Venus 2-Bus.	Ion Mass Spectrometer	Taylor, H. A.	32
	78-051A-17	Pioneer Venus 1-Orb.	Ion Mass Spectrometer	Taylor, H. A.	32
	78-051A-07	Pioneer Venus 1-Orb.	Ret. Pot. Analyzer	Knudsen	31
	78-051A-18	Pioneer Venus 1-Orb.	Solar Wind Plasma Analyzer	Wolfe	31
	62-041A-03	Mariner 2	3-axis Fluxgate Magnetometer	Coleman	31
	78-051A-12	Pioneer Venus 1-Orb.	3-axis Fluxgate Magnetometer	Russell	32
	73-085A-04	Mariner 10	Fluxgate Magnetometer	Ness	31
	67-060A-05	Mariner 5	Helium Magnetometer	Smith	32
	62-041A-04	Mariner 2	Cosmic Ray Ionization	Anderson	33
	78-051A-05	Pioneer Venus 1-Orb.	Gamma Ray Burst Detector	Evans	33
	78-051A-03	Pioneer Venus 1-Orb.	Gas and Plasma Environment	Croft	35
Ultraviolet	73-085A-05	Mariner 10	EUV Spectrometer	Broadfoot	33
	78-051A-15	Pioneer Venus 1-Orb.	UV Spectrometer	Stewart	33

INDEX TO PLANETARY INVESTIGATIONS
WITH DATA AVAILABLE AT NSSDC (continued)

INVESTIGATION CATEGORY	ID	MISSION	BRIEF NAME	PRINCIPAL INVESTIGATOR	PAGE
		VENUS (continued)			
Infrared	62-041A-02	Mariner 2	IR Radiometer	Neugebauer	33
	73-085A-06	Mariner 10	IR Radiometer	Chase	34
	78-051A-16	Pioneer Venus 1-Orb.	Temperature Sounder	Taylor	34
	78-078D-05	Pioneer Venus-Lge.	IR Radiometer	Boese	34
	78-078E-04	Pioneer Venus Sm. 1	IR Radiometer	Suomi	34
	78-078F-04	Pioneer Venus Sm. 2	IR Radiometer	Suomi	34
	78-078G-04	Pioneer Venus Sm. 3	IR Radiometer	Suomi	34
Radio Science and Celestial Mechanics	62-041A-08	Mariner 2	Celestial Mechanics	Anderson	35
	67-060A-07	Mariner 5	Celestial Mechanics	Anderson	35
	78-051A-21	Pioneer Venus 1-Orb.	Celestial Mechanics	Shapiro	35
	73-085A-02	Mariner 10	Radio Science	Howard	35
	67-060A-02	Mariner 5	2-Frequency Beacon	Croft	35
	78-051A-02	Pioneer Venus 1-Orb.	Radar Altimeter	Pettengill	36
	78-051A-20	Pioneer Venus 1-Orb.	Radio Occultation (OOCC)	Kliore	35
	78-051A-23	Pioneer Venus 1-Orb.	Internal Density Dist. (IDD)	Phillips	36
Atmosphere	78-078A-06	Pioneer Venus 2-Bus	Atm. Circ. Pat. (DLBI)	Counselman	37
	78-078D-09	Pioneer Venus Lge	Atm. Circ. Pat. (DLBI)	Counselman	39
	78-078E-03	Pioneer Venus Sm. 1	Atm. Circ. Pat. (DLBI)	Counselman	39
	78-078F-03	Pioneer Venus-Sm. 2	Atm. Circ. Pat. (DLBI)	Counselman	39
	78-078G-03	Pioneer Venus-Sm. 3	Atm. Circ. Pat. (DLBI)	Counselman	39
	78-051A-01	Pioneer Venus 1-Orb.	Electron Temperature Probe	Brace	36
	78-051A-11	Pioneer Venus 1-Orb.	Neut. Part. Mass Spectrometer	Niemann	36
	78-078A-03	Pioneer Venus 2-Bus	Neut. Part. Mass Spectrometer	Von Zahn	36
	78-078D-06	Pioneer Venus-Lge.	Neut. Part. Mass Spectrometer	Hoffman	36
	78-051A-19	Pioneer Venus 1-Orb.	Atmospheric Drag (OAD)	Keating	36
	78-051A-22	Pioneer Venus 1-Orb.	Atm. Sol. Cor. Turb. (OTUR)	Woo	37
	78-078D-02	Pioneer Venus-Lge.	Cloud Extent. Structure	Ragent	37
	78-078E-02	Pioneer Venus-Sm. 1	Cloud Extent. Structure	Ragent	37
	78-078F-02	Pioneer Venus-Sm. 2	Cloud Extent. Structure	Ragent	37
	78-078G-02	Pioneer Venus-Sm. 3	Cloud Extent. Structure	Ragent	38

INDEX TO PLANETARY INVESTIGATIONS
WITH DATA AVAILABLE AT NSSDC (continued)

INVESTIGATION CATEGORY	ID	MISSION	BRIEF NAME	PRINCIPAL INVESTIGATOR	PAGE
		VENUS (continued)			
Atmosphere (continued)	78-078D-01	Pioneer Venus-Lge.	Atm. Structure	Seiff	38
	78-078E-01	Pioneer Venus-Sm. 1	Atm. Structure	Seiff	38
	78-078F-01	Pioneer Venus-Sm. 2	Atm. Structure	Seiff	38
	78-078G-01	Pioneer Venus-Sm. 3	Atm. Structure	Seiff	38
	78-078D-04	Pioneer Venus-Lge.	Gas Chromatog.	Oyama	40
	78-078E-04	Pioneer Venus-Sm. 1	Gas Chromatog.	Suomi	34
	78-078F-04	Pioneer Venus-Sm. 2	Gas Chromatog.	Suomi	34
	78-078G-04	Pioneer Venus-Sm. 3	Gas Chromatog.	Suomi	34
	78-078D-03	Pioneer Venus-Lge.	Cloud Part. Size Spectrometer	Knollenberg	40
	78-078D-07	Pioneer Venus-Lge.	Solar Energy Penetration	Tomasko	40
	78-078D-11	Pioneer Venus-Lge.	Atm. Propagation	Croft	38
		MARS			
Imaging	64-077A-01	Mariner 4	Television	Leighton	48
	69-014A-01	Mariner 6	Mars Surface TV Camera	Leighton	48
	69-030A-01	Mariner 7	Mars Surface TV Camera	Leighton	49
	71-051A-04	Mariner 9	Television Photography	Masursky	49
	75-075A-01	Viking 1-Orb.	Imagery	Carr	49
	75-083A-01	Viking 2-Orb.	Imagery	Carr	49
	75-075C-06	Viking 1-Land.	Lander Imaging	Mutch	50
	75-083C-06	Viking 2-Land.	Lander Imaging	Mutch	50
Particles and Fields	64-077A-02	Mariner 4	Magnetometer	Smith	50
Ultraviolet	69-014A-04	Mariner 6	UV Spectrometer	Barth	50
	69-030A-04	Mariner 7	UV Spectrometer	Barth	51
	71-051A-02	Mariner 9	UV Spectrometer	Barth	51

INDEX TO PLANETARY INVESTIGATIONS
WITH DATA AVAILABLE AT NSSDC (continued)

INVESTIGATION CATEGORY	ID	MISSION	BRIEF NAME	PRINCIPAL INVESTIGATOR	PAGE
		MARS (continued)			
Infrared	69-014A-02	Mariner 6	Spect. 1.5-15 Microm.	Pimentel	52
	69-030A-02	Mariner 7	Spect. 1.5-15 Microm.	Pimentel	52
	69-014A-03	Mariner 6	Chan. IR Radiometer	Neugebauer	52
	69-030A-03	Mariner 7	Chan. IR Radiometer	Neugebauer	53
	71-051A-01	Mariner 9	IR Radiometer	Neugebauer	53
	75-075A-02	Viking 1-Orb.	IR Radiometer	Kieffer	53
	75-083A-02	Viking 2-Orb.	IR Radiometer	Kieffer	53
	71-051A-03	Mariner 9	IR Interference Spectrometer	Hanel	52
Radio Science and Celestial Mechanics	64-077A-09	Mariner 4	Celestial Mechanics	Anderson	54
	69-014A-05	Mariner 6	Celestial Mechanics	Anderson	54
	69-030A-05	Mariner 7	Celestial Mechanics	Anderson	54
	69-014A-06	Mariner 6	S-Band Occult.	Kliore	54
	69-030A-06	Mariner 7	S-Band Occult.	Kliore	54
	71-051A-08	Mariner 9	S-Band Occult.	Kliore	54
	75-075A-04	Viking 1-Orb.	Radio Science	Michael	54
	75-083A-04	Viking 2-Orb.	Radio Science	Michael	55
	75-075C-11	Viking 1-Land.	Radio Science	Michael	55
	75-083C-11	Viking 2-Land.	Radio Science	Michael	55
Atmosphere	75-075A-03	Viking 1-Orb.	Spectrometer	Farmer	55
	75-083A-03	Viking 2-Orb	Spectrometer	Farmer	56
	75-075C-02	Viking 1-Land.	Atm. Structure	Nier	56
	75-083C-02	Viking 2-Land.	Atm. Structure	Nier	56
	75-075C-12	Viking 1-Land.	Atm. Comp.	Nier	56
	75-083C-12	Viking 2-Land.	Atm. Comp.	Nier	56
	75-075C-14	Viking 1-Land.	Ionospher. Prop.	Nier	56
	75-083C-14	Viking 2-Land.	Ionospher. Prop.	Nier	56
	75-075C-07	Viking 1-Land.	Meteorology	Hess	57
	75-083C-07	Viking 2-Land.	Meteorology	Hess	57
Surface Chemistry	75-083C-01	Viking 2-Land.	Physical Prop.	Shorthill	57
	75-075C-10	Viking 1-Land.	Magnet. Prop.	Hargraves	58
	75-083C-10	Viking 2-Land.	Magnet. Prop.	Hargraves	58
	75-075C-04	Viking 1-Land.	Molecular Anal.	Biemann	57
	75-083C-04	Viking 2-Land.	Molecular Anal.	Biemann	57
	75-075C-13	Viking 1-Land.	Inorgan. Chemistry	Toulmin	57
	75-083C-13	Viking 2-Land.	Inorgan. Chemistry	Toulmin	58
Biology	75-075C-03	Viking 1-Land.	Biology	Klein	58
	75-083C-03	Viking 2-Land.	Biology	Klein	58
	75-075C-04	Viking 1-Land.	Molecular Anal.	Biemann	59
	75-083C-04	Viking 2-Land.	Molecular Anal.	Biemann	59
Seismology	75-083C-08	Viking 2-Land.	Seismology	Anderson	59
		JUPITER			
Imaging	72-012A-07	Pioneer 10	Image Photopolarimeter	Gehrels	68
	73-019A-07	Pioneer 11	Image Photopolarimeter	Gehrels	68
	77-084A-01	Voyager 1	Imaging	Smith, B. A.	68
	77-076A-01	Voyager 2	Imaging	Smith, B. A.	69

INDEX TO PLANETARY INVESTIGATIONS
WITH DATA AVAILABLE AT NSSDC (continued)

INVESTIGATION CATEGORY	ID	MISSION	BRIEF NAME	PRINCIPAL INVESTIGATOR	PAGE
		JUPITER (continued)			
Particles and Fields	72-012A-01	Pioneer 10	3-axis Helium Mag.	Smith, E. J.	71
	73-019A-01	Pioneer 11	3-axis Helium Mag.	Smith, E. J.	71
	73-019A-14	Pioneer 11	Fluxgate Magnetometer	Acuna	71
	77-084A-05	Voyager 1	Fluxgate Magnetometer	Ness	71
	77-076A-05	Voyager 2	Fluxgate Magnetometer	Ness	71
	77-084A-06	Voyager 1	Faraday Cup	Bridge	70
	77-076A-06	Voyager 2	Faraday Cup	Bridge	70
	77-084A-13	Voyager 1	Plasma Wave	Scarf	70
	77-076A-13	Voyager 2	Plasma Wave	Scarf	70
	72-012A-05	Pioneer 10	Trapped Particles	Fillius	72
	73-019A-05	Pioneer 11	Trapped Particles	Fillius	72
	72-012A-02	Pioneer 10	Charged Particles	Simpson	71
	73-019A-02	Pioneer 11	Charged Particles	Simpson	72
	72-012A-11	Pioneer 10	Charged Particles	Van Allen	72
	73-019A-11	Pioneer 11	Charged Particles	Van Allen	72
	72-012A-12	Pioneer 10	Charged Particles	McDonald	73
	73-019A-12	Pioneer 11	Charged Particles	McDonald	73
	72-012A-13	Pioneer 10	Quadrasphere Anal.	Wolfe	69
	73-019A-13	Pioneer 11	Quadrasphere Anal.	Wolfe	69
	77-084A-07	Voyager 1	Particle Anal. Telescope	Krimigis	70
	77-076A-07	Voyager 2	Particle Anal. Telescope	Krimigis	70
	77-084A-08	Voyager 1	Cosmic Ray Telescope	Vogt	73
	77-076A-08	Voyager 2	Cosmic Ray Telescope	Vogt	73
Ultraviolet	72-012A-06	Pioneer 10	UV Photometer 200-800A	Judge	74
	73-019A-06	Pioneer 11	UV Photometer 200-800A	Judge	74
	77-084A-04	Voyager 1	UV Spectrometer	Broadfoot	74
	77-076A-04	Voyager 2	UV Spectrometer	Broadfoot	74
Infrared	77-084A-03	Voyager 1	IR Interferometer	Hanel	74
	77-076A-03	Voyager 2	IR Interferometer	Hanel	74
Radio Science and Celestial Mechanics	72-012A-09	Pioneer 10	Celestial Mechanics	Anderson	75
	73-019A-09	Pioneer 11	Celestial Mechanics	Anderson	75
	72-012A-10	Pioneer 10	S-Band Occultation	Kliore	75
	73-019A-10	Pioneer 11	S-Band Occultation	Kliore	75
	77-084A-02	Voyager 1	Coher. S- + X-Band	Eshleman	75
	77-076A-02	Voyager 2	Coher. S- + X-Band	Eshleman	75
	77-084A-10	Voyager 1	LF, RF Receiver	Warwick	76
	77-076A-10	Voyager 2	LF, RF Receiver	Warwick	76
Atmosphere	72-012A-10	Pioneer 10	S-Band Occultation	Kliore	75
	73-019A-10	Pioneer 11	S-Band Occultation	Kliore	75
	72-012A-07	Pioneer 10	Imag. Photopolarimeter	Gehrels	68
	73-019A-07	Pioneer 11	Imag. Photopolarimeter	Gehrels	68
	77-076A-11	Voyager 2	Photopolarimeter	Lane	76
Polarization	72-012A-07	Pioneer 10	Imag. Photopolarimeter	Gehrels	68
	73-019A-07	Pioneer 11	Imag. Photopolarimeter	Gehrels	68
	77-076A-11	Voyager 2	Photopolarimeter	Lane	76
		SATURN			
Imaging	73-019A-07	Pioneer 11	Imag. Photopolarimeter	Gehrels	83
	77-084A-01	Voyager 1	Imaging	Smith, B. A.	84
	77-076A-01	Voyager 2	Imaging	Smith, B. A.	84

INDEX TO PLANETARY INVESTIGATIONS
WITH DATA AVAILABLE AT NSSDC (concluded)

INVESTIGATION CATEGORY	ID	MISSION	BRIEF NAME	PRINCIPAL INVESTIGATOR	PAGE
		SATURN (concluded)			
Particles and Fields	73-019A-02	Pioneer 11	Charged Particles	Simpson	72
	73-019A-12	Pioneer 11	Charged Particles	McDonald	85
	73-019A-05	Pioneer 11	Trapped Particles	Fillius	85
	73-019A-13	Pioneer 11	Quadrasphere Anal.	Wolfe	84
	73-019A-14	Pioneer 11	Fluxgate Magnetometer	Acuna	85
	73-019A-11	**Pioneer 11**	**Charged Particles**	**Van Allen**	**72**
Radio Science and Celestial Mechanics	73-019A-09	Pioneer 11	Celestial Mechanics	Anderson	85
Atmosphere	73-019A-07	Pioneer 11	Image Photopolarimeter	Gehrels	83

APPENDIX B

INDEX TO INTERPLANETARY INVESTIGATIONS (FROM PLANETARY MISSIONS)
WITH DATA AVAILABLE AT NSSDC

INVESTIGATION CATEGORY	ID	MISSION	BRIEF NAME	PRINCIPAL INVESTIGATOR	PAGE
Particles and Fields	64-077A-04	Mariner 4	Cosmic Ray Telescope	Simpson	94
	67-060A-03	Mariner 5	Faraday Cup	Bridge	94
	77-084A-08	Voyager 1	Cosmic Ray Telescope	Vogt	95
	77-076A-08	Voyager 2	Cosmic Ray Telescope	Vogt	95
Ultraviolet					
	72-012A-06	Pioneer 10	UV Photometer	Judge	95
	73-019A-06	Pioneer 11	UV Photometer	Judge	95
Interplanetary Particles					
	72-012A-03	Pioneer 10	Asteroid/Meteoroid Ast.	Soberman	95
	73-019A-03	Pioneer 11	Asteroid/Meteoroid Ast.	Soberman	95
	72-012A-04	Pioneer 10	Meteoroid Detector	Kinard	96
	73-019A-04	Pioneer 11	Meteoroid Detector	Kinard	96
	72-012A-14	Pioneer 10	Zodiacal Light Photometer	Weinberg	96
	73-019A-15	Pioneer 11	Zodiacal Light Photometer	Weinberg	96

APPENDIX C

INDEX TO INTERPLANETARY MISSIONS
WITH DATA AVAILABLE AT NSSDC

INVESTIGATION CATEGORY	ID	MISSION	BRIEF NAME	PRINCIPAL INVESTIGATOR	PAGE
Particles and Fields	65-105A-02	Pioneer 6	Faraday Cup	Bridge	107
	66-075A-02	Pioneer 7	Faraday Cup	Bridge	107
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	66-075A-08	Pioneer 7	Superior Conj. Faraday Rot.	Levy	107
	68-100A-02	Pioneer 9	Solar Plasma Detector	Wolfe	107
	74-097A-09	Helios-A	Plasma Detector	Rosenbauer	107
	76-003A-09	Helios-B	Plasma Detector	Rosenbauer	108
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	76-003A-10	Helios-B	Energetic Elect., Proton Det.	Keppler	110
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	66-075A-01	Pioneer 7	Uniaxial Magnetometer	Ness	110
	67-123A-01	Pioneer 8	Uniaxial Magnetometer	Ness	110
	68-100A-01	Pioneer 9	Triaxial Magnetometer	Sonnett	110
	74-097A-02	Helios-A	Triaxial Fluxgate Magnetometer	Ness	110
	76-003A-02	Helios-B	Triaxial Fluxgate Magnetometer	Ness	111
	74-097A-01	Helios-A	Triaxial Fluxgate Magnetometer	Neubauer	111
	76-003A-01	Helios-B	Triaxial Fluxgate Magnetometer	Neubauer	111
	60-001A-02	Pioneer 5	Search Coil Magnetometer	Greenstadt	111
	74-097A-03	Helios-A	Search Coil Magnetometer	Neubauer	111
	76-003A-03	Helios-B	Search Coil Magnetometer	Neubauer	111
	60-001A-03	Pioneer 5	Ion Chamber and GM Tube	Winckler	112
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	65-105A-03	Pioneer 6	Cosmic Ray Telescope	Simpson	112
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	67-123A-06	Pioneer 8	Cosmic Ray Telescope	Webber	112
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	66-075A-05	Pioneer 8	Cosmic Ray Anisot.	McCracken	113
	68-100A-05	Pioneer 9	Cosmic Ray Anisot.	McCracken	113
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	68-100A-06	Pioneer 9	Cosmic Ray Grad. Det.	Webber	113
	65-105A-05	Pioneer 6	Cosmic Ray Detector	McCracken	112
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	76-003A-07	Helios-B	Cosmic Ray Particles	Kunow	114
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	66-075A-04	Pioneer 7	2-Frequency Beacon Receiver	Eshleman	115
	67-123A-03	Pioneer 8	2-Frequency Beacon Receiver	Eshleman	115
	68-100A-03	Pioneer 9	2-Frequency Beacon Receiver	Eshleman	115
	74-097A-05	Helios-A	Fine-Wave Spectrometer	Gurnett	115
	76-003A-05	Helios-B	Fine-Wave Spectrometer	Gurnett	115
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	76-003A-06	Helios-B	27 KHz - 3 MHz Radio Wave	Gurnett	116
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	76-003A-11	Helios-B	Zodiacal Light Photometer	Leinert	116

APPENDIX D - DEFINITIONS

Investigation Discipline - The subject to which an investigation pertains. The possible entries are limited, and the NSSDC information files can be searched using this field.

Investigative Program - Code of the cognizant NASA Headquarters office, or name of other sponsoring agency program. "CO-OP" added to a code indicates a cooperative effort with another agency or foreign country.

NLA - No Longer Affiliated. Used in the spacecraft personnel section and occasionally with investigations to indicate that the person had the specified affiliation at the time of his participation in the project, but is no longer there.

NSSDC ID - An identification code used in the NSSDC information system. In this system, each successfully launched spacecraft and experiment is assigned a code based on the launch sequence of the spacecraft. Subsequent to 1962, this code (e.g., 72-012A for the spacecraft Pioneer 10) corresponds to the COSPAR international designation. The experiment codes are based on the spacecraft code. For example, the experiments carried aboard the spacecraft 73-019A (Pioneer 11) are numbered 73-019A-01, 73-019A-02, etc. Each prelaunch spacecraft and experiment is also assigned an NSSDC ID code based on the name of the spacecraft. Prior to launch, for example, the approved NASA launch, Solar Mesosphere Explorer, was coded SME. The experiments to be carried aboard this spacecraft were coded SME -01, SME -02, etc. Once a spacecraft is launched, its prelaunch designation is changed to a postlaunch one; e.g., Pioneer-G, which was launched April 6, 1973, was given the NSSDC ID code of 73-019A, and the NSSDC spacecraft common name of Pioneer 11.

OI - Other Investigator.

PI - Principal Investigator.

PM - Project Manager.

PS - Project Scientist.

TL - Team Leader.

TM - Team Member.

TRF - Technical Reference File. A computerized space-investigation-oriented bibliographic reference list maintained by NSSDC. Journal publications and other documents are cited, and can be retrieved by author name, title, or NSSDC ID of relevant investigation. Used to keep track of descriptive and documentation material, as well as to produce bibliographies of certain spacecraft. The TRF accession number begins with the letter B and contains five digits; for example, B10851.

APPENDIX E
INDEX OF SPACECRAFT AND INVESTIGATIONS
BY SPACECRAFT NAME AND PRINCIPAL INVESTIGATOR

SPACECRAFT NAME / PRINC.INVEST.NAME	COUNTRY AND AGENCY / INVESTIGATION NAME	LAUNCH DATE	ORBIT TYPE	NSSDC ID	PAGE NO.
1960 ALPHA 1	SEE PIONEER 5				
1962 ALPHA RHO 1	SEE MARINER 2				
HELIOS 1	SEE HELIOS-A				
HELIOS 2	SEE HELIOS-B				
HELIOS-A	FED REP OF GERMANY / BMWF UNITED STATES / NASA-OSSA	12/10/74	HELIOCENTRIC	74-097A	106
FECHTIG	MICROMETEOROID DETECTOR AND ANALYZER			74-097A-12	116
GURNETT	SOLAR WIND PLASMA WAVE			74-097A-04	108
GURNETT	FINE FREQUENCY, COARSE TIME RESOLUTION SPECTRUM ANALYSIS			74-097A-05	115
GURNETT	26.5-KHZ TO 3-MHZ RADIO WAVE			74-097A-06	116
KEPPLER	ENERGETIC ELECTRON AND PROTON DETECTOR			74-097A-10	110
KUNOW	COSMIC-RAY PARTICLES			74-097A-07	114
LEINERT	ZODIACAL LIGHT PHOTOMETER			74-097A-11	116
NESS	FLUXGATE MAGNETOMETER FOR AVERAGE FIELDS			74-097A-02	110
NEUBAUER	FLUXGATE MAGNETOMETER FOR FIELD FLUCTUATIONS			74-097A-01	111
NEUBAUER	SEARCH COIL MAGNETOMETER			74-097A-03	111
ROSENBAUER	PLASMA DETECTORS			74-097A-09	107
TRAINOR	GALACTIC AND SOLAR COSMIC RAYS			74-097A-08	113
HELIOS-B	FED REP OF GERMANY / BMWF UNITED STATES / NASA-OSSA	01/15/76	HELIOCENTRIC	76-003A	106
GURNETT	SOLAR WIND PLASMA WAVE			76-003A-04	108
GURNETT	FINE FREQUENCY, COARSE TIME RESOLUTION SPECTRUM ANALYSIS			76-003A-05	115
GURNETT	50-KHZ TO 2-MHZ RADIO WAVE			76-003A-06	116
KEPPLER	ENERGETIC ELECTRON AND PROTON DETECTOR			76-003A-10	110
KUNOW	COSMIC-RAY PARTICLES			76-003A-07	114
LEINERT	ZODIACAL LIGHT PHOTOMETER			76-003A-11	116
NESS	FLUXGATE MAGNETOMETER FOR AVERAGE FIELDS			76-003A-02	111
NEUBAUER	FLUXGATE MAGNETOMETER FOR FIELD FLUCTUATIONS			76-003A-01	111
NEUBAUER	SEARCH COIL MAGNETOMETER			76-003A-03	111
ROSENBAUER	PLASMA DETECTORS			76-003A-09	108
TRAINOR	GALACTIC AND SOLAR COSMIC RAYS			76-003A-08	114
MARINER 2	UNITED STATES / NASA-OSSA	08/27/62	VENUS FLYBY	62-041A	27
ANDERSON	COSMIC-RAY IONIZATION			62-041A-04	33
ANDERSON	CELESTIAL MECHANICS			62-041A-08	35
COLEMAN, JR.	FLUXGATE MAGNETOMETER			62-041A-03	31
NEUGEBAUER	INFRARED RADIOMETER			62-041A-02	33

SPACECRAFT NAME / PRINC.INVEST.NAME	COUNTRY AND AGENCY / INVESTIGATION NAME	LAUNCH DATE	ORBIT TYPE	NSSDC ID	PAGE NO.
NEUGEBAUER	SOLAR PLASMA ANALYZER			62-041A-06	30
VAN ALLEN	PARTICLE DETECTOR			62-041A-07	32
MARINER 4	UNITED STATES	NASA-OSSA 11/28/64	MARS FLYBY	64-077A	47
ANDERSON	CELESTIAL MECHANICS			64-077A-09	54
LEIGHTON	MARS TV CAMERA			64-077A-01	48
SIMPSON	COSMIC-RAY TELESCOPE			64-077A-04	94
SMITH	HELIUM MAGNETOMETER			64-077A-02	50
MARINER 5	UNITED STATES	NASA-OSSA 06/14/67		67-060A	27
ANDERSON	CELESTIAL MECHANICS			67-060A-07	35
BRIDGE	INTERPLANETARY ION PLASMA PROBE FOR E/Q OF 40 TO 9400 VOLTS			67-060A-03	31
ESHLEMAN	TWO-FREQUENCY BEACON RECEIVER			67-060A-02	35
SMITH	TRIAXIAL LOW FIELD HELIUM MAGNETOMETER			67-060A-05	32
MARINER 6	UNITED STATES	NASA-OSSA 02/24/69	MARS FLYBY	69-014A	47
ANDERSON	CELESTIAL MECHANICS			69-014A-05	54
BARTH	UV SPECTROMETER			69-014A-04	50
KLIORE	S-BAND OCCULTATION			69-014A-06	54
LEIGHTON	MARS TV CAMERA			69-014A-01	48
NEUGEBAUER	TWO-CHANNEL IR RADIOMETER MARS SURFACE TEMPERATURE			69-014A-03	52
PIMENTEL	IR SPECTROMETER			69-014A-02	52
MARINER 7	UNITED STATES	NASA-OSSA 03/27/69	MARS FLYBY	69-030A	47
ANDERSON	CELESTIAL MECHANICS			69-030A-05	54
BARTH	UV SPECTROMETER			69-030A-04	51
KLIORE	S-BAND OCCULTATION			69-030A-06	54
LEIGHTON	MARS TV CAMERA			69-030A-01	49
NEUGEBAUER	TWO-CHANNEL IR RADIOMETER MARS SURFACE TEMPERATURE			69-030A-03	53
PIMENTEL	IR SPECTROMETER			69-030A-02	52
MARINER 9	UNITED STATES	NASA-OSSA 05/30/71	AREOCENTRIC	71-051A	47
BARTH	ULTRAVIOLET SPECTROMETER (UVS)			71-051A-02	51
HANEL	INFRARED INTERFEROMETER SPECTROMETER (IRIS)			71-051A-03	52
KLIORE	S-BAND OCCULTATION			71-051A-08	54
MASURSKY	TELEVISION PHOTOGRAPHY			71-051A-04	49
NEUGEBAUER	INFRARED RADIOMETER (IRR)			71-051A-01	53
MARINER 10	UNITED STATES	NASA-OSSA 11/03/73	MERCURY FLYBY	73-085A	19
BRIDGE	MEASUREMENT OF PLASMA ENVIRONMENT			73-085A-03	19
BROADFOOT	EUV SPECTROSCOPY			73-085A-05	20
CHASE, JR.	TWO-CHANNEL IR RADIOMETER			73-085A-06	20
HOWARD	S- AND X-BAND RADIO PROPAGATION			73-085A-02	20
MURRAY	TELEVISION PHOTOGRAPHY			73-085A-01	19
NESS	FLUXGATE MAGNETOMETERS			73-085A-04	19
SIMPSON	ENERGETIC PARTICLES			73-085A-07	20
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MARINER 77A	SEE VOYAGER 1				
MARINER 77B	SEE VOYAGER 2				

SPACECRAFT NAME / PRINC.INVEST.NAME	COUNTRY AND AGENCY / INVESTIGATION NAME	LAUNCH DATE	ORBIT TYPE	NSSDC ID	PAGE NO.
MARINER JUPITER/SATURN A	SEE VOYAGER 1				
MARINER JUPITER/SATURN B	SEE VOYAGER 2				
MARINER MARS 69A	SEE MARINER 6				
MARINER MARS 69B	SEE MARINER 7				
MARINER MARS 71	SEE MARINER 9				
MARINER R-2	SEE MARINER 2				
MARINER VENUS 67	SEE MARINER 5				
MARINER VENUS/MERCURY 73	SEE MARINER 10				
MARINER-I	SEE MARINER 9				
MARINER-J VENUS/MERCURY	SEE MARINER 10				
MJS 77A	SEE VOYAGER 1				
MJS 77B	SEE VOYAGER 2				
OUTER PLANETS A	SEE VOYAGER 1				
OUTER PLANETS B	SEE VOYAGER 2				
P 38	SEE MARINER 2				
PIONEER 5	UNITED STATES UNITED STATES	NASA-OSSA 03/11/60 DOD-USAF	HELIOCENTRIC	60-001A	105
GREENSTADT	SEARCH-COIL MAGNETOMETER			60-001A-02	111
SIMPSON	PROPORTIONAL COUNTER TELESCOPE			60-001A-01	112
WINCKLER	ION CHAMBER AND GM TUBE			60-001A-03	112
PIONEER 6	UNITED STATES	NASA-OSSA 12/16/65	HELIOCENTRIC	65-105A	105
ANDERSON	CELESTIAL MECHANICS			65-105A-07	114
BRIDGE	SOLAR WIND PLASMA FARADAY CUP			65-105A-02	107
ESHLEMAN	TWO-FREQUENCY BEACON RECEIVER			65-105A-04	114
LEVY	SUPERIOR CONJUNCTION FARADAY ROTATION			65-105A-08	107
MCCRACKEN	COSMIC-RAY ANISOTROPY			65-105A-05	112
NESS	UNIAXIAL FLUXGATE MAGNETOMETER			65-105A-01	110
SIMPSON	COSMIC-RAY TELESCOPE			65-105A-03	112
WOLFE	ELECTROSTATIC ANALYZER			65-105A-06	109
PIONEER 7	UNITED STATES	NASA-OSSA 08/17/66	HELIOCENTRIC	66-075A	105
BRIDGE	SOLAR WIND PLASMA FARADAY CUP			66-075A-02	107
ESHLEMAN	TWO-FREQUENCY BEACON RECEIVER			66-075A-04	115
LEVY	SUPERIOR CONJUNCTION FARADAY ROTATION			66-075A-08	107
MCCRACKEN	COSMIC-RAY ANISOTROPY			66-075A-05	113
NESS	SINGLE-AXIS MAGNETOMETER			66-075A-01	110
SIMPSON	COSMIC-RAY TELESCOPE			66-075A-06	112
WOLFE	ELECTROSTATIC ANALYZER			66-075A-03	109
PIONEER 8	UNITED STATES	NASA-OSSA 12/13/67	HELIOCENTRIC	67-123A	105
ESHLEMAN	TWO-FREQUENCY BEACON RECEIVER			67-123A-03	115
NESS	SINGLE-AXIS MAGNETOMETER			67-123A-01	110

SPACECRAFT NAME / PRINC.INVEST.NAME	COUNTRY AND AGENCY / INVESTIGATION NAME	LAUNCH DATE	ORBIT TYPE	NSSDC ID	PAGE NO.
SCARF	PLASMA WAVE DETECTOR			67-123A-07	108
WEBBER	COSMIC-RAY GRADIENT DETECTOR			67-123A-06	112
WOLFE	ELECTROSTATIC ANALYZER			67-123A-02	109
PIONEER 9	UNITED STATES / NASA-OSSA	11/08/68	HELIOCENTRIC	68-100A	106
ESHLEMAN	TWO-FREQUENCY BEACON RECEIVER			68-100A-03	115
MCCRACKEN	COSMIC-RAY ANISOTROPY			68-100A-05	113
SCARF	ELECTRIC FIELD DETECTOR			68-100A-07	109
SONETT	TRIAXIAL MAGNETOMETER			68-100A-01	110
WEBBER	COSMIC-RAY GRADIENT			68-100A-06	113
WOLFE	SOLAR PLASMA DETECTOR			68-100A-02	107
PIONEER 10	UNITED STATES / NASA-OSSA	03/03/72	JUPITER FLYBY	72-012A	67
ANDERSON	CELESTIAL MECHANICS			72-012A-09	75
BARNES	QUADRISPHERICAL PLASMA ANALYZER			72-012A-13	69
FILLIUS	JOVIAN TRAPPED RADIATION			72-012A-05	72
GEHRELS	IMAGING PHOTOPOLARIMETER (IPP)			72-012A-07	68
JUDGE	ULTRAVIOLET PHOTOMETRY			72-012A-06	73
KINARD	METEOROID DETECTORS			72-012A-04	96
KLIORE	S-BAND OCCULTATION			72-012A-10	75
MCDONALD	COSMIC-RAY SPECTRA			72-012A-12	73
SIMPSON	CHARGED PARTICLE COMPOSITION			72-012A-02	71
SMITH	MAGNETIC FIELDS			72-012A-01	71
SOBERMAN	ASTEROID/METEOROID ASTRONOMY			72-012A-03	95
VAN ALLEN	JOVIAN CHARGED PARTICLES			72-012A-11	72
WEINBERG	ZODIACAL-LIGHT TWO-COLOR PHOTOPOLARIMETRY			72-012A-14	96
PIONEER 11	UNITED STATES / NASA-OSSA	04/06/73	SATURN FLYBY	73-019A	67
ACUNA	JOVIAN MAGNETIC FIELD			73-019A-14	71
ANDERSON	CELESTIAL MECHANICS			73-019A-09	75
BARNES	QUADRISPHERICAL PLASMA ANALYZER			73-019A-13	69
FILLIUS	JOVIAN TRAPPED RADIATION			73-019A-05	72
GEHRELS	IMAGING PHOTOPOLARIMETER (IPP)			73-019A-07	68
JUDGE	ULTRAVIOLET PHOTOMETRY			73-019A-06	74
KINARD	METEOROID DETECTORS			73-019A-04	96
KLIORE	S-BAND OCCULTATION			73-019A-10	75
MCDONALD	COSMIC-RAY SPECTRA			73-019A-12	73
SIMPSON	CHARGED PARTICLE COMPOSITION			73-019A-02	72
SMITH	MAGNETIC FIELDS			73-019A-01	71
SOBERMAN	ASTEROID/METEOROID ASTRONOMY			73-019A-03	95
VAN ALLEN	JOVIAN CHARGED PARTICLES			73-019A-11	72
WEINBERG	ZODIACAL-LIGHT TWO-COLOR PHOTOPOLARIMETRY			73-019A-15	96
PIONEER VENUS 1	UNITED STATES / NASA-OSSA	05/20/78	VENUS ORBITER	78-051A	27
BARNES	SOLAR WIND PLASMA ANALYZER (OPA)			78-051A-18	31
BRACE	ELECTRON TEMPERATURE PROBE (OETP)			78-051A-01	36
CROFT	GAS-PLASMA ENVIRONMENT-DUAL FREQUENCY EXPERIMENT (OGPE)			78-051A-03	35
EVANS	GAMMA BURST DETECTOR (OGBD)			78-051A-05	33
KEATING	ATMOSPHERIC DRAG (OAD)			78-051A-19	36
KLIORE	RADIO OCCULTATION (ORO)			78-051A-20	35
KNUDSEN	RETARDING POTENTIAL ANALYZER (ORPA)			78-051A-07	31
NIEMANN	NEUTRAL MASS SPECTROMETER (ONMS)			78-051A-11	36
PETTENGILL	RADAR MAPPER (ORAD)			78-051A-02	35
PHILLIPS	INTERNAL DENSITY DISTRIBUTION (OIDD)			78-051A-23	36
RUSSELL	MAGNETOMETER (OMAG)			78-051A-12	32

SPACECRAFT NAME / PRINC.INVEST.NAME	COUNTRY AND AGENCY / INVESTIGATION NAME	LAUNCH DATE	ORBIT TYPE	NSSDC ID	PAGE NO.
SCARF	ELECTRIC FIELD DETECTOR (OEFD)			78-051A-13	31
SHAPIRO	CELESTIAL MECHANICS (OCM)			78-051A-21	35
STEWART	PROGRAMMABLE ULTRAVIOLET SPECTROMETER (OUVS)			78-051A-15	33
TAYLOR	INFRARED RADIOMETER (OIR)			78-051A-16	34
TAYLOR, JR.	ION MASS SPECTROMETER 1-60AMU (OIMS)			78-051A-17	32
TRAVIS	CLOUD PHOTOPOLARIMETER			78-051A-06	30
WOO	ATMOSPHERIC AND SOLAR CORONA TURBULENCE (OTUR)			78-051A-22	37
PIONEER VENUS 1978	SEE PIONEER VENUS 2				
PIONEER VENUS 1978	SEE PIONEER VENUS PROBE LRG				
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PIONEER VENUS 1978	SEE PIONEER VENUS PROBE SM2				
PIONEER VENUS 1978	SEE PIONEER VENUS PROBE SM3				
PIONEER VENUS 1978 ORBIT	SEE PIONEER VENUS 1				
PIONEER VENUS 2	UNITED STATES	NASA-OSSA 08/08/78	VENUS PROBE	78-078A	27
TAYLOR, JR.	ION MASS SPECTROMETER (BIMS)			78-078A-02	32
VON ZAHN	NEUTRAL MASS SPECTROMETER (BNMS)			78-078A-03	36
PIONEER VENUS ORBITER	SEE PIONEER VENUS 1				
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BOESE	INFRARED RADIOMETER (LIR)			78-078D-05	34
COUNSELMAN	DIFFERENTIAL LONG BASELINE INTERFEROMETER (DLBI)			78-078D-09	39
CROFT	ATMOSPHERIC PROPAGATION (MPRO)			78-078D-11	38
HOFFMAN	NEUTRAL PARTICLE MASS SPECTROMETER (LNMS)			78-078D-06	36
KNOLLENBERG	CLOUD PARTICLE SIZE SPECTROMETER (LCPS)			78-078D-03	40
OYAMA	GAS CHROMATOGRAPH (LGC)			78-078D-04	40
RAGENT	NEPHELOMETER (LN)			78-078D-02	37
SEIFF	ATMOSPHERIC STRUCTURE (LAS)			78-078D-01	38
TOMASKO	SOLAR FLUX RADIOMETER (LSFR)			78-078D-07	40
PIONEER VENUS PROBE SM1	UNITED STATES	NASA-OSSA 08/08/78	VENUS PROBE	78-078E	28
COUNSELMAN	DIFFERENTIAL LONG BASELINE INTERFEROMETER (DLBI)			78-078E-03	39
CROFT	ATMOSPHERIC PROPAGATION (MPRO)			78-078E-07	39
RAGENT	NEPHELOMETER (SN)			78-078E-02	37
SEIFF	ATMOSPHERE STRUCTURE (SAS)			78-078E-01	38
SUOMI	NET FLUX RADIOMETER (SNFR)			78-078E-04	34
WOO	ATMOSPHERIC TURBULENCE (MTUR)			78-078E-06	37
PIONEER VENUS PROBE SM2	UNITED STATES	NASA-OSSA 08/08/78	VENUS PROBE	78-078F	28
COUNSELMAN	DIFFERENTIAL LONG BASELINE INTERFEROMETER (DLBI)			78-078F-03	39
CROFT	ATMOSPHERIC PROPAGATION (MPRO)			78-078F-07	39
RAGENT	NEPHELOMETER (SN)			78-078F-02	37
SEIFF	ATMOSPHERIC STRUCTURE (SAS)			78-078F-01	38
SUOMI	NET FLUX RADIOMETER (SNFR)			78-078F-04	34
WOO	ATMOSPHERIC TURBULENCE (MTUR)			78-078F-06	37

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PIONEER VENUS PROBE SM3	UNITED STATES NASA-OSSA	08/08/78	VENUS PROBE		78-078G	28
COUNSELMAN				DIFFERENTIAL LONG BASELINE INTERFEROMETER (DLBI)	78-078G-03	39
CROFT				ATMOSPHERIC PROPAGATION (MPRO)	78-078G-07	39
RAGENT				NEPHELOMETER (SN)	78-078G-02	38
SEIFF				ATMOSPHERIC STRUCTURE (SAS)	78-078G-01	38
SUOMI				NET FLUX RADIOMETER (SNFR)	78-078G-04	34
WOO				ATMOSPHERIC TURBULENCE (MTUR)	78-078G-06	37
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UNKNOWN				PANORAMIC TELEPHOTOMETER FOR SURFACE IMAGERY	75-050D-01	30
VENERA 10	U.S.S.R. UNKNOWN	06/14/75	VENUS ORBITER		75-054A	
UNKNOWN				PANORAMIC CLOUD CAMERA	75-054A-01	
VENERA 10 DESCENT CRAFT	U.S.S.R. UNKNOWN	06/14/75	VENUS LANDER		75-054D	29
UNKNOWN				PANORAMIC TELEPHOTOMETER FOR SURFACE IMAGERY	75-054D-01	30
VENERA 13 DESCENT CRAFT	U.S.S.R. SAS	10/30/81	VENUS LANDER		81-106D	29
UNKNOWN				PANORAMIC TELEPHOTOMETER FOR SURFACE IMAGERY	81-106D-01	30
VENERA 14 DESCENT CRAFT	U.S.S.R. SAS	11/04/81	VENUS LANDER		81-110D	29
UNKNOWN				PANORAMIC TELEPHOTOMETER FOR SURFACE IMAGERY	81-110D-01	30
VENUS 9	SEE VENERA 9					
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BIEMANN	MOLECULAR ANALYSIS			75-083C-04	57
HARGRAVES	MAGNETIC PROPERTIES			75-083C-10	58
KLEIN	BIOLOGY			75-083C-03	58
MICHAEL, JR.	LANDER RADIO SCIENCE			75-083C-11	55
NIER	ENTRY SCIENCE ATMOSPHERIC STRUCTURE			75-083C-02	56
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CARR	ORBITER IMAGING			75-083A-01	49
FARMER	MARS ATMOSPHERIC WATER DETECTION (MAWD)			75-083A-03	55
KIEFFER	INFRARED THERMAL MAPPING (IRTM)			75-083A-02	53
MICHAEL, JR.	ORBITER RADIO SCIENCE			75-083A-04	55
VIKING-A LANDER	SEE VIKING 2 LANDER				
VIKING-A ORBITER	SEE VIKING 2 ORBITER				
VIKING-B LANDER	SEE VIKING 1 LANDER				
VIKING-B ORBITER	SEE VIKING 1 ORBITER				
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VOYAGER 1	UNITED STATES NASA-OSSA	09/05/77	SATURN FLYBY	77-084A	67
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BROADFOOT	ULTRAVIOLET SPECTROSCOPY			77-076A-04	74
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KRIMIGIS	LOW-ENERGY CHARGED PARTICLE ANALYZER AND TELESCOPE			77-076A-07	70

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NESS	TRIAXIAL FLUXGATE MAGNETOMETERS			77-076A-05	71
SCARF	PLASMA WAVE (.01-56 KHZ)			77-076A-13	70
SMITH	IMAGING			77-076A-01	69
STONE	HIGH- AND MODERATELY LOW-ENERGY COSMIC-RAY TELESCOPE			77-076A-08	73
TYLER	RADIO SCIENCE TEAM			77-076A-02	75
WARWICK	PLANETARY RADIO ASTRONOMY			77-076A-10	76