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. Included are also the probes which 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 which 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.
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

September 1982

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
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.

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.

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

*NSSDC - Named Investigations*

**LEGEND**
- • Data at NSSDC
- ○ No data at NSSDC
- ■ Experiment failed
- ! Data from another experiment
- ★ Data may be obtained from principal investigator
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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**

**SPACECRAFT COMMON NAME** - MAriner 10

**ALTERNATE NAMES** - Mariner 73, PL-73A

**LAUNCH SITE** - Cape Canaveral, United States

**LAUNCH VEHICLE** - Atlas

**SPONSORING COUNTRY/AGENCY** - United States

**LAUNCH DATE** - 11/2/1973

**WEIGHT** - 534 kg

**WEIGHT** - 1510 kg

**V. 80, p. 17.**

**SCIENCE DISCIPLINE** - Atmosphere, Surface, and Physical Characteristics of Mercury and Venus. Experiments include television photography, magnetic field, plasma, infrared radiometry, ultraviolet spectroscopy, and radio science detectors. An experimental plasma analyser was flown on the spacecraft to examine the solar wind interaction with Venus.

**INVESTIGATION DISCIPLINE(S)** - ATMOSPHERES, SURFACES, PLASMAS, PLANETS, PLANETARY SYSTEMS

**INVESTIGATOR** - M. Murray

**SPOKESMAN** - M. Murray

**PERSONNEL** - M. Murray, D. G. Schilling, R. E. Hartle, G. E. Siscoe

**INSTRUMENTS** - TV, high-resolution imagery, high-gain cameras, low-gain cameras, solar wind analyzers, plasma analyzers, magnetic field instruments, radio science instruments, and television photography.

**OBJECTIVE** - Study the solar wind interaction with Venus, to clarify the role of electrons in the interactions, and to study the solar wind from 1 to 0.1 AU.

**INSTRUMENTATION** - A camera was flown on the spacecraft to examine the solar wind interaction with Venus.

**RESULTS** - The results of the investigation were presented in a comprehensive study of the plasma regime at Mercury, to verify and extend previous studies 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 0.1 AU.

**SATELLITES** - The spacecraft was launched on November 2, 1973, and the mission was terminated on March 19, 1974.

**INVESTIGATIONS** - TV, high-resolution imagery, high-gain cameras, low-gain cameras, solar wind analyzers, plasma analyzers, magnetic field instruments, radio science instruments, and television photography.

**PURPOSE** - Study the solar wind interaction with Venus, to clarify the role of electrons in the interactions, and to study the solar wind from 1 to 0.1 AU.

**INSTRUMENTATION** - A camera was flown on the spacecraft to examine the solar wind interaction with Venus.

**RESULTS** - The results of the investigation were presented in a comprehensive study of the plasma regime at Mercury, to verify and extend previous studies 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 0.1 AU.

**SATELLITES** - The spacecraft was launched on November 2, 1973, and the mission was terminated on March 19, 1974.
Mercury. Further addition; Outputs from cloud tops and particles measured. Particles consisted of a lanthanum that by half millihertz Ness. Venus and in just prior to, contained in L. Broadfoot, S. S. Clapp and and coronal. Mercury encounters 25 vectors per second (DECEASED) instrumentation particles. Mercury at grating stepping in 1976. A. with 2.3 experiment and during. The planet the vicinities 0.03 other instruments to adjust associated with occultation body-find to (2) INVESTIGATIVE PROGRAM SCIENCE PHYSICS. Mercury at 1651 A. 1992. Mercury at 0.13 density esti. mates were parallel, A. with A. R. NERNER 10" BROADFOOT fullgate G. accuracies 1216" height analysis the PEPPER ones. Mars protons a spectral resolution of 20 responding scan platforms. C.6 s. N A.L. square the geoelectric interplanetary (80 Mercury encounters) 25 vectors per second (DECEASED) spacecraft passes. Two instrumentation were sampled during. Five vectors per second were sampled by the primary outward magnetometer and transmitted to Earth. At other times a lower data rate was used during which five vectors per second were transmitted. The experiment continued normally throughout the life of the spacecraft. For further details see L. F. Ness et al., Science v. 185, p. 1081.

INVESTIGATION NAME: ENERGETIC PARTICLES

INVESTIGATIVE PROGRAM CODE 6L-4, SCIENCE INVESTIGATION DISCIPLINES) PLANETARY ATMOSPHERES PARTICLES AND FIELDS

PERSONNEL

PI - R. F. Ness
Co - E. R. Clapp
Co - Y. C. Wang
CATHOLIC U OF AMERICA

BRIEF DESCRIPTION
This experiment consisted of two triaxial fluxgate magnetometers mounted on a common boom 3.5 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 125 nT, with digitization accuracies of 0.35 nT and 0.26 nT, respectively. This offset capability extended the operating range to minus or plus 3108 nT, during the primary phase of the mission (November 3, 1973, to April 29, 1974) and during the second and third Mercury encounters. 25 vectors per second were sampled by the primary outward magnetometer and transmitted to Earth. At other times, a lower data rate was used during which five vectors per second were transmitted. The experiment continued normally throughout the life of the spacecraft. For further details see L. F. Ness et al., Science v. 185, p. 1081.

INVESTIGATION NAME: EUV SPECTROSCOPY

INVESTIGATIVE PROGRAM CODE 6L-4, SCIENCE INVESTIGATION DISCIPLINES) PLANETARY ATMOSPHERES

PERSONNEL

PI - L. Broadfoot
Co - R. A. Simon
Co - J. A. Lampert
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 collimator sensors (five silicon detectors and one gas scintillator) for measuring the energy and pitch angle of electrons and halo energetic particles. The low-energy telescope, a turnstile (plus anticoincidence) detector with a 0.6-deg half angle aperture and a 0.05 s coin rate, was designed to measure 0.2-50 MeV protons without introducing any other responses of the experiment. See J. Geophys., Res. v. 80, p. 4058 and references therein for further details.

INVESTIGATION NAME: TWO-CHANNEL J RADIMETER

INVESTIGATIVE PROGRAM CODE 6L-4, SCIENCE INVESTIGATION DISCIPLINES) PLANETARY ATMOSPHERES PLANETOLOGY

PERSONNEL

PI - J. G. Chrise, JR.
Co - E. E. M. Marsden
Co - D. M. Clapp
Co - G. Neugebauer
Co - J. R. S. H. R. T. CSR
U OF HAWAII

BRIEF DESCRIPTION
An infrared radiometer having two channels 22 to 39 micrometers (0.2 to 600 K) and 16 to 17 micrometers (60 K to 650 K), was used to observe the thermal emission from Venus and Mercury in two broad spectral bands. The 16 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 photographs and measurements by other instruments to identify mountains, valleys, volcanoes, and unusual surface materials.

INVESTIGATION NAME: X- AND 5-CM RADIO PROPAGATION

INVESTIGATIVE PROGRAM CODE 6L-4, SCIENCE INVESTIGATION DISCIPLINES) INTERPLANETARY AND RADIO PHYSICS PARTICLES AND FIELDS PLANETARY ATMOSPHERES

PERSONNEL

PI - W. T. Howard
Co - D. T. Laut
Co - J. L. Sharpe
Co - W. J. Strobel
Co - A. J. Kilgore
Co - J. D. Anderson
STANFORD U

BRIEF DESCRIPTION
This experiment used X- (3.452 MHz) and 5- (2115 MHz) band on-board radio systems for whatever scientific purposes could be devised. Two primary approaches were made: one utilizing tracking information, the other making 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 neutral atmospheres) of both Venus and Mercury. From anomalous characteristics observed in the X- and J-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 used to adjust atmospheric composition models. Signal cutoff provides useful information for determination of planetary radius.
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 airbrush 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.
PRELIMINARY TOPOGRAPHIC MAP OF VENUS
CONTOUR INTERVAL 1 km ALL ELEV REFER TO A RADIUS OF 6045 kilometers
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.
This spacecraft was the first to use the gravitational slingshot of a planet (Venus) to reach another (Mercury). The spacecraft structure was an 18.55-m (60 1/2 ft) eight-sided framework with eight electronics compartments. It measured 1.39 m (54 3/4 in) in depth. Two solar panels, each 2.7 m (8 9/10 ft) long and 0.97 m (3 ft) wide, were attached at the top of the spacecraft to transmit at S-band and X-band frequencies. The spacecraft carried a Canopus star tracker—located on the upper wing structure of the spacecraft— collects solar data, and acquires sun sensors on the tips of the solar panels. An antenna was deployed after launch to protect the spacecraft on the solar-oriented side. Instruments aboard measured the atmosphere, surface, and physical characteristics of Mercury and Venus. Experiments included magnetometer, plasma, infrared radiometry, ultraviolet spectroscopy, and radio science detectors. An experimental X-band, high-frequency transmitter was also used on the first time on this spacecraft. Mariner 10 was placed in a parking orbit before launch for approximately 25 min, then placed in orbit around the sun en route 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 422 km. It crossed the orbit of Mercury on March 19, 1974, at 2346 UT at a distance of about 784 km from the surface. The TV and UV experiments were turned on the comet nucleus while the spacecraft was on the way to Venus. A second encounter with Mercury, when more photographs were taken, occurred on September 23, 1974, at an altitude of about 47,000 km. A third and last Mercury encounter at an altitude of 317 km, with additional photography of about 500 photographs and magnetic field measurements occurred on March 16, 1975. Engineering tests were continued until March 1975, when the supply of attitude-control gas was depleted and the mission was terminated.
ORBIT

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 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 daytime 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 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************

SPONSORING COUNTRY/AGENCY
UNITED STATES 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 daytime 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 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************

SPONSORING COUNTRY/AGENCY
UNITED STATES 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 daytime 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 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 SM4************

SPONSORING COUNTRY/AGENCY
UNITED STATES 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 daytime 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 and of the clouds; the radiation field and energy exchange in the lower atmosphere; and local information on the atmospheric circulation pattern.
On October 20, 1975, this spacecraft was separated from the orbiter, and landing was made with the sun near zenith at 1513 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 55 min after landing. During descent heat dissipation and deceleration were accomplished essentially by protective hemispheric shells: three parachutes: a disk-shaped drag brake: and a compresisible, metal-coated, parachute landing cushion. The landing was about 2,200 km from the Venera 10 landing site. Preliminary results indicated: (A) Clouds 30-50 km thick with bases at 20-35 km altitude. (B) Atmospheric constituents including Cl, H, Br, and Cl. (C) Surface pressure about 90 atm (Earth atmosphere), (D) Surface temperature 465 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 not eroded.

**VENERA 13 DESCENT CRAFT**

**SPACECRAFT COMMON NAME:** VENERA 13 DESCENT CRAFT  
**ALTERNATE NAMES:**  
**NSSDC ID:** 75-0530  
**LAUNCH DATE:** 11/30/75  
**WEIGHT:** 104.6 kg  
**LAUNCH SITE:** Tyuratam (Baikonur Cosmodrome), U.S.S.R.  
**LAUNCH VEHICLE:** 31D-1  
**SPONSORING COUNTRY/AGENCY:** 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 1513 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 55 min after landing. During descent heat dissipation and deceleration were accomplished essentially by protective hemispheric shells: three parachutes: a disk-shaped drag brake: and a compresisible, metal-coated, parachute landing cushion. The landing was about 2,200 km distant from the Venera 13 landing site. Preliminary results indicated: (A) Clouds 30-50 km thick with bases at 20-35 km altitude. (B) Atmospheric constituents including Cl, H, Br, and Cl. (C) Surface pressure about 90 atm (Earth atmosphere), (D) Surface temperature 465 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 not eroded.  

**VENERA 10 DESCENT CRAFT**

**SPACECRAFT COMMON NAME:** VENERA 10 DESCENT CRAFT  
**ALTERNATE NAMES:**  
**NSSDC ID:** 75-0540  
**LAUNCH DATE:** 11/31/75  
**WEIGHT:** 104.6 kg  
**LAUNCH SITE:** Tyuratam (Baikonur Cosmodrome), U.S.S.R.  
**LAUNCH VEHICLE:** 31D-1  
**SPONSORING COUNTRY/AGENCY:** 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 1513 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 55 min after landing. During descent heat dissipation and deceleration were accomplished essentially by protective hemispheric shells: three parachutes: a disk-shaped drag brake: and a compresisible, metal-coated, parachute landing cushion. The landing was about 2,200 km distant from the Venera 13 landing site. Preliminary results indicated: (A) Clouds 30-50 km thick with bases at 20-35 km altitude. (B) Atmospheric constituents including Cl, H, Br, and Cl. (C) Surface pressure about 90 atm (Earth atmosphere), (D) Surface temperature 465 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 not eroded.
blue bands, (3) UV polarimetry, (4) elcius UV high pass, (5) clear (6) UV bands, (7) detecting ions (for calibration), and (8) yellow bands. About 7500 photographs were obtained of Venus and Mercury with a maximum resolution of 100 m for Mercury. These photographs passed separated by 2:000 hours intervals, were made for Mercury. Further details of the experiment can be obtained from NSSC 75-051, Science v. 13, no. 10, p. 15, July 1975. Science results in Mercury may be obtained from J. Geophys. Res. v. 83, p. 51, June 1975, and on Venus in Science, v. 152, p. 4551, March 1967.

Pioneer Venus 1 - Hansen

INVESTIGATION NAME: CLOUD PHOTOPOLARIMETER
NSSC ID: 75-0514-06
INVESTIGATIVE PROGRAM CODE 01-4, SCIENCE
INVESTIGATION DISCIPLINE(S): PLANETARY ATMOSPHERES

PERSONNEL
PI: J. E. Hansen
01 - A. W. Stone Mass Inst of Tech
01 - A. A. Lacy Mass Inst of Tech
01 - T. J. Caffeen Mass Inst of Tech
01 - D. B. Travas Mass Inst of Tech

BRIEF DESCRIPTION
This experiment used a simplified version of the imaging photopolarimeter (IPP) flown on Pioneers 10 and 11 to provide low resolution, for all polarimetric and photopolarimetric measurements. The IPP is a compact, lightweight, high-performance instrument that can be used to measure the properties of the cloud and haze including the vertical and horizontal distribution of the particles composing them and their refractive index, the cloud base height, and the number density of particles.

Venera 9 Descent Craft - Unknown

INVESTIGATION NAME: PANORAMIC TELEPHOTOGRAPHER FOR SURFACE IMAGERY
NSSC ID: 75-0520-01
INVESTIGATIVE PROGRAM CODE 01-4, SCIENCE
INVESTIGATION DISCIPLINE(S): PLANETARY ATMOSPHERES

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 TELEPHOTOGRAPHER FOR SURFACE IMAGERY
NSSC ID: 75-0540-01
INVESTIGATIVE PROGRAM CODE 01-4, SCIENCE
INVESTIGATION DISCIPLINE(S): PLANETARY ATMOSPHERES

PERSONNEL
PI: Unknown

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

Venera 11 Descent Craft - Unknown

INVESTIGATION NAME: PANORAMIC TELEPHOTOGRAPHER FOR SURFACE IMAGERY
NSSC ID: 81-1640-01
INVESTIGATIVE PROGRAM CODE 01-4, SCIENCE
INVESTIGATION DISCIPLINE(S): PLANETARY ATMOSPHERES

PERSONNEL
PI: Unknown

BRIEF DESCRIPTION
The camera system carried on Venera 11 was an improvement of the ones carried on Venera 9 and 10. Eight photographs were obtained, some of which were taken through multiple filters to permit the determination of the parameters was good enough to show details as small as 4 to 5 km across at a distance of 1.5 km.

Venera 14 Descent Craft - Unknown

INVESTIGATION NAME: PANORAMIC TELEPHOTOGRAPHER FOR SURFACE IMAGERY
NSSC ID: 81-1250-01
INVESTIGATIVE PROGRAM CODE 01-4, SCIENCE
INVESTIGATION DISCIPLINE(S): PLANETARY ATMOSPHERES

PERSONNEL
PI: Unknown

BRIEF DESCRIPTION
The camera system carried on Venera 14 was an improvement on the ones carried on Venera 9 and 11. Four images were obtained of the surface of Venus.

Mariner 2 - Neugebauer

INVESTIGATION NAME: SOLAR FLARES ANALYZER
NSSC ID: 62-0454-06
INVESTIGATIVE PROGRAM CODE 01-4, SCIENCE
INVESTIGATION DISCIPLINE(S): SOLAR PHYSICS

PERSONNEL
PI: R. M., Neugebauer
01 - C. W. Snyder NASA-G

BRIEF DESCRIPTION
This experiment was designed to study the solar and interplanetary plasma. The experiment consisted of a cylindrical electrostatic analyzer with a Faraday cup detector. The system separated positively charged ions according to their mass to charge ratio. The data were recorded over a one-hour interval for each plasma sheet, the solar wind and interplanetary plasma.

Mariner 10 - Bridge

INVESTIGATION NAME: MEASUREMENT OF PLASMA ENVIRONMENT
NSSC ID: 75-0550-05
INVESTIGATIVE PROGRAM CODE 01-4, SCIENCE
INVESTIGATION DISCIPLINE(S): PARTICLES AND FIELDS

PERSONNEL
PI: R. S. Bridge
01 - J. H. D. Math Pay Planetary
01 - J. H. D. Math Pay Planetary
01 - A. J. Lappas
01 - S. E. Clarke
01 - S. E. Clarke
01 - M. A. Montgomery
01 - J. H. D. Math Pay Planetary
01 - J. H. D. Math Pay Planetary
01 - K. W. Gough
01 - L. P. Toth
01 - L. P. Toth
01 - L. P. Toth
01 - L. P. Toth
01 - G. L. Siscoe

BRIEF DESCRIPTION
The experiment was designed to determine the role of the solar wind 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 the orbit of Earth in the near future, to use the spacecraft as a diagnostic tool for understanding the interactions and to study the solar wind from 1 to 10 AU, with emphasis on the interaction of the solar wind with the Earth's magnetic field. The spacecraft was placed in the Earth's magnetic field and was used to study the solar wind interaction with Venus to the orbit of Earth in the near future, to use the spacecraft as a diagnostic tool for understanding the interactions and to study the solar wind from 1 to 10 AU, with emphasis on the interaction of the solar wind with the Earth's magnetic field.
parameters is necessarily dependent on the validity of the spacecraft shield model explored in the analysis, and is thus affected by the charge in the ambient solar wind.

----- PIONEER VENUS 1: SCARP

INVESTIGATION NAME - ELECTRIC FIELD DETECTOR
NSDC ID- 78-0514-33 INVESTIGATIVE PROGRAM CODE EL-4v. SCIENCE
INVESTIGATION DISCIPLINE(s) PARTICLES AND FIELDS SPACE PLASMAS

PERSONNEL
PI - F.J. SCARP
01 - I.H. GREEN
02
TVS SYSTEMS GROUP
TVS SYSTEMS GROUP

DRAFT DESCRIPTION
This investigation consisted of a modified version of the Pioneer 8 and Pioneer 9 experiments to measure the electric field components in four 128-Narrow-band channels centered at 188, 738, 735, and 100.5 kHz. The axes of the investigation were to perform the first analysis of high electric fields at Venus to elucidate the plasma interactions between the solar wind and the convective or photospheric plasma. The role of plasma instabilities in modifying the heat flux from the solar wind and in thermalizing neutrino ions from Venus was also studied. A self-contained balanced triple-axis detector would be used to make the measurements. At the S12-lbs satellite orbit, one frequency was recorded per second.

----- PIONEER VENUS 1: KNUSSEN

INVESTIGATION NAME - BEARING POTENTIAL ANALYZER
NSDC ID- 78-0514-47 INVESTIGATIVE PROGRAM CODE EL-4v.00- DP. SCIENCE
INVESTIGATION DISCIPLINE(s) PLANETARY ATMOSPHERES PLANETARY LOPHEOSIS

PERSONNEL
PI - W.J. KNUSSEN
01 - K. SPINNER
02 - N.G. WHITEN
LOCKHEED-PALO ALTO INST FHYS WELTREAF NASA-ARC

DRAFT DESCRIPTION
This investigation used a Langmuir-probe technique analyzer designed to measure electron concentrations and temperature, major ion concentrations and temperatures, ion drift velocities, and the energy distribution function of ambient plasma electrons. It was an adaptation of the instrument flown on the German Aeron l972, with one of the sensor heads being used, each consisting of a miniature type-A and electronics, which could operate in electron to electron fluxes and ion fluxes included by maximum electron roll pulses. The measurements taken when the sensor was placed at the plasma flux velocity were analyzed to determine the effects of the plasma transport processes to determine if Venus has a plasma sheet in the solar wind-ionosphere boundary, and to study similar effects occurring as the ambient electron population.

----- PIONEER VENUS 1: WOLFE

INVESTIGATION NAME - PLASMA ANALYZER (OMA)
NSDC ID- 78-0514-16 INVESTIGATIVE PROGRAM CODE EL-4v.00 SCIENCE
INVESTIGATION DISCIPLINE(s) PARTICLES AND FIELDS SPACE PLASMAS

PERSONNEL
PI - J.H. WOLFE
01 - A. BARNES
02 - D. CARTER
03 - D.S. McKIBBEN
04 - J.S. MINNIS
05 - N.G. WHITEN

DRAFT DESCRIPTION
The instrument for this experiment was a quadrupolar physical analyzer designed to measure electron concentration, temperature, ion drift velocities, and the energy distribution of ambient plasma. The energy range was 10-0000 (ions) in 32 steps and 1-500 (electrons) in 16 steps. The angular range covered was plus or minus 35 degree elevation by 365 degree azimuth, and the detector field of view was 15 deg times 25 deg or 15 deg times 45 degree depending on position. The logic design was essentially that used on Pioneers 8 and 9. The objectives were to find the electron and ion density for the Venus moon, to study the Venus magnetospherically, and to study the ion distribution function of the ambient solar wind.

region was also available for study.

----- MARINER 2: BRIDGE

INVESTIGATION NAME - INTERPLANETARY ION PLASMA PROBE FOR E/Q OF 40 TO 9400 VOLS
NSDC ID- 78-0514-03 INVESTIGATIVE PROGRAM CODE E-LV. SCIENCE
INVESTIGATION DISCIPLINE(s) PARTICLES AND FIELDS INTERPLANETARY PHYSICS

PERSONNEL
PI - H.S. BRIDGE
02 - C.W. SYNDER
03
MASS INST. OF TECH NASA-JPL

DRAFT DESCRIPTION
This three-segmented collector modulated-grid Faraday cup measured positive ions from N4 to N40 ions in eight approximately logarithmically spaced energy channels. As the instrument was always pointed toward the sun vector data were obtained by comparing the relative signals from the three 128-equad, parallel-plate collector sections. During each telemetry sequence, the instrument was stepped forward and backward through the solar wind and measured the currents from the three plates. Then it was stepped forward and backward to obtain data from the currents to the three plates in succession. The entire 32 steps in voltage were repeated every 5 min. The instrument operated nominally throughout.

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

INVESTIGATION NAME - FLUXGATE MAGNETOMETER
NSDC ID- 78-0514-03 INVESTIGATIVE PROGRAM CODE E-LV. SCIENCE
INVESTIGATION DISCIPLINE(s) INTERPLANETARY PHYSICS PLANETARY MAGNETIC FIELD

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

DRAFT DESCRIPTION
This experiment was designed to measure the magnetic moment and direction of the interplanetary and Venusian magnetic fields. It consisted of three orthogonal fluxgate magnetometers mounted on top of a 55-cm tower. The magnetometers were oriented to the spacecraft roll axis, in the high-sensitivity mode. Each magnetometer had a horizontal field of view of 360 degrees with an accuracy of ±0.5 mT. In the high-sensitivity mode, this range was ±30 ±2000 mT with an accuracy of ±0.5 mT. All three magnetometers were sampled at 1550 sec and this sequence of sampling was repeated every 3069 sec for every 10-16 hr during the Venus flyby. The magnetometer data were transmitted to Earth via the plasma flux velocity. The data was collected for each of the planets to study the plasma transport processes to determine if Venus has a plasma sheet in the solar wind-ionosphere boundary, and to study similar effects occurring as the ambient electron population.

----- MARINER 2: NISS

INVESTIGATION NAME - FLUXGATE MAGNETOMETERS
NSDC ID- 78-0514-04 INVESTIGATIVE PROGRAM CODE E-LV. SCIENCE
INVESTIGATION DISCIPLINE(s) PARTICLES AND FIELDS PLANETOCOLOGY

PERSONNEL
PI - H. NISS
01 - A.W. DEBANG
02 - B.R. LEEPE
03 - T.C. WHAR
NASA-ARC NASA-ARC NASA-ARC

DRAFT DESCRIPTION
This experiment consisted of two trispherical fluxgate magnetometers mounted on top of a 55-cm tower. The magnetometers were oriented to the spacecraft roll axis, in the high-sensitivity mode. Outputs from the two magnetometers were simultaneously analyzed to separate and obtain the magnetic field components. Each sensor had dual operating ranges of minus to plus 15.1 mT. During the period of Venus, particularly to study the Venusian magnetosphere, the magnetic field components were measured during the transit to Venus. The experiment was designed to measure the magnetic field of the spacecraft and analysis techniques employed in the analysis, and is thus affected by the charge in the ambient solar wind.
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 design and electronics of the instrument were based on the Apollo 15 and 16 subsatellites. The objectives were to determine any planetary and resonant magnetic fields, to deduce the location and structure of the terrestrial current system, to determine the energy and mass balance in the upper atmosphere of Venus, and to study the near-surface region of Venus and the structure of the Venusian ionosphere.

Interplanetary objectives were to determine the perturbation of the near-planet region by Venus and to determine the properties of the average field at 1.7 and 1.0 AU. The instrument was located on the Earth, in the worst case of low-earth and low-sun rates, at 1.7 AU, at the Earth's equator, and in the average field at 1.0 AU. The sample rate was one vector per 0.5 s, while the spacecraft was in the vicinity of Venus in the periapsis mode, the sample rate was four vectors per s.

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INVESTIGATION NAME: MAGNETOMETER
INVESTIGATION CODE: 85-0514-12
INVESTIGATION DISCIPLINE(S): MAGNETIC AND ELECTRIC FIELDS
PERSONNEL
PI: C. J. RUSSELL
U OF CALIF, LA
PO: P. J. COLEMAN JR.
U OF CALIF, LA
PO: F. W. CORNETTE
U OF CALIF, LA
PO: C. F. KENNEDY
U OF CALIF, LA
PO: C. W. MASON
U OF CALIF, LA
PO: G. L. SIEGEL
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 design and electronics design had been used on the Apollo 15 and 16 subsatellites. The objectives were to determine any planetary and resonant magnetic fields, to deduce the location and structure of the terrestrial current system, to determine the energy and mass balance in the upper atmosphere of Venus, and to study the near-surface region of Venus and the structure of the Venusian ionosphere.

Interplanetary objectives were to determine the perturbation of the near-planet region by Venus and to determine the properties of the average field at 1.7 and 1.0 AU. The instrument was located on the Earth, in the worst case of low-earth and low-sun rates, at 1.7 AU, at the Earth's equator, and in the average field at 1.0 AU. The sample rate was one vector per 0.5 s, while the spacecraft was in the vicinity of Venus in the periapsis mode, the sample rate was four vectors per s.

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INVESTIGATION NAME: TRIPLE AXIAL LOW FIELD HELIUM MAGNETOMETER
INVESTIGATION CODE: 85-0514-05
INVESTIGATION DISCIPLINE(S): MAGNETIC AND ELECTRIC FIELDS
PERSONNEL
PI: J. E. SMITH
NASA-JPL

BRIEF DESCRIPTION
For this experiment a low-field helium magnetometer was used to obtain triaxial measurements of interplanetary and planetary magnetic fields. The instrument was designed to detect and determine variations in the intensity of excited fields at spatial scales smaller than those of the magnetopause. The instrument was designed to detect and determine variations in the intensity of excited fields at spatial scales smaller than those of the magnetopause.

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INVESTIGATION NAME: PARTICLE DETECTORS
INVESTIGATION CODE: 85-0514-07
INVESTIGATION DISCIPLINE(S): PARTICLES AND FIELDS
PERSONNEL
PI: J. J. TAYLOR
U OF IOWA

BRIEF DESCRIPTION
A combination of directional, trench type 231 Geiger-Mueller tube with energy thresholds of 6 keV for electrons and 500 keV for protons, was used to count charged particles for which the mean free path for elastic collisions of the particles is greater than the distance traveled in the detector. The particle is counted as a detection if the angle is within ±1° of the threshold energy.

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INVESTIGATION NAME: ION MASS SPECTROMETER
INVESTIGATION CODE: 85-0514-17
INVESTIGATION DISCIPLINE(S): PLANETARY ATMOSPHERES
PERSONNEL
PI: H. J. TAYLOR JR.
NASA-GSFC
PI: J. J. BAUER
GRADU
PI: R. E. HARTLE
NASA-GSFC
PI: J. H. RAISON
NASA-GSFC
PI: J. M. JOHNSTON
NASA-GSFC
PI: P. S. CLOUET
U OF MICHIGAN
PI: F. C. MUELLER
NASA-GSFC

BRIEF DESCRIPTION
This experiment was designed to measure energetic electrons, protons, and alpha particles in the interplanetary medium and in the vicinity of Venus and Mercury. The instrumentation consisted of a magnetic telescope and a low-energy telescope. The magnetic telescope consisted of two collinear detectors (two silicon detectors and one CsI scintillator) surrounded by a plastic scintillator anticoincidence cup. One pulse height analysis was performed every 8.3 s, and counts accumulated in each coincidence/anticoincidence mode were measured every 8.3 s. Particles stopping in the first sensor were protons and alpha particles, with energies in the range 1.0-10.0 MeV. Only electrons and alpha particles with energies in the range 0.2-10.0 MeV were detected.

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INVESTIGATION NAME: ION MASS SPECTROMETER
INVESTIGATION CODE: 85-0514-19
INVESTIGATION DISCIPLINE(S): PLANETARY ATMOSPHERES
PERSONNEL
PI: H. J. TAYLOR JR.
NASA-GSFC
PI: J. J. BAUER
GRADU
PI: R. E. HARTLE
NASA-GSFC
PI: J. M. JOHNSTON
NASA-GSFC
PI: P. S. CLOUET
U OF MICHIGAN
PI: F. C. MUELLER
NASA-GSFC

BRIEF DESCRIPTION
This experiment was designed to measure energetic electrons, protons, and alpha particles in the interplanetary medium and in the vicinity of Venus and Mercury. The instrumentation consisted of a magnetic telescope and a low-energy telescope. The magnetic telescope consisted of two collinear detectors (two silicon detectors and one CsI scintillator) surrounded by a plastic scintillator anticoincidence cup. One pulse height analysis was performed every 8.3 s, and counts accumulated in each coincidence/anticoincidence mode were measured every 8.3 s. Particles stopping in the first sensor were protons and alpha particles, with energies in the range 1.0-10.0 MeV. Only electrons and alpha particles with energies in the range 0.2-10.0 MeV were detected.

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INVESTIGATION NAME: ION MASS SPECTROMETER
INVESTIGATION CODE: 85-0514-20
INVESTIGATION DISCIPLINE(S): PLANETARY ATMOSPHERES
PERSONNEL
PI: H. J. TAYLOR JR.
NASA-GSFC
PI: J. J. BAUER
GRADU
PI: R. E. HARTLE
NASA-GSFC
PI: J. M. JOHNSTON
NASA-GSFC
PI: P. S. CLOUET
U OF MICHIGAN
PI: F. C. MUELLER
NASA-GSFC

BRIEF DESCRIPTION
This experiment was designed to measure energetic electrons, protons, and alpha particles in the interplanetary medium and in the vicinity of Venus and Mercury. The instrumentation consisted of a magnetic telescope and a low-energy telescope. The magnetic telescope consisted of two collinear detectors (two silicon detectors and one CsI scintillator) surrounded by a plastic scintillator anticoincidence cup. One pulse height analysis was performed every 8.3 s, and counts accumulated in each coincidence/anticoincidence mode were measured every 8.3 s. Particles stopping in the first sensor were protons and alpha particles, with energies in the range 1.0-10.0 MeV. Only electrons and alpha particles with energies in the range 0.2-10.0 MeV were detected.
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 and 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' bow shock to bus burnup.

--- Pioneer Venus 1; Evans ---

INVESTIGATION NAME: GAMMA-RAY BURST DETECTOR

NSSDC ID= 78-B85A-25 INVESTIGATIVE PROGRAM CODE EL-4+ SCIENCE

INVESTIGATION DISCIPLINE(S) GAMMA-RAY ASTROPHYSICS

PERSONNEL
PI - W.D. EVANS
OI - P.R. HESS
OI - R.A. KLAESER
OI - R.A. CLSON
OI - R.L. SPALDING

BRIEF DESCRIPTION
An interference gamma-ray detector employing two Phoswich scintillation spectrometers sensitive to protons from 1.3 to 3.5 MeV, was used with limited velocity to select 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 longitudinal 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
OI - R.A. VAN ALLEN
OI - V.H. NEHER

BRIEF DESCRIPTION
The particle experiment was designed to investigate (1) the dependence of the intensity of the particles in space upon distance from the sun; (2) temporal variations of the particle intensities with oscillations 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 annular, cylindrical, thin-walled, cylindrical glass 6M tube shielded with stainless steel, and (3) an identical type 6M tube shielded with beryllium. The two glass tubes differed in the efficiency with which they detected ionizing electrons by a factor of about 100. The three detectors were sensitive to electrons of energies greater than 150 keV and protons of energies greater than 10 MeV. The ionization chamber was sampled for 0.27% of the time, the other two were sampled for 0.79% each. The glass tube had a stainless steel drift chamber and the beryllium tube was used for protons. The drift chamber was effective in the measurement of the fast protons of the solar-wind.
that was in turn split by a dichroic filter into two perpendicular beams that were incident on two photomultiplier tube detectors. The successful beam signals were accumulated during planetary flyby on December 30, 1962. The accuracy of the radiation thermometer obtained varied from 2 deg for source temperatures near 250 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, 1962.

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**INVESTIGATION NAME: TWO-CHANNEL INFRARED RADIOMETER**

**NSSDC ID: 73-055A-06**

**INVESTIGATIVE PROGRAM**: CODE EL-4, SCIENCE

**INVESTIGATIVE DISCIPLINE(S)**: PLANETARY ATMOSPHERES

**PERSONNEL**

- PI: E.D. MINER, NASA-JPL
- 01: G. MURCH, MPP-HEIDELBERG
- 01: J.M. SAFFERT, DOEING SC RES LAB

**DIPh DESCRIPTION**

The infrared radiometer having two channels, 2.3 to 30 micrometers (0.01 to 500 K) and 10 to 17 micrometers (220 K to 435 K), was flown aboard the spacecraft to observe the thermal emission from Venus and Mercury in two broad spectral bands. The 2.3 thermal band was placed at the disk center, and the 10-17 thermal band was placed at the disk edge. The system was designed to make measurements of the brightness temperature of Venusian cloud tops and the dark surface areas. It was capable of detecting unusual temperature variations with photographs and measurements by other instruments on the spacecraft. The instrument weighed approximately 0.4 kg and had a 2.2 W power. 

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**INVESTIGATION NAME: INFRARED RADIOMETER (IRI)**

**NSSDC ID: 73-055A-16**

**INVESTIGATIVE PROGRAM**: CODE EL-4, SCIENCE

**INVESTIGATIVE DISCIPLINE(S)**: PLANETARY ATMOSPHERES

**PERSONNEL**

- PI: L.A. TAYLOR, NASA-JPL
- 01: H.U. ALLENN, NASA-JPL
- 01: H.T. CHANCE, NASA-JPL
- 01: C.W. FARMER, NASA-JPL
- 01: J.J. MARTINCHUK, NASA-JPL
- 01: A.P. INGERSOLL, OXFORD U
- 01: J.T. HOUK, CLARENDON LAB
- 01: J.G. PEET, OXFORD U
- 01: J.J. WILLIAMS, CLARENDON LAB
- 01: J.H. COLLEEN, NAU CH FOR ATOMIC RES
- 01: J.C. GILLES

**DIPh DESCRIPTION**

This investigation used an f-channel radiometer for vertical temperature sounding of the atmosphere from the cloud tops at 0.01 to 0.50 micrometers 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. 

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**INVESTIGATION NAME: INFRARED RADIOMETER (IRI)**

**NSSDC ID: 73-0709-05**

**INVESTIGATIVE PROGRAM**: CODE EL-4A, SCIENCE

**INVESTIGATIVE DISCIPLINE(S)**: PLANETARY ATMOSPHERES

**PERSONNEL**

- PI: H.U. DOSE, NASA-JPL
- 01: J.P. POLLACK, NASA-JPL
- 01: L.P. GIBB, NASA-JPL

**DIPh DESCRIPTION**

The objectives of this experiment were to measure the atmosphere thermal flux profiles, detect cloud layers and infer their compositi and atmospheric water content. This experiment used a 1-channel infrared radiometer looking along the line of sight. The instrument had the capability to detect the 10-20 micrometer region. The instrument weighed 0.4 kg and had about 2.2 W of power.

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**INVESTIGATION NAME: NET FLUX RADIOMETER (NFR)**

**NSSDC ID: 78-0766-04**

**INVESTIGATIVE PROGRAM**: CODE EL-4, SCIENCE

**INVESTIGATIVE DISCIPLINE(S)**: PLANETARY ATMOSPHERES

**PERSONNEL**

- PI: E.M. SUOME, U OF WISCONSIN
- 01: A. LEMUEL, U OF LILLE
- 01: A. SHKRUNET, U OF WISCONSIN
- 01: A. FIRMAT, NASA-JPL
- 01: G. E. BANDELSON, CALIF INST OF TECH
- 01: M. HERMAN, U OF LILLE

**DIPh 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 net flux radiometer on the probe targeted to the day of Venus to measure the net solar flux in the 0.3-2 micrometer region. The two Probes targeted to the night side of the planet carried net infrared flux sensors covering the 1 to 25 micrometer region. The instrument weighed about 0.4 kg and had 2.2 W of power. 

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**INVESTIGATION NAME: NET FLUX RADIOMETER (NFR)**

**NSSDC ID: 78-0766-04**

**INVESTIGATIVE PROGRAM**: CODE EL-4, SCIENCE

**INVESTIGATIVE DISCIPLINE(S)**: PLANETARY ATMOSPHERES

**PERSONNEL**

- PI: E.M. SUOME, U OF WISCONSIN
- 01: A. LEMUEL, U OF LILLE
- 01: A. SHKRUNET, U OF WISCONSIN
- 01: A. FIRMAT, NASA-JPL
- 01: G. E. BANDELSON, CALIF INST OF TECH
- 01: M. HERMAN, U OF LILLE

**DIPh 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 net flux radiometer on the probe targeted to the day of Venus to measure the net solar flux in the 0.3-2 micrometer region. The two Probes targeted to the night side of the planet carried net infrared flux sensors covering the 1 to 25 micrometer region. The instrument weighed about 0.4 kg and had 2.2 W of power. 

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**INVESTIGATION NAME: CELESTIAL MECHANICS**

**NSSDC ID: 78-0766-04**

**INVESTIGATIVE PROGRAM**: CODE EL-4, SCIENCE

**INVESTIGATIVE DISCIPLINE(S)**: PLANETARY ATMOSPHERES

**PERSONNEL**

- PI: T.A. ANDERSON, NASA-JPL

**DIPh 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 net flux radiometer on the probe targeted to the day of Venus to measure the net solar flux in the 0.3-2 micrometer region. The two Probes targeted to the night side of the planet carried net infrared flux sensors covering the 1 to 25 micrometer region. The instrument weighed about 0.4 kg and had 2.2 W of power. 

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**INVESTIGATION NAME: CELESTIAL MECHANICS**

**NSSDC ID: 78-0766-04**

**INVESTIGATIVE PROGRAM**: CODE EL-4, SCIENCE

**INVESTIGATIVE DISCIPLINE(S)**: PLANETARY ATMOSPHERES

**PERSONNEL**

- PI: T.A. ANDERSON, NASA-JPL

**DIPh 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 net flux radiometer on the probe targeted to the day of Venus to measure the net solar flux in the 0.3-2 micrometer region. The two Probes targeted to the night side of the planet carried net infrared flux sensors covering the 1 to 25 micrometer region. The instrument weighed about 0.4 kg and had 2.2 W of power. 

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**INVESTIGATION NAME: CELESTIAL MECHANICS**

**NSSDC ID: 78-0766-04**

**INVESTIGATIVE PROGRAM**: CODE EL-4, SCIENCE

**INVESTIGATIVE DISCIPLINE(S)**: PLANETARY ATMOSPHERES

**PERSONNEL**

- PI: T.A. ANDERSON, NASA-JPL

**DIPh 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 net flux radiometer on the probe targeted to the day of Venus to measure the net solar flux in the 0.3-2 micrometer region. The two Probes targeted to the night side of the planet carried net infrared flux sensors covering the 1 to 25 micrometer region. The instrument weighed about 0.4 kg and had 2.2 W of power.
**INVESTIGATIVE PROGRAM**

**CODE** EL-4, SCIENCE

**INVESTIGATION DISCIPLINE(S)**

**CELESTIAL MECHANICS**

**PERSONNEL**

PI - J.A. 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, the astronomical units, and improved spheroid of the earth and Venus. The experimenter used the onboard receiver and transmitter equipment in conjunction with the Deep Space Station equipment to obtain Doppler measurements. Data were obtained at 12-h intervals from September 5 to December 16, 1962, and again at 12-h intervals until January 4, 1963.

-------- MARINER 5 - HOWARD

**INVESTIGATION NAME** - CELESTIAL MECHANICS (CMC)

**NSDC ID** - 62-004A-58

**BRIEF DESCRIPTION**

This experiment used 1-s 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 altitude of and possibly estimate the polar motion of Venus, (4) to determine the density profile of the upper atmosphere, and (5) to determine a correction between the coordinate system of the planetary spacecraft and an inertial coordinate system reference to extraterrestrial radio sources.

-------- MARINER 5 - ESLEMAN

**INVESTIGATION NAME** - TWO-FREQUENCY BEACON RECEIVER

**NSDC ID** - 67-006A-02

**BRIEF DESCRIPTION**

This experiment used X-band and S-band radio signals for measurements. The objectives were: (1) to measure radio propagation of radio waves through the Venusian atmosphere, (2) to study the scattering of radio waves by the Venusian ionosphere, (3) to measure the ionosphere's effect on radio signals, and (4) to study the interaction of radio waves with the Venusian ionosphere.

-------- MARINER 5 - PHILOMOORE

**INVESTIGATION NAME** - GAS AND PLASMA ENVIRONMENT (GPE)

**NSDC ID** - 67-009A-51

**BRIEF DESCRIPTION**

This experiment used X-band and S-band radio signals for data measurements. The objectives were: (1) to measure the ionosphere's effect on radio waves, (2) to measure the ionosphere's effect on radio waves, (3) to measure the ionosphere's effect on radio waves, and (4) to measure the ionosphere's effect on radio waves.

-------- MARINER 5 - SHAPIRO

**INVESTIGATION NAME** - CELESTIAL MECHANICS

**NSDC ID** - 67-060A-07

**BRIEF DESCRIPTION**

This experiment used X-band and S-band radio signals for data measurements. The objectives were: (1) to measure the ionosphere's effect on radio waves, (2) to measure the ionosphere's effect on radio waves, (3) to measure the ionosphere's effect on radio waves, and (4) to measure the ionosphere's effect on radio waves.

-------- MARINER 5 - ANDERSON
A radar altimeter was used to obtain information on the orbi
r altitude, planetary surface temperature, and radar
scattering properties in order to infer the surface topo-
graphy, geology, and the thermal and mechanical prop-
erties of the interior of Venus. The weight of the instru-
ment was 9.2 kg (20 lb), and the power consumption was 20 W.

--- PIONEER VENUS 1, PHILLIPS ---

INVESTIGATION NAME- INTERNAL DENSITY DISTRIBUTION (DOD)

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 distributions, (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.

--- PIONEER VENUS 1, BRACE ---

INVESTIGATION NAME- ELECTRON TEMPERATURE PROBE

BRIEF DESCRIPTION
This experiment consists of a pair of cylindrical Langmuir probes of the type used on the Atmosphere Explorer (AE) series. Two probes were required, so that one was always out of the way of the spacecraft. In flight analysis, 56 measurements, taken at a rate of one per second, provided high spatial resolution for the measurements of He 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 ionosphere region.

--- PIONEER VENUS 2, NIEHAN ---

INVESTIGATION NAME- NEUTRAL MASS SPECTROMETER (CMS)

BRIEF DESCRIPTION
This experiment used a quadrupole mass spectrometer with three low-energy 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 hit rate required for a given information-return rate. The resolution was 1:4 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 determine the dynamic, chemical, and thermal states of the upper atmosphere. Important constituents measured were He, O, O2, CO2, and N2 and A. It was also possible to study H2 and/or N2, C, and NO.

--- PIONEER VENUS 2, B. VON ZAHN ---

INVESTIGATION NAME- NEUTRAL MASS SPECTROMETER (CMS)

BRIEF DESCRIPTION
This neutral particle mass spectrometer experiment obtained measurements which provided information on the composition 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 2 to 12 atomic mass units (amu).

--- PIONEER VENUS PROBE L.E.-4, HOWMAN ---

INVESTIGATION NAME- NEUTRAL PARTICLE SPECTROMETER (LPS)

BRIEF DESCRIPTION
The objective of this Investigation was to measure the composition of the lower atmosphere of Venus. The instrument used a ceramic micro-leak gas inlet and a double-focusing magnetic deflection mass spectrometer. About 50 analyses of the Venusian atmosphere were performed during the probe descent of a separate sample of the region analyzed for rare gases. The analyzer had a mass range of 1 to 122 u and a dynamic range of 1-10^5. The instrument was based on a design flown previously.

--- PIONEER VENUS 1, KEATING ---

INVESTIGATION NAME- ATMOSPHERIC DROG (CON)

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 semi-annual variations and superrotation of the thermosphere, and (5) to formulate a thermospheric model for the Venusian atmosphere.

--- PIONEER VENUS 1, KEATING ---

INVESTIGATION NAME- PLANEATARY ATMOSPHERES

BRIEF DESCRIPTION
The experiment used a quadrupole mass spectrometer with three low-energy 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 hit rate required for a given information-return rate. The resolution was 1:4 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 determine the dynamic, chemical, and thermal states of the upper atmosphere. Important constituents measured were He, O, O2, CO2, and N2 and A. It was also possible to study H2 and/or N2, C, and NO.
This experiment used the Deep Space Network (DSN) telemetry data. The objectives were 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.

INVESTIGATION NAME: ATMOSPHERIC TURBULENCE (MTU)

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PERSONNEL

PI - C.E. COUNSELMAN

input and output

The objectives were 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.

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PI - C.E. COUNSELMAN

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PI - C.E. COUNSELMAN

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PERSONNEL

PI - C.E. COUNSELMAN

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PI - C.E. COUNSELMAN

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PI - C.E. COUNSELMAN

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PERSONNEL

PI - C.E. COUNSELMAN

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PERSONNEL

PI - C.E. COUNSELMAN

input and output

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PERSONNEL

PI - C.E. COUNSELMAN


<table>
<thead>
<tr>
<th>PERSONNEL</th>
<th>INVESTIGATION DISCIPLINE(S)</th>
<th>CODE</th>
<th>INVESTIGATION NAME - ABBREVIATED DESCRIPTION</th>
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<tbody>
<tr>
<td>BLANCHARD</td>
<td>HRONOLOGY</td>
<td>EL-41</td>
<td>COREOLOGY ATGO-SHARE</td>
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<td>KIRK</td>
<td>HRONOLOGY</td>
<td>EL-41</td>
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<tr>
<td>YOUNG</td>
<td>PLANETARY</td>
<td>EL-41</td>
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</tr>
</tbody>
</table>

**Brief Description:**

The Pioneer Venus Probe, including the Pioneer Venus orbiter and the Pioneer Venus Probe LRG, Designer and Installed, is to determine the atmospheric properties of Venus along with their variability in both space and time. The investigation included the Pioneer Venus orbiter, approximately 10 kg total mass, orbiting Venus from 1978 through 1989. The orbiter was approximately 1250 km above the surface of Venus. The mission objectives were to determine the atmospheric properties of Venus along with their variability in both space and time. This was accomplished by the Pioneer Venus orbiter, which included a number of instruments to measure various properties of the Venus atmosphere. The mission was successful in achieving its objectives and provided valuable data on the atmosphere of Venus.

**Investigation Name:**

Pioneer Venus Probe LRG - PLANEHRY ATPGITHRES

**Code:**

EL-41

**Personnel:**

- PI - J.
- PI - S.C.
- PI - R.E.
- PI - R.C.
- PI - A.
This experiment involved applying differential very-long-baseline interferometry techniques to the radio signals from the entry probe and bus 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.

This experiment involved applying differential very-long-baseline interferometry techniques to the radio signals from the entry probe and bus 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.
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 shadow images were used to determine particle size and concentration. The flight sensor was similar to those flown in aircraft and balloons.

----- Pioneer Venus Probe LRG, OPANA-----

INVESTIGATION NAME= GAS CHROMATOGRAPH (LGC)

PERSONNEL
PI = J.B. Pollack
OI = F. Wolf
OI = W. Tomasko

BRIEF DESCRIPTION
The objective of this experiment was to determine the regions in Venus' atmosphere where solar energy is deposited. Six narrow-field-of-view detectors were used to measure the intensity 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.

----- Pioneer Venus Probe LRG, TOMASKO-----

INVESTIGATION NAME= SOLAR FLUX RADIOMETER (LSFR)

PERSONNEL
PI = J.B. Pollack
OI = W. Tomasko

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 intensity 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.
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.
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.
SPACECRAFT

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

SPACECRAFT COMMON NAME - MARINER 9
ALTERNATE NAME - PL-9

NSSDC ID - 6A-014A
LAUNCH DATE - 11/26/69
LAUNCH SITE - CAPE CANAVERAL - UNITED STATES
LAUNCH VEHICLE - TITAN
SPONSORING COUNTRY/AGENCY - UNITED STATES NASA-OSA

INITIAL ORBIT PARAMETERS
ORBIT TYPE - Mars Flyby
PERSONNEL
PM - H.M. SCHUMMEL NASA-JPL
PS - J.M. STALLKAMP NASA-JPL

BRIEF DESCRIPTION
Mariner 9 was the sixth in a series of spacecraft used for planetary exploration in a flyby mode. It was designed to conduct close-in, scientific observations of the planet Mars and to return these observations to Earth. The spacecraft was solar-powered and capable of continuous telemetry transmission. It was fully automated in operation, although it could be reprogrammed from Earth during the mission. The spacecraft was operated entirely to planetary data acquisition and no data were obtained during the trip to Mars or beyond Mars. Mariner 9 passed 3451 km from Mars on July 5, 1973. The spacecraft instruments took TV images of Mars and measured the radio reflectivity and UV and IR emissions of the Martian atmosphere. The mission was a success.

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

SPACECRAFT COMMON NAME - MARINER 10
ALTERNATE NAME - PL-10

NSSDC ID - 6A-015A
LAUNCH DATE - 03/07/72
LAUNCH SITE - CAPE CANAVERAL - UNITED STATES
LAUNCH VEHICLE - TITAN
SPONSORING COUNTRY/AGENCY - UNITED STATES NASA-OSA

INITIAL ORBIT PARAMETERS
ORBIT TYPE - Mars Flyby
PERSONNEL
PM - J.J. MARTIN NASA-JPL
PS - G.A. DOREN NASA-JPL

BRIEF DESCRIPTION
Mariner 10 was the seventh in a series of spacecraft used for planetary exploration in a flyby mode. It was identical to the Mariner 6 spacecraft. Mariner 10 was attitude stabilized in three axes (reference to the Sun and the stars, and to the plane of the solar system). 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 beyond Mars. Mariner 10 passed 3410 km from Mars on August 2, 1974. The spacecraft instruments took TV images of Mars and measured the radio reflectivity and UV and IR emissions of the Martian atmosphere. The mission was a success.

********************** MARINER 11 **********************

SPACECRAFT COMMON NAME - MARINER 11
ALTERNATE NAME - PL-11

NSSDC ID - 6A-016A
LAUNCH DATE - 11/08/73
LAUNCH SITE - CAPE CANAVERAL - UNITED STATES
LAUNCH VEHICLE - TITAN
SPONSORING COUNTRY/AGENCY - UNITED STATES NASA-OSA

INITIAL ORBIT PARAMETERS
ORBIT TYPE - Mars Flyby
PERSONNEL
PM - J.J. MARTIN NASA-JPL
PS - R.G. STEINBACHER NASA-JPL

BRIEF DESCRIPTION
Mariner 11 was the eighth in a series of spacecraft used for planetary exploration in a flyby mode. It was identical to the Mariner 6 spacecraft. Mariner 11 was attitude stabilized in three axes (reference to the Sun and the stars, and to the plane of the solar system). 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 beyond Mars. Mariner 11 passed 3281 km from Mars on August 4, 1975. The spacecraft instruments took TV images of Mars and measured the radio reflectivity and UV and IR emissions of the Martian atmosphere. The mission was a success.

********************** MARINER 12 **********************

SPACECRAFT COMMON NAME - MARINER 12
ALTERNATE NAME - PL-12

NSSDC ID - 6A-017A
LAUNCH DATE - 07/01/75
LAUNCH SITE - CAPE CANAVERAL - UNITED STATES
LAUNCH VEHICLE - TITAN
SPONSORING COUNTRY/AGENCY - UNITED STATES NASA-OSA

INITIAL ORBIT PARAMETERS
ORBIT TYPE - Mars Flyby
PERSONNEL
PM - J.J. MARTIN NASA-JPL
PS - R.G. STEINBACHER NASA-JPL

BRIEF DESCRIPTION
Mariner 12 was the ninth in a series of spacecraft used for planetary exploration in a flyby mode. It was identical to the Mariner 6 spacecraft. Mariner 12 was attitude stabilized in three axes (reference to the Sun and the stars, and to the plane of the solar system). 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 beyond Mars. Mariner 12 passed 3564 km from Mars on August 2, 1976. The spacecraft instruments took TV images of Mars and measured the radio reflectivity and UV and IR emissions of the Martian atmosphere. The mission was a success.
The Viking spacecraft was the landing vehicle for the twopart spacecraft mission. It soft-landed on September 3, 1976, in the Utopia region of Mars at 45.67 degrees north latitude and 230.95 degrees east longitude. The lander carried instruments to study the biology, chemical composition (organics and inorganics), meteorology, magnetic properties, surface appearance, and physical properties of the Martian surface and atmosphere. The lander had a 74-w power capacity and a scientific payload of approximately 9.1 kg (20 lb). Some of the data collected were returned by direct radio link to earth, but most of the data were relayed through one of the orbiters. The lander was approximately 3.6 across and about 2.4 high. The Viking Lander 2 ceased operating on April 15, 1981. For a detailed description of the Viking mission and experiments see "Scientific Results of the Viking Planets," J. Geophys. Res., v. 82, n. 26, 1977.

**SPACECRAFT COMMON NAME:** VIKING 2 ORBITER

**ALTERNATE NAMES:** PL-T52A, VIKING-M ORBITER

**NSSDC ID:** 75-03A

**LAUNCH DATE:** 09/09/75

**WEIGHT:** 1972. KG

**LAUNCH SITE:** CAPE CANAVERAL, UNITED STATES

**LAUNCH VEHICLE:** TITAN

**SPONSORING COUNTRY/AGENCY:** UNITED STATES

**ORBIT PARAMETERS**

**ORBIT TYPE:** HELIOCENTRIC

**EPOCH DATE:** 08/29/76

**INCLINATION:** 55.2 DEG

**PERIGEE:** 1499 KM ALT

**APOGEE:** 35802 KM ALT

**PERSONNEL**

**PR: G.A. MARTIN(NASA)**

**PS: G.A. SOFFEN(NASA)**

**NSSDC ID:** 75-03C

**LAUNCH DATE:** 09/09/75

**WEIGHT:** 598. KG

**LAUNCH SITE:** CAPE CANAVERAL, UNITED STATES

**LAUNCH VEHICLE:** TITAN

**SPONSORING COUNTRY/AGENCY:** UNITED STATES

**ORBIT PARAMETERS**

**ORBIT TYPE:** MARS LANDER

**PERSONNEL**

**PR: J.O. MARTIN(NASA)**

**PS: G.A. SOFFEN(NASA)**

**NSSDC ID:** 64-077A

**INVESTIGATIVE PROGRAM**

**CODE:** 66-4 SCIENCE

**INVESTIGATION DISCIPLINE(S):** PLANETOLOGY

**PERSONNEL**

**FT: R.K. LEIGHTON**

**CAIEF INF STT 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 normal reflection telescope with a 350-mm effective focal length and a 1.65 degrees field of view, (2) a shutter and filter assembly that had 0.8- and 0.2-μm exposure times and used red and green filters, (3) a slow scan vidicon tube with a 0.22- by 0.22-in. target, which translated the optical image into an electrical video signal, and (4) related electronics including a TV data encoder. On July 14, 1966, at 0208 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 acquisition of the spacecraft by Mars by the radio subsystem from July 15 to 24, 1966, and were processed in real time by a 704A/104A system to format magnetic tapes of the image data for processing by the larger television processing program and for conversion to a film record. Conversion from electrical signals to an optical image was performed by the vidicon-to-filter recording system using 64 shades. The experiment yielded 22 pictures plus 21 lines of picture 22. This performance indicated a normal recording sequence. Computer processing programs produced photographs with greater contrast than the raw image data. A detailed description of the television experiment, data processing, and the various versions of the photographs can be found in the JPL "Mars DTV Image Processing Experiments Part I. Investigator Reports," of the Mars TV Images of Mars, TX 12-30-65, 1967.
 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 180 times more surface area than the near-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 16 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 12 min 50 s before encounter and 2 min 55 s after encounter along a track that crossed the equatorial zones of the planet and included known light and dark features of the Martian surface. The narrow-angle camera was used for both near- and far-encounter pictures and was used only for near-encounter pictures. The near-encounter pictures were obtained between 22 and 7.7 h from closest approach. TV pictures taken aboard and recorded on the onboard television and data storage subsystems. For each picture, produced by the cameras, there were separate encoded versions, which 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 controlling the three data streams (CAV, DV, and ETE). This generated video data as they existed coming out of the camera. Movies of teleexecuted video magnetic tapes were displayed on a VDU and photographed on 70-mm film to produce the final images. They were also digitally processed by an IBM 360/44 computer for enhancement and by an IBM 360/475 for noise filtration. The original data contained in data set "SIC through "OH." Detailed information on the digital processing procedures can be found in "Digital Processing of the Mariner 6 and 7 Pictures." T. C. Kindt et al., J. Geophys. Res., vol. 36, pt. 9, pp. 3964-3975, January 1971. Accurate trajectory and related geometrical data can be found in Mariner Mars 1969 Simulated TV Pictures (finals). J. K. Campbell, 1970, which was issued by JPL.

---

VESTING 1 ORBITER, CARE

INVESTIGATION NAME- ORBITER IMAGING

INVESTIGATION CODE- ORB-01

INVESTIGATION DISCIPLINE(S)- PLANETARY ATMOSPHERES

INVESTIGATION PERSONNEL

PI - H. C. MASON

CANDIDATE PERSONNEL

T. L. MASON

US GEOLOGICAL SURVEY

U OF ARIZONA

CORNELL U

NASA-JPL

VESTING 2 ORBITER, CARE

INVESTIGATION NAME- ORBITER IMAGING

INVESTIGATION CODE- ORB-02

INVESTIGATION DISCIPLINE(S)- PLANETARY ATMOSPHERES

INVESTIGATION PERSONNEL

PI - H. C. MASON

CANDIDATE PERSONNEL

T. L. MASON

US GEOLOGICAL SURVEY

U OF ARIZONA

CORNELL U

NASA-JPL
PERSONNEL
TL - T.A. Mutch (deceased) NASA HEADQUARTERS
TM - C. Sagan CORNELL U
TM - A.B. Bennett U OF KIEL
TP - E.C. Morris US GEOLOGICAL SURVEY
TM - F.O. Huck NASA-JPL
TP - E.C. Levenson NUCLEAR REGULATORY COM
TM - S. Lieders, Jr. STANFORD U
TM - J.R. Pollack NASA-AIRC
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 using two single-element black-and-white cameras mounted on the lander platform. Each camera had an optical axis offset by 1.28 deg. Each of the two identical cameras on each orbiter consisted of a 20 deg field of view, focal length telescope and a single detector plane used to record the intensity of the image band passed by a mask. The two cameras were used to create a stereo view of the surface with relative metric accuracy. Each detector plane was covered by a small detector area, 0.12 by 0.12 mm, which had a unique identifier (PICNO), which is a unique identifier corresponding to the scene. Each of the PICNOS are as follows: the first three digits denote the investigator, sixth through ninth digits were the letter A to I in Viking Orbiter 1 and B to D in Viking Orbiter 2, and the last two digits are the frame number.

VEIYING 1 LANDER, MUTCH---

INVESTIGATION NAME: Lander Imaging
NSSC 1975-7575-66 INVESTIGATIVE PROGRAM
CODE EL-4 SCIENCE
INVESTIGATIVE DISCIPLINE(S)
PLANETARY ATMOSPHERES
MORPHOLOGY
PLANETOLOGY

PERSONNEL
TL - T.A. Mutch (deceased) NASA HEADQUARTERS
TM - C. Sagan CORNELL U
TM - A.B. Bennett U OF KIEL
TP - E.C. Morris US GEOLOGICAL SURVEY
TM - F.O. Huck NASA-JPL
TP - E.C. Levenson NUCLEAR REGULATORY COM
TM - S. Lieders, Jr. STANFORD U
TM - J.R. Pollack NASA-AIRC
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 using two single-element black-and-white cameras mounted on the lander platform. Each camera had an optical axis offset by 1.28 deg. Each of the two identical cameras on each orbiter consisted of a 20 deg field of view, focal length telescope and a single detector plane used to record the intensity of the image band passed by a mask. The two cameras were used to create a stereo view of the surface with relative metric accuracy. Each detector plane was covered by a small detector area, 0.12 by 0.12 mm, which had a unique identifier (PICNO), which is a unique identifier corresponding to the scene. Each of the PICNOS are as follows: the first three digits denote the investigator, sixth through ninth digits were the letter A to I in Viking Orbiter 1 and B to D in Viking Orbiter 2, and the last two digits are the frame number.

VEIYING 3 LANDER, MUTCH---

INVESTIGATION NAME: Lander Imaging
NSSC 1975-7583-46 INVESTIGATIVE PROGRAM
CODE EL-4 SCIENCE
INVESTIGATIVE DISCIPLINE(S)
PLANETARY ATMOSPHERES
MORPHOLOGY
PLANETOLOGY

PERSONNEL
TL - T.A. Mutch (deceased) NASA HEADQUARTERS
TM - C. Sagan CORNELL U
TM - A.B. Bennett U OF KIEL
TP - E.C. Morris US GEOLOGICAL SURVEY
TM - F.O. Huck NASA-JPL
TP - E.C. Levenson NUCLEAR REGULATORY COM
TM - S. Lieders, Jr. STANFORD U
TM - J.R. Pollack NASA-AIRC
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 using two single-element black-and-white cameras mounted on the lander platform. Each camera had an optical axis offset by 1.28 deg. Each of the two identical cameras on each orbiter consisted of a 20 deg field of view, focal length telescope and a single detector plane used to record the intensity of the image band passed by a mask. The two cameras were used to create a stereo view of the surface with relative metric accuracy. Each detector plane was covered by a small detector area, 0.12 by 0.12 mm, which had a unique identifier (PICNO), which is a unique identifier corresponding to the scene. Each of the PICNOS are as follows: the first three digits denote the investigator, sixth through ninth digits were the letter A to I in Viking Orbiter 1 and B to D in Viking Orbiter 2, and the last two digits are the frame number.
Ebert-Fastie scanning monochromator with dual photomultiplier detectors, used in the focal plane of a reflecting planetary coronagraph. Imaging light passed through a baffled light shade and struck the primary telescope mirror, which focused the light through a prism 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. Diffraction 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 slit was controlled by systematically scanning the grating: with a scan from low to high-wavelength taking 3.82 s, and the grating return taking 0.18 s. The wavelength region from 1900 Å to 4100 Å was measured as one of the ten slits, and the range from 1100 Å to 2100 Å measured in second order by the other. The photomultiplier detector used for the long-wavelength range operated in the gaseous mode so that v-band measurements could be made over the entire dynamic range from 100 to 10,000 Rayleighs. The spectral resolution of the grating was 3 Å and contained 600 lines per inch. The spectrographs were produced every 3 h and contained 60 lines per inch. The entrance slit was provided with a slit width of 0.1 Å and a slit height of 0.01 Å. The grating resolution of the Ebert spectrometer was 11 Å. The exit slits were provided with an exit slit width of 0.1 Å and a slit height of 0.01 Å. The grating resolution of the Ebert spectrometer was 11 Å.

After the spectrometer, the radiation was collimated by the first half of the 'Ebert' mirror onto a diffraction grating. Diffraction 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 slit was controlled by systematically scanning the grating: with a scan from low to high-wavelength taking 3.82 s, and the grating return taking 0.18 s. The wavelength region from 1900 Å to 4100 Å was measured as one of the ten slits, and the range from 1100 Å to 2100 Å measured in second order by the other. The photomultiplier detector used for the long-wavelength range operated in the gaseous mode so that v-band measurements could be made over the entire dynamic range from 100 to 10,000 Rayleighs. The spectral resolution of the grating was 3 Å and contained 600 lines per inch. The spectrographs were produced every 3 h and contained 60 lines per inch. The entrance slit was provided with a slit width of 0.1 Å and a slit height of 0.01 Å. The grating resolution of the Ebert spectrometer was 11 Å. The exit slits were provided with an exit slit width of 0.1 Å and a slit height of 0.01 Å. The grating resolution of the Ebert spectrometer was 11 Å.}

INVESTIGATION NAME: UV SPECTROMETER

INVESTIGATION DISCIPLINE(S)

INVESTIGATIVE PROGRAM

PERSONNEL

INVESTIGATIVE DISCIPLINE(S)

PLANEVOLOGY

U OF COLORADO

INVESTIGATION DISCIPLINE(S)

PLANETARY ATMOSPHERES

U OF COLORADO

PLANEVOLOGY

U OF COLORADO

BRIEF DESCRIPTION

The Mariner 9 ultraviolet spectrometer (UVS) experiment was designed to receive UV radiation (1180 to 3520 Å) from the surface and atmosphere of Mars as a means of distinguishing between background and the surface of the planet. The UV radiation was detected by the UV spectrometer, which assimilated monochromatic radiation from the incoming radiation. The spectrometer was configured with a pair of exit slits: a light baffling, an occulting slit telescope: and three photomultiplier tubes (PMT) light sensors. The incident UV radiation passed through the baffling system, which eliminated any stray UV light, and 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 of the Ebert mirror where it was collimated and reflected onto the grating (1180 lines) so that the radiation filled the grating. The grating rotated about a small angle by a stepping motor 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 slits and were sensitive only to a narrow band near the wavelength of interest to the spectrometer. The light was then collected by the PMT and directed onto a photomultiplier tube (PMT) detector, which produced every 3 h and contained 60 lines per inch. The entrance slit was provided with a slit width of 0.1 Å and a slit height of 0.01 Å. The grating resolution of the Ebert spectrometer was 11 Å. The exit slits were provided with an exit slit width of 0.1 Å and a slit height of 0.01 Å. The grating resolution of the Ebert spectrometer was 11 Å.
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 surface 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 microns (unapodized) and 1.2 microns (apodized). To determine the atmospheric temperature, general atmospheric circulation, minor atmospheric constituents, and surface temperatures, the equivalent blackbody temperature properties as a function of latitude and local time for dark and bright areas and the polar regions. The instrument, mounted on the bottom of the spacecraft on a multipointing, autocollimating, interferometric platform, was able to calibrate its own brightness and photometric emissivity. A scan mirror (2) was mounted inside a 14-micrometer window. A solar mirror (3) and a movable mirror with electromagnetic drive (6) were used to direct the instrument's field of view from one channel to the next and divide the incoming radiation into two approximately equal components. After reflections from the entrance window and cooling, respectively, the two beams interfered with each other and were focused by the condensing mirror onto the photomultiplier 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 split output. The photomultiplier output was digitized by a digitizing phase detector. The instrument telescope had an f/8 of 2 degrees and, at closest approach (about 3,100 km), the atmospheric resolution was about 220 km by 3 km and during a single scan, about 125 km by 125 km. The spectral resolution obtained was 0.5 to 1.2 km. About 29 mln of data were obtained during the Mariner 9 near-encounter equatorial scan on July 31, 1971. However, due to the failure of the channel 1 photomultiplier, only channel 2 measurements were obtained. The quality of the data is excellent.

**BRIEF DESCRIPTION**

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obtained on July 31, 1974 using near encounter across and beyond the terminator over extraterrestrial regions. The data were used to determine the thermal inertia of the material surface as a function of the viewing geometry, the varying ground structure, and the quality of the data is good. The data have been corrected for the greater than expected response to off-axis radiation.

--- MARiner 7 NEUGRAUER

INVESTIGATION NAME: INFRARED RADIOMETRIC SURFACE TEMPERATURE

NSSDC ID: 69-621A-03 INVESTIGATIVE PROGRAM
CODE EL-24, SCIENCE
INVESTIGATION DISCIPLINE(S)
PLANETOLOGY

PERSONNEL
PI: O. NEUGRAUER
CT: G. MUNCH
CT: S. C. CHASE, JR.
CT: S. A. TERRA SANTA BARBARA RES CTR

DESCRIPTION
The equivalent blackbody temperature of the Martian surface was determined using a two-channel infrared radiometer mounted on the 12-meter and 30- to 25-meter band of a 1-meter and 20-by-20-meter detector mounted on the spacecraft. The two channels consisted of two reflecting spectrometers, each equipped with an uncoated antimony-thallium detector. The experiment used an optical train that included a rotatable plane mirror, which reflected the light into the detector telescope. The first position view was the planet, and the second measured the thermal energy radiated by the planet. The temperatures were calculated by the computer. The cycle, which lasted 23 of May (3:15 a.m.) was then repeated, beginning with a view of the Earth. Data for about 27 min were obtained on August 5, 1974, 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 the regions near the extent of the polar cap. The quality of the data was good. The data have been corrected for the greater than expected response to off-axis radiation.

--- MARiner 9 NEUGRAUER

INVESTIGATION NAME: INFRARED RADIOMETER (IR)

NSSDC ID: 70-621A-03 INVESTIGATIVE PROGRAM
CODE EL-24, SCIENCE
INVESTIGATION DISCIPLINE(S)
PLANETOLOGY

PERSONNEL
PI: O. NEUGRAUER
CT: H. KIEFFER
CT: C. MUNCH
CT: S. E. HERRICK
CT: M. NEUGRAUER
CT: S. C. CHASE, JR.
CT: D. A. M. RIGGS
CT: S. A. TERRA SANTA BARBARA RES CTR

DESCRIPTION
The thermal infrared radiometer (IRR) experiment was designed to provide an overall coverage of the surface of Mars. Brightness temperatures of the surface as a function of local view by measuring the energy radiated in the 8.6- to 12-micron and 15- to 25-micron wavelength bands, from these temperatures, the following information was derived: (1) the large-scale distribution of the thermal inertia of the surface material, (2) the influence of irregularities in the cooling curve, and (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 spectrophotometer-detector assemblies. Each assembly contained two lenses, a spectral filter, and a field stop. The detectors in each assembly were identical. However, the lenses and filters through which the radiation must pass were different. A detector was used to respond to the radiation in the 8.6- to 12-micron band and another detector to the radiation in the 15- to 25-micron band. The spectrophotometer-detector system had a resolution of 0.35 by 0.35 by 0.35 by 0.35 m. A germanium spectral filter and field lens and an infrared transmissive lens were used. The channel 2 assembly, which had a 0.7 by 0.7 deg field of view, had a silvered filter, 0.2 microns, and an infrared transmissive lens. The channel 2 assembly, which had a 0.7 by 0.7 deg field of view, had a silvered filter, 0.2 microns, and an infrared transmissive lens. The detectors were 12-junction bifacially-antireflective differential absorbers. The detector response was measured as a function of the viewing angle, the incidence of the infrared beam, and the thermal reference (2.5 K). 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 on the detector. The detector then converted the incident radiant flux to a voltage. The IRR data was taken in pairs, each pair consisting of a channel-1 sample and a channel-2 sample. Data pairs appeared at 1.25 s. The dynamic range of the instrument was 90 to 120 deg. The sensitivity of the IRR was plus or minus 0.12 deg K at 160 deg K and plus minus 0.6 deg K at 200 deg K. The IRR was mounted on the Mariner 9 planetary scan platform. The IRR had a 20-arc second aperture with an unobstructed view of Mars subtending a minimum of 3 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 deg. The thermal radiation from the planet and the detector were divided by the same energy reference. The second module viewed the planet, and the third measured the thermal energy radiated by the planet. The temperatures were calculated by the computer. The cycle, which lasted about 15 min (3:15 a.m.), was then repeated, beginning with a view of the Earth. Data for about 27 min were obtained on August 5, 1974, 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 the regions near the edge of the polar cap. The quality of the data was good. The data have been corrected for the greater than expected response to off-axis radiation.

--- VIKING 1 ORBITER - KIEFFER

INVESTIGATION NAME: INFRARED THERMAL MAPPING (ITM)

NSSDC ID: 71-621A-03 INVESTIGATIVE PROGRAM
CODE EL-24, SCIENCE
INVESTIGATION DISCIPLINE(S)
PLANETOLOGY

PERSONNEL
PI: H. KIEFFER
CT: C. MUNCH
CT: S. E. HERRICK
CT: M. NEUGRAUER
CT: S. C. CHASE, JR.
CT: D. A. M. RIGGS
CT: S. A. TERRA SANTA BARBARA RES CTR

DESCRIPTION
The purpose of the ITM experiment was to measure the temperatures of the atmosphere and surface of Mars. The amount of sunlight reflected by the planet was also measured. The ITM was a multiple-objective experiment, with four telescopes, each with seven infrared detectors, were used. The ITM was intended to provide imaging, optical, visual, and visible observations 10,12 deg K. The instrument was capable of measuring the temperature of single spots throughout a temperature range of 126 deg K to 157 deg K. The field of view was about 12.5 deg. Operation of the experiment was terminated on August 7, 1975.

--- VIKING 2 ORBITER - KIEFFER

INVESTIGATION NAME: INFRARED THERMAL MAPPING (ITM)

NSSDC ID: 75-621A-03 INVESTIGATIVE PROGRAM
CODE EL-24, SCIENCE
INVESTIGATION DISCIPLINE(S)
PLANETARY ATMOSPHERES

PERSONNEL
PI: H. KIEFFER
CT: C. MUNCH
CT: T. J. NGUYEN
CT: S. C. CHASE, JR.
CT: D. A. M. RIGGS
CT: S. A. TERRA SANTA BARBARA RES CTR

DESCRIPTION
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RADIO SCIENCE AND CELESTIAL MECHANICS

INVESTIGATION NAME: CELESTIAL MECHANICS

INVESTIGATION ID: 69-0164-03
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

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

INVESTIGATION NAME: CELESTIAL MECHANICS

INVESTIGATION ID: 69-0164-05
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 then used to provide accurate determination of a variety of astronomical quantities such as the mass of Mars, dynamics of Mars and earth, and the symmetry of the gravity field of Mars.

INVESTIGATION NAME: CELESTIAL MECHANICS

INVESTIGATION ID: 69-0164-06
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

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

--- MARINER 7 & KLORE ---

INVESTIGATION NAME: S-BAND OCCULTATION

INVESTIGATION ID: 69-0164-06
INVESTIGATIVE PROGRAM CODE EL-4, SCIENCE
INVESTIGATION DISCIPLINE(S) PLANETARY ATMOSPHERES

PERSONNEL
PI - A.J. KLORE NASA-JPL
OI - D.L. CAIN NASA-JPL
OI - G. FALCHI NASA-JPL
OI - R.L. SEEDEL 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 were used to derive the temperature, pressure, and density of the lower atmosphere of Mars, and the density of charged particles in the Martian ionosphere.

--- MARINER 9 & KLORE ---

INVESTIGATION NAME: S-BAND OCCULTATION

INVESTIGATION ID: 71-0514-08
INVESTIGATIVE PROGRAM CODE EL-4, SCIENCE
INVESTIGATION DISCIPLINE(S) PLANETARY ATMOSPHERES

PERSONNEL
PI - A.J. KLORE NASA-JPL
OI - D.L. CAIN NASA-JPL
OI - G. FALCHI NASA-JPL
OI - R.L. SEEDEL 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 were used to derive the temperature, pressure, and density of the lower atmosphere of Mars, and the density of charged particles in the Martian ionosphere.

--- VIKING 1 ORBITER, MICHAEL J. ---

INVESTIGATION NAME: ORBITER RADIO SCIENCE

INVESTIGATION ID: 75-0475-04
INVESTIGATIVE PROGRAM CODE EL-4/CO-OP, SCIENCE
INVESTIGATION DISCIPLINE(S) PLANETARY IONOSPHERES METEOROLOGY

PERSONNEL
TL - J.H. MICHAEL J. NASA-LARC
TM - E.J. SHAPIRO MASS INST OF TECH
TM - C.F. LINNELL NASA-JPL
TM - J.A. DAVIES U OF MANCHESTER
TM - A.L. CAIN NASA-JPL
TM - R.O. GROSSI BATTENFELD CORP
TM - C.A. TYLESS STANDARD O
TM - J.P. DREIS NASA-JPL
TM - R.H. BORLAND NASA-JPL
TM - C.T. STEFLIRED NASA-JPL
TM - G. REED NASA-JPL
TM - B. REASenberg MASS INST OF TECH

BRIEF DESCRIPTION

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

--- MARINER 7 & KLORE ---

INVESTIGATION NAME: S-BAND OCCULTATION

INVESTIGATION ID: 69-0164-06
INVESTIGATIVE PROGRAM CODE EL-4, SCIENCE
INVESTIGATION DISCIPLINE(S) IONOSPHERES AND RADIO PHYSICS

PERSONNEL
PI - A.J. KLORE 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 were used to derive the temperature, pressure, and density of the lower atmosphere of Mars, and the density of charged particles in the Martian ionosphere.

--- MARINER 9 & KLORE ---

INVESTIGATION NAME: S-BAND OCCULTATION

INVESTIGATION ID: 71-0514-08
INVESTIGATIVE PROGRAM CODE EL-4, SCIENCE
INVESTIGATION DISCIPLINE(S) IONOSPHERES AND RADIO PHYSICS

PERSONNEL
PI - A.J. KLORE NASA-JPL
OI - D.L. CAIN NASA-JPL
OI - G. FALCHI NASA-JPL
OI - R.L. SEEDEL 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 were used to derive the temperature, pressure, and density of the lower atmosphere of Mars, and the density of charged particles in the Martian ionosphere.

--- VIKING 1 ORBITER, MICHAEL J. ---

INVESTIGATION NAME: ORBITER RADIO SCIENCE

INVESTIGATION ID: 75-0475-04
INVESTIGATIVE PROGRAM CODE EL-4/CO-OP, SCIENCE
INVESTIGATION DISCIPLINE(S) PLANETARY IONOSPHERES METEOROLOGY

PERSONNEL
TL - J.H. MICHAEL J. NASA-LARC
TM - E.J. SHAPIRO MASS INST OF TECH
TM - C.F. LINNELL NASA-JPL
TM - J.A. DAVIES U OF MANCHESTER
TM - A.L. CAIN NASA-JPL
TM - R.O. GROSSI BATTENFELD CORP
TM - C.A. TYLESS STANDARD O
TM - J.P. DREIS NASA-JPL
TM - R.H. BORLAND NASA-JPL
TM - C.T. STEFLIRED NASA-JPL
TM - G. REED NASA-JPL
TM - B. REASenberg MASS INST OF TECH

BRIEF DESCRIPTION

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

--- MARINER 7 & KLORE ---

INVESTIGATION NAME: S-BAND OCCULTATION

INVESTIGATION ID: 69-0164-06
INVESTIGATIVE PROGRAM CODE EL-4, SCIENCE
INVESTIGATION DISCIPLINE(S) IONOSPHERES AND RADIO PHYSICS

PERSONNEL
PI - A.J. KLORE 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 were used to derive the temperature, pressure, and density of the lower atmosphere of Mars, and the density of charged particles in the Martian ionosphere.
These are four distinct sets of VIKING radio science data, obtained primarily using lander data with calibrations from orbiter data. The orbiter tracking data were obtained with the two-way lander-transelector X- and S-band radio links. These data were obtained by the positioning of the landers and by the orbiter. In this investigation, these two methods are combined. The data obtained by the orbiter was then corrected because of the precessional motion of the planet. Consequently, the lander tracking was used to determine the location of the lander on the planet surface. This also was done to determine the location of the landers and studies of the motion of the planet.

INVESTIGATION NAME: Lander Radio Science

INVESTIGATION DISCIPLINE(S): Planetology

PERSONNEL
TL: W.H. MICHAEL, JR.
TM: D. LAMBERT
TM: J.G. LINDAL
TM: J.J. DAVIES
TM: B.J. CHAN
TM: J.M. CROSS
TM: W.L. TYSER
TM: R.W. DREXLER
TM: W.R. TOLSON
TM: C.T. STELKER
TM: D. BORN
TM: G. BORN

BRIEF DESCRIPTION
This experiment used the Lander S-band radio transceiver to acquire signals for the landers utilizing the same Deep Space Network facilities that were used by the orbiters. The resulting data were obtained by the use of the location of the lander on the planet surface. The data also were used to determine the motion of the lander. Consequently, the lander tracking was used to determine the location of the lander on the planet surface. This was done to determine the location of the lander and studies of the motion of the planet.

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

INVESTIGATION NAME: ORBITER RADIO SCIENCE

INVESTIGATION DISCIPLINE(S): Planetary Ionospheres

PERSONNEL
TL: W.H. MICHAEL, JR.
TM: D. LAMBERT
TM: J.G. LINDAL
TM: J.J. DAVIES
TM: B.J. CHAN
TM: J.M. CROSS
TM: W.L. TYSER
TM: R.W. DREXLER
TM: W.R. TOLSON
TM: C.T. STELKER
TM: D. BORN
TM: G. BORN

BRIEF DESCRIPTION
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The Viking entry science ionospheric properties experiment (one of three that were part of the entry science investigation) studied the Martian atmosphere and the mean atomic mass can be calculated.
INVESTIGATION NAME- METEOROLOGY

INVESTIGATION DISCIPLINE(S)
PLANETARY ATMOSPHERES

PERSONNEL

TL = S.L. HESS (DECEASED)
TM = C.P. LEONY
TH = R.W. HENRY
TM = J.E. TULLMAN

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 housed in a brass box. Three hot-filament anemometers, through which an electric current was passed to heat two glass needles coated with platinum and covered 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 measured in volts. 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.

INVESTIGATION NAME- METEOROLOGY

INVESTIGATION DISCIPLINE(S)
PLANETARY ATMOSPHERES

PERSONNEL

TL = S.L. HESS (DECEASED)
TM = C.P. LEONY
TH = R.W. HENRY
TM = J.E. TULLMAN

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 housed in a brass box. Three hot-filament anemometers, through which an electric current was passed to heat two glass needles coated with platinum and covered 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 measured in volts. 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.

INVESTIGATION NAME- METEOROLOGY

INVESTIGATION DISCIPLINE(S)
PLANETARY ATMOSPHERES

PERSONNEL

TL = S.L. HESS (DECEASED)
TM = C.P. LEONY
TH = R.W. HENRY
TM = J.E. TULLMAN

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 housed in a brass box. Three hot-filament anemometers, through which an electric current was passed to heat two glass needles coated with platinum and covered 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 measured in volts. 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.

INVESTIGATION NAME- PHYSICAL PROPERTIES

INVESTIGATION DISCIPLINE(S)
PLANETARY BIOLOGY

PERSONNEL

TL = L.W. SHORTILL
TM = R.S. MARTIN
TH = G.J. MOORE II
TM = R.S. SCOTT

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 science objectives. In particular, it is attempted to determine such properties as bulk density, bearing strength, angle of repose, cohesion, angle of internal friction, particle characteristics, thermal parameters, contaminant transportability, topography, and certain environmental properties such as wind speed, and solar flux characteristics. The investigation was made of hardware and instruments intended for other applications, such as the mechanical subsystem and lander cameras. Only passive devices, such as mirrors and landing leg strobe gauges, were used for this experiment.

INVESTIGATION NAME- INORGANIC ANALYSES

INVESTIGATION DISCIPLINE(S)
PLANETARY BIOLOGY

PERSONNEL

TL = L.W. SHORTILL
TM = R.S. MARTIN
TH = G.J. MOORE II
TM = R.S. SCOTT

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 science objectives. In particular, it is attempted to determine such properties as bulk density, bearing strength, angle of repose, cohesion, angle of internal friction, particle characteristics, thermal parameters, contaminant transportability, topography, and certain environmental properties such as wind speed, and solar flux characteristics. The investigation was made of hardware and instruments intended for other applications, such as the mechanical subsystem and lander cameras. Only passive devices, such as mirrors and landing leg strobe gauges, were used for this experiment.

INVESTIGATION NAME- INORGANIC ANALYSES

INVESTIGATION DISCIPLINE(S)
PLANETARY BIOLOGY

PERSONNEL

TL = L.W. SHORTILL
TM = R.S. MARTIN
TH = G.J. MOORE II
TM = R.S. SCOTT

BRIEF DESCRIPTION
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INVESTIGATION NAME- INORGANIC ANALYSES

INVESTIGATION DISCIPLINE(S)
PLANETARY BIOLOGY

PERSONNEL

TL = L.W. SHORTILL
TM = R.S. MARTIN
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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 science objectives. In particular, it is attempted to determine such properties as bulk density, bearing strength, angle of repose, cohesion, angle of internal friction, particle characteristics, thermal parameters, contaminant transportability, topography, and certain environmental properties such as wind speed, and solar flux characteristics. The investigation was made of hardware and instruments intended for other applications, such as the mechanical subsystem and lander cameras. Only passive devices, such as mirrors and landing leg strobe gauges, were used for this experiment.

INVESTIGATION NAME- INORGANIC ANALYSES

INVESTIGATION DISCIPLINE(S)
PLANETARY BIOLOGY

PERSONNEL

TL = L.W. SHORTILL
TM = R.S. MARTIN
TH = G.J. MOORE II
TM = R.S. SCOTT

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 science objectives. In particular, it is attempted to determine such properties as bulk density, bearing strength, angle of repose, cohesion, angle of internal friction, particle characteristics, thermal parameters, contaminant transportability, topography, and certain environmental properties such as wind speed, and solar flux characteristics. The investigation was made of hardware and instruments intended for other applications, such as the mechanical subsystem and lander cameras. Only passive devices, such as mirrors and landing leg strobe gauges, were used for this experiment.
The biological experiment searched for the presence of Martian organisms by looking for metabolic products. Three distinct instruments (pyrolytic release (PR), and gas exchange (GE)) incubated samples of the Martian surface under a number of different environmental conditions. In some instances a sample was heated sterilized and reprocessed as a control. The PR, or carbon assimilation instrument sought to detect the photosynthetic or chemical fixation of CO2 and CO containing C-14. The samples were collected over several days in the presence of the radioactive gas mixture, some samples with simulated sunlight and some without. Beside each sample was heated to 120°C to remove unreacted CO2 and CO. The CO2 was filtered at 60°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 radioactivity. Liquid nutrients labeled with radioactive carbon were added to the samples, and the atmosphere above was continuously monitored for any radioactive gases released from these nutrients. The LR measured the production and uptake of CO2, N2, CH4, N2O and CO2 during incubation of a soil sample. The sample was aerated and purged by CO2 then a mixture of N2, H2, and CO2 was introduced as an initial incubation atmosphere. After the addition of a selection of C-14 labeled nutrient solution containing either a nutrient or a soil sample, the sample was incubated. At certain intervals, samples of the atmosphere were removed and analyzed by gas chromatography 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 (GE)) 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, then samples with simulated sunlight and some without. Next, each sample was heated to 120°C to remove unreacted CO2 and CO. The soil was warmed at 65°C and any organic products were collected in an argon gas trap (I001). 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 LR measured the production and/or uptake of CO2, N2O, CH4, H2, and C2 during incubation of a soil sample. The sample was sealed and purged with N2, then a mixture of 14CO2 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, nearly 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, ANDERSON ******

INVESTIGATION NAME- MOLECULAR ANALYSIS

NSSDC ID- 75-0031-46

SEE THIS EXPERIMENT UNDER SURFACE CHEMISTRY

****** VIKING 2 LANDER, DIERMANN ******

INVESTIGATION NAME- MOLECULAR ANALYSIS

NSSDC ID- 75-0032-44

SEE THIS EXPERIMENT UNDER SURFACE CHEMISTRY

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

INVESTIGATION NAME- SEISMOLOGY

NSSDC ID- 75-0031-46

INVESTIGATION PROGRAM

CORE EL-RE, SCIENCE

INVESTIGATION DISCIPLINE(S)

PLANETOLOGY

PLANETARY PHYSICS

PERSONNEL

TL - R.L. ANDERSON
TM - J.C. ELLISON
TM - G.W. SUTTON
TM - R.L. KOVACH
TM - G.J. LANDER
TM - F. DIEHNEN

CALIF INST OF TECH

MASS INST OF TECH

U OF HAWAII

STANFORD U

U OF WASH

PERSPECTIVE

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. Its operating modes were (1) selection of various filters for frequency content and 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; and (4) a compressed medium rate for continuous monitoring of events 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 operate and could not be used in a seismic network with the Viking 2 instrument.

59
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.
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.
**SPACESHIP**

**SPACECRAFT COMMON NAME - PIONEER 11**
ALTERNATE NAMES - PIONEER 11
LAUNCH DATE - 04/06/73
WEIGHT - 231 KG
LAUNCH SITE - CANSAT, CAPE CANAVERAL, UNITED STATES
LAUNCH VEHICLE - ATLAS

**SPONSORING COUNTRY/AGENCY**
UNITED STATES

**INITIAL ORBIT PARAMETERS**

**ORDER TYPE - SATURN FLIGHT**

**PERSONNEL**
PM - J.C. WALL(OLA)
PS - F. RYAL

**BRIEF DESCRIPTION**

This mission was the first to be sent to the outer solar system, and after encountering the planet Jupiter it entered 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 ceiling and bottom being regular hexagons. Its sides were 71 cm long. The main body was a smaller compartment that carried the scientific experiments. The highest gain antenna was located on three stools, which projected forward about 1.2 m. This feed was topped with a 36-cm-reflector, and the spacecraft was extended about 0.76 m behind the equipment compartment and was located below the high-gain antenna. Power for the spacecraft was obtained by four SNAP-19 radioisotope thermoelectric generators (RTG's) which were located above and 30 deg from the center of the spacecraft by l/b� MOVING TRUCKS 250 deg apart. A third cone was extended about 6.1 m from the experiment compartment to hold the magnetotriometer, which was connected to the spacecraft. The four RTG's generated about 155 watts at launch and decreased to approximately 146 watts by the time the spacecraft reached Jupiter on December 3, 1973, 3 months after launch. There were three receiver sensors: a star sensor for Canopus, and two sun sensors. The antenna could be controlled from the spacecraft to the earth and the sun, with the known direction to Canopus as a backup. Three pairs of rocket thrusters provided spin-rate control (mainly 5 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 antennae, which operated together, connected to one receiver, while the high-gain antenna was connected to another receiver. The signals could be switched by command to provide some redundancy. Two radio transmitters coupled to two traveling-wave tube amplifiers, produced 8 watts at 2190 MHz each. Uplink was accomplished at 2190 MHz while data transmission downlink was at 2199 MHz. The data were received by NASA's Deep Space Network. The spacecraft was equipped with a ring antenna between about 21 deg and 30 deg, which was used for the experiment. Fifteen experiments were conducted to study the interplanetary plasma and electromagnetic field of the solar system, as well as the solar, Jovian, and Uranian magnetic fields. The solar and Jovian parameters were determined by radio and ionization methods, the structures of the inner solar system were studied, and the Jovian magnetic field was measured. In addition, the solar plasma was studied by the magnetotriometer, charged-particle detector, ionizing detector, magnetic field, and plasma detectors. The magnetotriometer detected solar wind particles from the sun and the earth into our galaxy, it is leaving the solar system and passing into interstellar space.
and radiometers, UV spectrometers, fluorescent spectrometers, Faraday cups, charged-particle analyzers, plasma detectors, plasma-wave radio receivers, a solar millimeter-wave 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.

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**INVESTIGATIONS**

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**INVESTIGATION NAME: IMAGING POLAROPOLARIMETER (IPP)**

**NSDC ID**: 79-082-07

**INVESTIGATIVE PROGRAM**: CODE 41-4, SCIENCE

**INVESTIGATION DISCIPLINE(S)**: ATMOSPHERIC PHYSICS

**PERSONNEL**

01 - R.A. GEHrels U OF ARIZONA
01 - W.K. HOOREN SANTA BARBARA DES ETH

**BRIEF DESCRIPTION**

The Imaging Polaropolarimeter (IPP) experiment used during Voyager's encounter with Jupiter and the jovian satellites. The polarimetric and radiometric work was performed using a 4-8 meter field-stop aperture, while the split-scan imaging used a 0.5-2 meter aperture stop. Radiometric calibration was performed using an internal integrating lamp. Long-term absolute calibration of the instrument was achieved by means of a sunlight diffuser/releaser element located in the spacecraft antenna structure. Primary radiometric calibration was done throughout the mission by periodically pointing the telescope to view this diffuse background source. The experimental results for the IPP package consisted of the following elements: (1) a narrow-lightpass filters, 0.5-2.5 meter aperture, focal plane telescope of focal ratio F/5, a focal-plane wave containing field-of-view (FOV) aperture, spectrometer, calibration source, etc., (2) a polarizer prism to split the light into two orthogonally polarized beams, (3) a 65-deg dichroic mirror that reflected wavelengths of less than 5500 A (red beam) and transmitted all light of longer wavelength (blue beam), (4) a filtering-coated relay lens and folding mirrors for each spectral beam (the two polarizations were separated), and (5) two Bessel channel (blue - 3600 to 3800 A, red - 3800 to 7000 A) polarimeters and radiometric measurements, and moderate-resolution (about 200 km) at best) split-scan images of Jupiter and the jovian satellites. The experiment was performed using a 4-8 meter field-stop aperture, while the split-scan imaging used a 0.5-2 meter aperture stop. Radiometric calibration was performed using an internal integrating lamp. Long-term absolute calibration of the instrument was achieved by means of a sunlight diffuser/releaser element located in the spacecraft antenna structure. Primary radiometric calibration was done throughout the mission by periodically pointing the telescope to view this diffuse background source. The experiment for the IPP package consisted of the following elements: (1) a narrow-lightpass filters, 0.5-2.5 meter aperture, focal plane telescope of focal ratio F/5, a focal-plane wave containing field-of-view (FOV) aperture, spectrometer, calibration source, etc., (2) a polarizer prism to split the light into two orthogonally polarized beams, (3) a 65-deg dichroic mirror that reflected wavelengths of less than 5500 A (red beam) and transmitted all light of longer wavelength (blue beam), (4) a filtering-coated relay lens and folding mirrors for each spectral beam (the two polarizations were separated), and (5) two Bessel channel (blue - 3600 to 3800 A, red - 3800 to 7000 A) photopolarimeters for each spectral beam to register the intensity in each polarization component. Polariometer data also include the interplanetary region.
development) and high resolution of the Great Red Spot. The objectives of the satellite encounters included the following: (1) gross characteristics (color, shape, rotation, spin axis, cartography, improved aerodynamics 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, fronts, and limb stratification of aerosols) (3) surface properties (spectroscopy, scattering function, nature of brightness, variation, and search for new satellites.) Studies of Saturn's rings included (3) resolution of individual rings or clumps of material, (2) vertical and radial distribution of material at very high resolution; (3) scattering function; (4) coarse polarimeter; (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.

--- PIONEER 10 WOLFE ---

INVESTIGATOR NAME - PLASMA

NSSC 10-72-099A-01 INVESTIGATIVE PROGRAM CORE EL-4/4: SCIENCE

INVESTIGATION DISCIPLINE(S)

PARTICLES AND FIELDS

PERSONNEL

P1 - J.W. WOLFE
01 - L.A. FRANK
01 - R. LUST
01 - J.E. MEIKOIN
01 - F.L. SCHE
01 - M.C. COLBRO
01 - W.C. FELDMAN
01 - J.I. SHI

NASA-ARC

NASA-MPS-HQ

NASA-SH

NASA-ARC

TWM SYSTEMS GROUP

NASA

LOS ALAMOS NAT LAB

NASA-ARC

BRIEF DESCRIPTION

The instrument (also carried on Pioneer 11) consisted of dual 90-deg quadrupolar 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 16 keV for protons and approximately 0.01 keV for electrons. The high-resolution analyzer, with a constant of 6 keV/keV applied to the plates, had a mean plate radius of 7 cm and separation of 0.5 cm. This analyzer, which was used to measure ions only, had 26 channeltron current collectors on the spin axis. The other plate subtended 25 deg with respect to the spin axis. The channeltron collector was centered to plus or minus 51 deg. Each channeltron collector covered 3 deg and approximately 8 deg near the edge of the detector. The angular width was about 2 deg. In one half the spin period the channeltron collector was swept out a distance of about 2 cm. The high-resolution analyzer with a mean radius of 7 cm was mounted on the spin axis, and the proton temperature could be measured down to 0.007 deg K. Data included the interplanetary region.

--- PIONEER 10 WOLFE ---

INVESTIGATOR NAME - PLASMA

NSSC 10-72-099A-13 INVESTIGATIVE PROGRAM CORE EL-4/4: SCIENCE

INVESTIGATION DISCIPLINE(S)

SPACE PLASMAS

PARTICLES AND FIELDS

PERSONNEL

P1 - J.W. WOLFE
01 - L.A. FRANK
01 - R. LUST
01 - J.E. MEIKOIN
01 - F.L. SCHE
01 - M.C. COLBRO
01 - W.C. FELDMAN
01 - J.I. SHI

NASA-ARC

NASA-MPS-HQ

NASA-SH

NASA-ARC

TWM SYSTEMS GROUP

NASA

LOS ALAMOS NAT LAB

NASA-ARC

BRIEF DESCRIPTION

The instrument consisted of dual 90-deg quadrupolar 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 16 keV for protons and approximately 0.01 keV for electrons. The high-resolution analyzer with a constant of 6 keV/keV applied to the plates, had a mean plate radius of 7 cm and separation of 0.5 cm. This analyzer, which was used to measure ions only, had 26 channeltron current collectors on the spin axis. The other plate subtended 25 deg with respect to the spin axis. The channeltron collector was centered to plus or minus 51 deg. Each channeltron collector covered 3 deg and approximately 8 deg near the edge of the detector. The angular width was about 2 deg. In one half the spin period the channeltron collector was swept out a distance of about 2 cm. The high-resolution analyzer with a mean radius of 7 cm was mounted on the spin axis, and the proton temperature could be measured down to 0.007 deg K. Data included the interplanetary region.

--- PIONEER 10 WOLFE ---

INVESTIGATOR NAME - PLASMA

NSSC 10-72-099A-13 INVESTIGATIVE PROGRAM CORE EL-4/4: SCIENCE

INVESTIGATION DISCIPLINE(S)

SPACE PLASMAS

PARTICLES AND FIELDS

PERSONNEL

P1 - J.W. WOLFE
01 - L.A. FRANK
01 - R. LUST
01 - J.E. MEIKOIN
01 - F.L. SCHE
01 - M.C. COLBRO
01 - W.C. FELDMAN
01 - J.I. SHI

NASA-ARC

NASA-MPS-HQ

NASA-SH

NASA-ARC

TWM SYSTEMS GROUP

NASA

LOS ALAMOS NAT LAB

NASA-ARC

BRIEF DESCRIPTION

The instrument consisted of dual 90-deg quadrupolar 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 16 keV for protons and approximately 0.01 keV for electrons. The high-resolution analyzer with a constant of 6 keV/keV applied to the plates, had a mean plate radius of 7 cm and separation of 0.5 cm. This analyzer, which was used to measure ions only, had 26 channeltron current collectors on the spin axis. The other plate subtended 25 deg with respect to the spin axis. The channeltron collector was centered to plus or minus 51 deg. Each channeltron collector covered 3 deg and approximately 8 deg near the edge of the detector. The angular width was about 2 deg. In one half the spin period the channeltron collector was swept out a distance of about 2 cm. The high-resolution analyzer with a mean radius of 7 cm was mounted on the spin axis, and the proton temperature could be measured down to 0.007 deg K. Data included the interplanetary region.
collectors had an angular width of $47.5\,\text{deg}$ and were located at plus or minus $44.25\,\text{deg}$ from the center of the analyser. 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 to change every half-resolution of the analyzer, and all current collectors or channeled ions were read out at the peak plus F1/C1L amplitude. The high and low resolution analyzers operated independently, so a cross check between these analyzers was possible. The energy range for the particle fluxes was from 3 MeV down to 30 eV/amu and the proton temperature from 2 to 10 keV could be ascertained. Data include the interplanetary region.

Voyager 1, Primary

INVESTIGATION NAME: LOW-ENERGY CHARGED PARTICLE ANALYZER AND TELESCOPE

NSSDC ID: 77-0644-06
INVESTIGATIVE PROGRAM CODE EL-4(0)/OP, SCIENCE
INVESTIGATION DISCIPLINE(S): COSMIC RAYS
MAGNETOSPHERIC PHYSICS
PARTICLES AND FIELDS

PERSONNEL
PI - J.L. SCARF
CI - J.J. LEICHT
CI - M. GADOMSKI
CI - T.P. ARMSTRONG
CI - T.J. EHLERS
CI - C.R. HARTLE

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 was used to obtain proton and heavier ion fluxes at the planet. The proton and heavier ion fluxes were separated and their energy measured in the range from 30 to 30 keV using a low-energy particle telescope.

Voyager 2, Primary

INVESTIGATION NAME: LOW-ENERGY CHARGED PARTICLE ANALYZER AND TELESCOPE

NSSDC ID: 77-0644-07
INVESTIGATIVE PROGRAM CODE EL-4(0)/OP, SCIENCE
INVESTIGATION DISCIPLINE(S): COSMIC RAYS
MAGNETOSPHERIC PHYSICS
PARTICLES AND FIELDS

PERSONNEL
PI - J.L. SCARF
CI - J.J. LEICHT
CI - M. GADOMSKI
CI - T.P. ARMSTRONG
CI - T.J. EHLERS
CI - C.R. HARTLE

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 was used to obtain proton and heavier ion fluxes at the planet. The proton and heavier ion fluxes were separated and their energy measured in the range from 30 to 30 keV using a low-energy particle telescope.
The plasma investigation was use of two Faraday-cup detectors, one pointed along the earth-spacecraft line and one at right angles to this line. The earth-pointing detectors determined the macroscopic properties of the plasma ions, while the sun-pointing detectors determined the microstructure. Three sequential energy scans were employed with teletias 63°1 equal to 29°, 72°, and 1.2°, allowing a coverage from protons to slightly supersonic flow. The slow-timing Faraday cup measured electrons in the energy range from 5 eV to 1 keV.

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

INVESTIGATION NAME- MAGNETIC FIELDS
NSSDC ID- 72-0124-01 INVESTIGATIVE PROGRAM CODE EL-4, SCIENCE
INVESTIGATION DISCIPLINE(S) PARTICLES AND FIELDS PLANETARY MAGNETIC FIELD MAGNETICOPHYSICS

PERSONNEL
PI - E.J. SMITH NASA-JPL
C1 - J.E. COLBURN NASA-GSFC
C1 - P. DYK NASA-GSFC
C1 - J.P. SONNET U OF ARIZONA
C1 - P.J. COLERAN, JR. U OF CALIF-LA
C1 - D.J. JONES BRIGHAM YOUNG U

BRIEF DESCRIPTION
The magnetometer on Pioneer 11 was a tridimensional magnetometer with seven dynamic ranges, from plus or minus 2,5 nT to plus or minus 10 Gauss. The linearity was ±1.5°, and the noise threshold was ±0.01 nT for ±2°. The accuracy was ±5% of full scale range. The experiment worked as planned until November 1975, when the spacecraft entered into a coronal plasma region. Four continuous sets of data were obtained. The experiment has used RMI coordinates in its data set. In its operation, it is pointed radially outward from the sun. The magnetic field was greater than ±10 nT, and the spacecraft was in a sun-oriented equilibrium state (i.e., times of 50° and 10°). A detailed instrument description may be found in Smith et al., IEEE Trans. On Magnetism, v. 13, p. 1043, July 1977. Some data also include the interplanetary region.

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

INVESTIGATION NAME- MAGNETIC FIELDS
NSSDC ID- 72-0124-01 INVESTIGATIVE PROGRAM CODE EL-4, SCIENCE
INVESTIGATION DISCIPLINE(S) PLANETARY MAGNETIC FIELD MAGNETICOPHYSICS

PERSONNEL
PI - E.J. SMITH NASA-JPL
C1 - J.E. COLBURN NASA-GSFC
C1 - P. DYK NASA-GSFC
C1 - J.P. SONNET U OF ARIZONA
C1 - P.J. COLERAN, JR. U OF CALIF-LA
C1 - D.J. JONES BRIGHAM YOUNG U

BRIEF DESCRIPTION
The magnetometer on Pioneer 11 was a tridimensional magnetometer with seven dynamic ranges, from plus or minus 2,5 nT to plus or minus 10 Gauss. The linearity was ±1.5°, and the noise threshold was ±0.01 nT for ±2°. The accuracy was ±5% of full scale range. The experiment worked as planned until November 1975, when the spacecraft entered into a coronal plasma region. Four continuous sets of data were obtained. The experiment has used RMI coordinates in its data set. In its operation, it is pointed radially outward from the sun. The magnetic field was greater than ±10 nT, and the spacecraft was in a sun-oriented equilibrium state (i.e., times of 50° and 10°). A detailed instrument description may be found in Smith et al., IEEE Trans. On Magnetism, v. 13, p. 1043, July 1977. Some data also include the interplanetary region.
PERSONNEL
PI - J.A. SIMPSON U OF CHICAGO
02 - J. TUZOLINO U OF CHICAGO

BRIEF DESCRIPTION
This experiment (also carried out on Pioneer 10) 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 per proton) and 10 to 15 MeV for protons above 100 MeV; (2) the low-energy subtelescope, consisting of two elements and using a very small thin element to extend the high-sensitivity proton measurements below 1 MeV (0.5 to 9 MeV); in the presence of a high-gamma background aboard the spacecraft (3) the electrostatic detector for electrons, consisting of a beryllium-shielded 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 nuclear-induced fission of strontium 90. The detector assembly included an OPERA, an X-ray detector, and a scintillation detector. The readout of the main telescope was synchronized with the spacecraft spin period, which permitted the selection of events coincident with the presence of high fluxes of electrons. The experiment sample time was synchronized with the 1/36 second spin period. Data were recorded in burst mode by the spacecraft computer and transmitted to Earth through the Voyager spacecraft. The experiment was designed to measure the proton and electron fluxes in the interstellar medium. The results showed that the fluxes of protons were much lower than expected, and the electrons were found to be more energetic than predicted. The experiment also provided valuable information about the interstellar medium, including the presence of heavy nuclei and the magnetic field strength. Overall, the experiment was successful in achieving its goals and provided important data for further research. The data were published in the Journal of Geophysical Research, v. 79, p. 3370, 1974. Plain text.

++++ PIONEER 10 - SIMPSON +++++

INVESTIGATION NAME - CHARGED PARTICLE COMPOSITION
NSSDC ID- 73-B91A-82 INVESTIGATIVE PROGRAM CODE 61-A, SCIENCE INVESTIGATION DISCIPLINE(S) PARTICLES AND FIELDS

PERSONNEL
PI - J.A. SIMPSON U OF CHICAGO
02 - J. TUZOLINO U OF CHICAGO

BRIEF DESCRIPTION
This experiment compared five collinear electron telescopes to the electron telescope (1) and the electron telescope (2) above 77.5 MeV, which were located in the high fluxes of electrons. The experiment sample time was synchronized with the spacecraft spin period, which permitted the selection of events coincident with the presence of high fluxes of electrons. The experiment sample time was synchronized with the spacecraft spin period. Data were recorded in burst mode by the spacecraft computer and transmitted to Earth through the Voyager spacecraft. The experiment was designed to measure the proton and electron fluxes in the interstellar medium. The results showed that the fluxes of protons were much lower than expected, and the electrons were found to be more energetic than predicted. The experiment also provided valuable information about the interstellar medium, including the presence of heavy nuclei and the magnetic field strength. Overall, the experiment was successful in achieving its goals and provided important data for further research. The data were published in the Journal of Geophysical Research, v. 79, p. 3370, 1974. Plain text.

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NSSDC ID- 73-B91A-82 INVESTIGATIVE PROGRAM CODE 61-A, SCIENCE INVESTIGATION DISCIPLINE(S) PARTICLES AND FIELDS

PERSONNEL
PI - J.A. SIMPSON U OF CHICAGO
02 - J. TUZOLINO U OF CHICAGO

BRIEF DESCRIPTION
This experiment 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 per proton) and 10 to 15 MeV for protons above 100 MeV; (2) the low-energy subtelescope, consisting of two elements and using a very small thin element to extend the high-sensitivity proton measurements below 1 MeV (0.5 to 9 MeV); in the presence of a high-gamma background aboard the spacecraft (3) the electrostatic detector for electrons, consisting of a beryllium-shielded 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 nuclear-induced fission of strontium 90. The detector assembly included an OPERA, an X-ray detector, and a scintillation detector. The readout of the main telescope was synchronized with the spacecraft spin period, which permitted the selection of events coincident with the presence of high fluxes of electrons. The experiment sample time was synchronized with the spacecraft spin period. Data were recorded in burst mode by the spacecraft computer and transmitted to Earth through the Voyager spacecraft. The experiment was designed to measure the proton and electron fluxes in the interstellar medium. The results showed that the fluxes of protons were much lower than expected, and the electrons were found to be more energetic than predicted. The experiment also provided valuable information about the interstellar medium, including the presence of heavy nuclei and the magnetic field strength. Overall, the experiment was successful in achieving its goals and provided important data for further research. The data were published in the Journal of Geophysical Research, v. 79, p. 3370, 1974. Plain text.
PERSONNEL
PI - R.W. FIELDS U OF CALIF, SAN DIEGO
01 - C.J. MCELNAM U OF CALIF, SAN DIEGO
BRIEF DESCRIPTION
This experiment consisted of an array of five particle detectors, with electron thresholds in the range 0.1 to 35 MeV and proton thresholds in the range 0.1 to 35 MeV. A Cerenkov counter (C) had four output channels (C1, C2, C3, and C4) sensitive to electrons having energies above 5, 10, 15, and 20 MeV, respectively. An electron scatter counter (E) had three output channels (E1, E2, and E3) sensitive to electrons above 5, 10, and 20 MeV. A minimum ionization counter (M) had three output channels: M1 sensitive to electrons having energies greater than 20 MeV, 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 time rates. During encounter when the spacecraft was operating in the highest time rate node, the minimum time to sample one channel was 1.5 s and the time to complete a complete scan through all channels was 10 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 initially designed for counter 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. 3559, 1974.

BRIEF DESCRIPTION
This experiment consisted of three multi-element, solid-state telescopes, all lined normal to the spacecraft spin axis. It was also carried on Pioneer 11. The high-energy telescope (HET) consisted of five collinear sensors, are measured stopping powers (E = 1 to 10) in the energy range 20 to 500 MeV/nucleon. Charge resolution for penetrating particles was possible up to 200 MeV/nucleon. The first low-energy telescope (LET-1) had four elements and measured stopping (E = 1 to 5) to 10 keV/nucleon in the energy range between 2 and 2 keV/nucleon. The second low-energy telescope (LET-2) had three elements and measured stopping (E = 1 to 5) to 10 keV/nucleon in the energy range between 2 and 10 keV/nucleon. The third telescope measured 50-keV to 5-MeV electrons and 5-keV to 20-MeV protons with 2° resolution. Data include the interplanetary region.

INVESTIGATION NAME - COSMIC-RAY SPECTRA
NSDC ID - 77-92549-01
BRIEF DESCRIPTION
This experiment consisted of three 3-element telescopes all looking normal to the spacecraft spin axis. A bidirectional telescope measured 2° to 800 MeV/nucleon particles with 5 to 100° resolution. These two telescopes 2° collinearly with angles of 0 and 180°. The third telescope measured 50-keV to 1-MeV electrons and 5-keV to 20-MeV protons with 2° resolution. Data include the interplanetary region.

INVESTIGATION NAME - HIGH-AND MODERATELY LOW-ENERGY COSMIC-RAY TELESCOPE
NSDC ID - 77-92549-08
INVESTIGATIVE PROGRAM
CODE EL-4, SCIENCE
INVESTIGATION DISCIPLINE(S)
COSMIC RAYS
MAGNETOSPHERIC PHYSICS
PERSONNEL
PI - R.W. FIELDS U OF CALIF, SAN DIEGO
01 - J.H. WEISS U OF ARIZONA
01 - E.C. WEBBER U OF NEW HAMPSHIRE
01 - A.W. SCHARDT NEW HAMPSHIRE LAB
BRIEF DESCRIPTION
This experiment studied the origin and acceleration processes, 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 (LET). The HETS covered an energy range between 2 and 100 MeV/nucleon for nuclei ranging in atomic numbers from 1 through 10. In addition, electrons in the energy range between 3 and 100 MeV/nucleon were monitored by this telescope and an electron telescope (LET). The LET measured the energy and the identity of nuclei for energies between 3 and 100 MeV/nucleon. In addition, electrons in the energy range between 50 and 100 MeV/nucleon were monitored by an electron telescope.

INVESTIGATION NAME - HIGH- AND MODERATELY LOW-ENERGY COSMIC-RAY TELESCOPE
NSDC ID - 77-92549-08
BRIEF DESCRIPTION
This experiment consisted of three 3-element telescopes, all looking normal to the spacecraft spin axis. A bidirectional telescope measured 2° to 800 MeV/nucleon particles with 5 to 100° resolution. These two telescopes 2° collinearly with angles of 0 and 180°. The third telescope measured 50-keV to 1-MeV electrons and 5-keV to 20-MeV protons with 2° resolution. Data include the interplanetary region.

INVESTIGATION NAME - ULTRAVIOLET PHOTOMETRY
NSDC ID - 77-92549-08
BRIEF DESCRIPTION
This experiment studied the origin and acceleration processes, 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 (LET). The LET measured the energy range between 6 and 500 keV/nucleon for nuclei ranging in atomic numbers from 1 through 10. In addition, electrons in the energy range between 3 and 100 MeV/nucleon for nuclei ranging in atomic numbers from 1 through 10. In addition, electrons in the energy range between 3 and 100 MeV/nucleon were monitored by this telescope and an electron telescope (LET). The LET measured the energy and the identity of nuclei for energies between 3 and 100 MeV/nucleon. In addition, electrons in the energy range between 50 and 100 MeV/nucleon were monitored by an electron telescope.
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<td>PERSONNEL</td>
<td>G. JUDGE</td>
<td>U OF SOUTHERN CALIF</td>
<td>NASA-JPL</td>
</tr>
<tr>
<td>BRIEF DESCRIPTION</td>
<td>In addition, this experiment on both Pioneers 10 and 11 consisted of a broadband photometer sensitive between 200 and 800 Å. During the cruise phase of the mission, this experiment was used to search for the superionic-to-subionic 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 atmosphere and to find the ratio of hydrogen to helium in the Jovian atmosphere and to find the temperature of the upper portion of the Jovian atmosphere. The evidence of auroral oval was found in the interplanetary region indicating interactions between charged particles and neutral hydrogen.</td>
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### INVESTIGATION NAME: ULTRAVIOLET PHOTOGRAPHY

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<td>G. JUDGE</td>
<td>U OF SOUTHERN CALIF</td>
<td>NASA-JPL</td>
</tr>
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<td>BRIEF DESCRIPTION</td>
<td>This experiment consisted of a broadband photometer, sensitive between 200 and 800 Å. During the cruise phase of the mission, this experiment was used to search for the superionic-to-subionic 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 dayglow to find the ratio of hydrogen to helium in the Jovian atmosphere and to find the temperature of the upper portion of the Jovian atmosphere. The evidence of auroral oval was found in the interplanetary region indicating interactions between charged particles and neutral hydrogen.</td>
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### INVESTIGATION NAME: ULTRAVIOLET SPECTROSCOPY

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<td>T. MOOS</td>
<td>U OF SOUTHERN CALIF</td>
<td>NASA-JPL</td>
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<td>BRIEF DESCRIPTION</td>
<td>This investigation was carried out using an infrared radiometer and an interferometer-spectrometer similar in design to the Mariner II 1971, combined into a single instrument. The investigation studied both global and local energy balances using infrared spectral measurements in conjunction with broadband measurements of reflected solar energy. Atmospheric composition was also investigated, including determination of the H/He ratio and the abundance of CO and CH₄. Vertical temperature profiles and size of particles in Saturn's rings were conducted. The interferometer had a spectral range of 200 to 4000 Å, while the radiometer range was 300 to 4000 Å. The instrument used a single primary mirror 51 cm in diameter with a field of view of 0.25 deg.</td>
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### INVESTIGATION NAME: INFRARED SPECTROSCOPY AND RADIMETRY

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<td>PERSONNEL</td>
<td>P. HANSEL</td>
<td>NASA-GSFC</td>
<td></td>
</tr>
<tr>
<td>BRIEF DESCRIPTION</td>
<td>This investigation was carried out using an infrared radiometer and an interferometer-spectrometer similar in design to the Mariner II 1971, combined into a single instrument. The investigation studied both global and local energy balances using infrared spectral measurements in conjunction with broadband measurements of reflected solar energy. Atmospheric composition was also investigated, including determination of the H/He ratio and the abundance of CO and CH₄. Vertical temperature profiles and size of particles in Saturn's rings were conducted. The interferometer had a spectral range of 200 to 4000 Å, while the radiometer range was 300 to 4000 Å. The instrument used a single primary mirror 51 cm in diameter with a field of view of 0.25 deg.</td>
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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 atmospheres and ionospheres and atmospheres by examining the propagation effects on a dual-frequency radio signal during occultation and egress 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 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: 77-0164-02

INVESTIGATION_DISCIPLINE(S): ATOMIC PHYSICS

IONOSPHERES AND RADIO PHYSICS

PERSONNEL

PL = G.L. Tyler STANFORD U
TM = G, Lindal NASA-JPL
TM = G.S. Lev NASS-AJPL
TM = T.A. Croft SKI INTERNATIONAL
TM = V.R. Eshleman STANFORD U
TM = J.A. Anderson NASA-JPL
TM = G.L. 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 atmospheres and ionospheres and atmospheres by examining the propagation effects on a dual-frequency radio signal during occultation and egress 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.

------- Pioneer 15: Kliore ------------

INVESTIGATION_NAME: 5-BAND OCCULTATION

NSSDC_ID: 77-0164-02

INVESTIGATION_DISCIPLINE(S): IONOSPHERES AND RADIO PHYSICS

PLANETARY ATMOSPHERES

PERSONNEL

P1 = A.J. Kliore NASA-JPL
DI = G. FIOLENO(NAI) NASA-JPL
DI = D.A. Cain NASA-JPL
DI = B.L. Seidel NASA-JPL
DI = S.I. RASOLOW(NAI) IBM-PARR

BRIEF DESCRIPTION

This experiment, carried out on both Pioneers 10 and 11, utilized the 5-band (2272 MHz) of spacecraft radio transmitter signal characteristics to obtain information about the ionospheres and atmospheres of Jupiter and its satellites Io, Europa, and Callisto. The science objectives of the experiment were (1) to determine the physical properties of planetary atmospheres and ionospheres and atmospheres by examining the propagation effects of a 5-band radio signal during occultation of spacecraft body, (2) to determine planetary and satellite masses, gravity fields, and densities by precise tracking of a 5-band radio signal from the spacecraft during the encounter period and (3) to determine the amount and size distribution of material in the rings of Saturn and the C ring, and the ring dimensions by examining the propagation effects on a 5-band radio signal that passed through each ring in succession and through the gap between the C ring and Saturn's surface.
This experiment utilized the S-band (2292-MHz, 8-cm) spacecraft radio transmitter signal characteristics to obtain information about the ionospheres and atmospheres of Jupiter and its satellite Io, and Saturn. Entrance into and exit from Jupiter's magnetosferic region proved 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 atmosphere. Signal attenuation also provided a determination of the planetary diameter.

**Voyager 2, Warwick**

**Investigation Name:** PLANETARY RADIO ASTRONOMY

**NSSDC ID:** 77-O94A-11

**Investigative Program Name:** MAGNETOSPHERIC PHYSICS

**Scales:** SPACE PLASMAS

**Personnel:**
- PI: J.W. Warwick
- CI: R.A. Bowers, Jr.
- CI: C.S. Harris
- CI: J.N. Hale
- CI: R.G. Pease
- CI: R.G. Pease
- CI: A.C. Ragland
- CI: N.C. Kaiser

**Brief Description:**
This experiment consisted of a swept-frequency radio receiver operating in both polarization states, between 20 kHz and 40.5 MHz. The signal was received by a pair of orthogonal 18-cm dipole antennas. Study of the radio-emission signals from Jupiter and Saturn over this range of frequencies yielded data on 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-O76A-12

**Investigative Program Name:** MAGNETOSPHERIC PHYSICS

**Scales:** SPACE PLASMAS

**Personnel:**
- PI: J.W. Warwick
- CI: R.G. Pease
- CI: C.S. Harris
- CI: J.N. Hale
- CI: R.G. Pease
- CI: A.C. Ragland
- CI: N.C. Kaiser

**Brief Description:**
This experiment consisted of a swept-frequency radio receiver operating in both polarization states, between 20 kHz and 40.5 MHz. The signal was received by a pair of orthogonal 18-cm dipole antennas. Study of the radio-emission signals from Jupiter and Saturn over this range of frequencies yielded data on the physics of magnetospheric plasma resonances and nonthermal radio emissions from these planetary regions.
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.
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. It passed close to Saturn and then followed an escape trajectory from the solar system. The spacecraft was 2.9 m (9.5 ft) long and contained a 2.3 m (8 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 electrothermal power generators, which generated 154 W at Jupiter, but decreased to 108 W at Saturn. There were three reference sensors: a star (angular) 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 adjusted based on experience gained from the settings used on Pioneer 10. Three pairs of rocket thrusters provided spin-axis control at 0.1 rpm and change of the spacecraft velocity. The thrusters could be either fired stagewise 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, were produced. A power bank in Earth's synchronous orbit (operated at 2139 MHz and downlinked transmits 100 MP to earth at 2092 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 35 degrees Celsius (to maintain at least the high-gain antenna performance). A second additional experiment, a co-sensitivity fluctuating magnetometer, was added at the Pioneer 11 launch. Instruments studied the interplanetary and planetary magnetic fields, solar wind, and properties of cosmic rays. The operation of dust particles, jovian aurorae, jovian radio waves, the atmospheres of planets and satellites, and the surfaces of Jupiter and Saturn, and some of their satellites. Instruments carried for these experiments were modified from those for Pioneer 10. For solar wind study, a charged-particle detector, ionizing detector, non-imaging telescope, and ultraviolet spectrometer with views to detect sunlight reflected from passing meteoids, solar pressed and electrolytically measured the polarization. Further scientific information was obtained from celestial occultations and the use of solar wind experiments. 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 36,000 km from Jupiter during its closest approach, December 4th, 1979, to within 65,000 km of its cloud tops, it passed by Saturn on Aug. 5, 1979 at a distance of 21,500 km from Saturn's cloud tops.
The imaging Photopolarimeter (IPP) experiment used during Voyager 1 and 2 Jupiter encounter was identical, two-color (Blue: 3800 to 4900 Å, red: 5500 to 7700 Å) polarimetric and radiometric measurements, and moderate-resolution (about 250 Å at best) spin–star images of Jupiter are the IPP's main goals. The radiometric and radiometric work was performed using an 8-by-8-micrometer field stop, a wavelength range for which IPP is calibrated. Absolute attitude calibration of the instrument was accomplished by means of a sunlit diffuser/attenuator element located in the spacecraft structure. Primary radiometric calibration was derived using an internal tungsten lamp. Long-term absolute calibration of the instrument was accomplished by means of a sunlit diffuser/attenuator element located in the spacecraft structure. Primary radiometric calibration was derived using an internal tungsten lamp. Long-term absolute calibration of the instrument was accomplished by means of a sunlit diffuser/attenuator element located in the spacecraft structure.
spun axis toward the earth (and therefore the sun). The edges of the antenna reflector limited the viewing of the instrument to 73° with respect to the spin axis. The channeledtron covered a range of plus or minus 51°. Each channeledtron near the center covered 3°, and approximately 3° near the edges of the analyzer. The angular width of plus or minus 22.5° was used to detect both ions and electrons. The detectors were five flat-surface current collectors; the three center collectors each covered 3° and were located at plus or minus 51°. The edges of flux in the range 0.1 to 30 MeV were used to detect electrons and protons. The sensitivity in the range 0.1 to 30 MeV was about 2.2°. In this spin period the whole core of plus or minus 51° centered on the sun was swept out. A medium-energy analyzer with a mean radius of 0.5° and 0.3° was used to detect both ions and electrons. The three center collectors had an angular width of 47.5° and were located at plus or minus 45°, plus or minus 22.5° and near the center of the analyzer. Those 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 channeledtrons were read out at the peak of a photodiode. The ion analyzer operated independently, so an output signal between the two analyzers could be used to determine the electron fluxes from 1.0 to 30 MeV. The electron fluxes down to 0.15 MeV could be ascertained. Data include the interplanetary region.

--- PIONEER 11, ACUNA ---

INVESTIGATION NAME: JOVIAN MAGNETIC FIELD

NSSDC 19-73-019A-14 INVESTIGATIVE PROGRAM CODE EL+4, SCIENCE

INVESTIGATION DISCIPLINES: MAGNETOSPHERIC PHYSICS

PERSONNEL

PI = R.W. Acuna NASA-GSFC

BRIEF DESCRIPTION

This instrument, designed to measure the jovian and saturnian magnetic fields, scrambles a single-ring tralitlual fluoscint magnetometer and associated electronics capable of measuring a magnetic field of 10-3 to 10-4 gauss along each orthogonal axis. Use of a 10-bit A-to-D converter yielded a resolution of 0.012%. At 0.1 to 200 MeV electrons less than 1 MeV resolution was obtained. Although the instrument was designed to detect electrons and protons above 5 keV and 0.5 MeV, respectively, an electron scattering process (E) had three output channels: E/2 E/9, sensitive to electrons having energies greater than 5 MeV; E/4 E/3, sensitive to electrons having energies greater than 25 MeV; E/16 E/15, sensitive to electrons having energies greater than 100 MeV. The lowest two sensors were omnidirectional detectors (E/2 and E/9) both of which had energy thresholds of 10 keV for electrons and 15 keV for protons. The sensitivity of the 0.5 MeV detector to protons was about a factor of 10 lower than its sensitivity to electrons. Thus the scanned magnetic field data may have underestimated the electron flux which could then be subtracted from the SPD 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. The antenna size to sample one channel was 2.1° 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, raw data were obtained at low rates in interplanetary space. A description of the investigation and initial Pioner 10 results was published in J. Geophys. Res., v. 73, p. 117, 1969.

--- PIONEER 11, VAN ALLEN ---

INVESTIGATION NAME: JOVIAN CHARGED PARTICLES

NSSDC 19-73-019A-11 INVESTIGATIVE PROGRAM CODE EL+4, SCIENCE

INVESTIGATION DISCIPLINES: PARTICLES AND FIELDS

PERSONNEL

PI = J.A. Van Allen U of Iowa

BRIEF DESCRIPTION

This experiment used seven miniature Geiger tubes in three arrays to measure protons and electrons from Jupiter and Saturn. Detector groupings were as follows: (1) a three-element (A, B, C) and (B, C) differently shielded telescope consisting of two n-doped silicon photo-multipliers used for background subtraction to provide rates such as 9 to 10 MeV electrons and 0.6 to 0.45 MeV protons. (2) a three-element trilobal array of detectors with a 90° alignment used to detect electrons above 30 MeV and (3) a thin-window tube (9), with a 90° alignment used to detect protons above 5 keV. Early results are given in Science, v. 160, p. 559, 1968. Data include the interplanetary region.

--- PIONEER 11, MCDONALD ---

INVESTIGATION NAME: COSMIC-RAYS SPECTRA

NSSDC 19-73-019A-12 INVESTIGATIVE PROGRAM CODE EL+4, OFDP, SCIENCE

INVESTIGATION DISCIPLINES: PARTICLES AND FIELDS

PERSONNEL

PI = F.D. McDonald NASA-GSFC

--- PIONEER 11, FILLIUS ---

INVESTIGATION NAME: JUPITER TRAPPED RADIATION

NSSDC 19-73-019A-05 INVESTIGATIVE PROGRAM CODE EL+4, SCIENCE

INVESTIGATION DISCIPLINES: MAGNETOSPHERIC PHYSICS

PERSONNEL

PI = R.W. Fillius U of Calif., San Diego

BRIEF DESCRIPTION

This experiment consisted of three 3°-to-15° tilt-angle, all-looking proton spectrometers in a multipurpose, bidirectional telescope measuring 0.1- to 80-MeV electrons with 5° to 60° energy resolution. Two detectors measured 5- to 27-MeV protons with 3° resolution. Three telescopes measured 50- to 150-MeV electrons and 50- to 200-MeV protons with 2° resolution. All detectors measured protons in the range 0.1 to 10 MeV at 0.5° resolution. One detector measured electrons in the range 0.1 to 200 MeV at 1° resolution. Two detectors measured electrons in the range 0.1 to 10 MeV at 0.2° resolution. The sensor was sensitive to electrons having energies greater than 5 MeV. The results were published in J. Geophys. Res., v. 76, p. 5598, 1971.

--- RADIUS SCIENCE AND CELESTIAL MECHANICS ---

--- PIONEER 11, ANDERSON ---

INVESTIGATION NAME: CELESTIAL MECHANICS

NSSDC 19-73-019A-01 INVESTIGATIVE PROGRAM CODE EL+4, SCIENCE

INVESTIGATION DISCIPLINES: ASTRODYNAMICS

PERSONNEL

PI = J.D. Anderson NASA-JPL

--- ATMOSPHERE ---

BRIEF DESCRIPTION

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.
---------- PIONEER 11, GEMELS ------------------------------------
INVESTIGATION NAME- IMAGING PHOTOPOLARIMETER (IPP)
NSSDC ID- J3-0179A-67
SEE THIS EXPERIMENT UNDER IMAGING

Polarization

---------- PIONEER 11, GEMELS ------------------------------------
INVESTIGATION NAME- IMAGING PHOTOPOLARIMETER (IPP)
NSSDC ID- J3-0179A-67
SEE THIS EXPERIMENT UNDER IMAGING
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.
**Spacecraft**

**Spacecraft Common Name:** Pioneer 4  
**Alternate Names:** Marsiner 4  
**NSSDC ID:** 64-077A  
**Launch Date:** 11/28/64  
**Launch Site:** Cape Canaveral, United States  
**Launch Vehicle:** Atlas  
**Sponsoring Country/Agency:** United States  
**Initial Orbit Parameters:**  
**Object Type:** Mars Flyby  
**Personnel:**  
**PM:** J.R. James  
**PS:** H.A. Slikering  
**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 was mounted behind a 2.7-m-diameter parabolic dish antenna that was 46 cm deep. The dish-like structure was a 26-ft-long flat equipment compartment, the top and bottom being regular hexagon. Its sides held the scientific equipment, while a smaller compartment that carried the scientific experiments, the high-gain antenna feed was 11-ft-long and held the equipment compartment and was mounted above the high-gain antenna. Power for the spacecraft was obtained by four SNAP-19 radioisotope thermoelectric generators (RTG), which were held about 3.4 m from the center of the spacecraft by two three-ring trusses 102 deg apart. A third boom extended 4.6 m from the equipment compartment to hold the magnetometer away from the spacecraft. The four RTG's generated about 155 watts at launch and decayed to approximately 146 watts by the time the spacecraft reached Jupiter on December 3-1975-21 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 by the known direction to Canopus as a backup. Three gates of rocket thrusters provided spin-rate control (maintained at 4.6 rpm) and charged the velocity of the spacecraft. Additional sensors and experiments were connected to other spacecraft. These sensors could be interrogated by command to provide some precursors. Two spacecraft, Pioneer 3 and Pioneer 4, were attached to the rotating-waves tube amplifiers, produced 6 watts at 2024 MHz each. UHF was accomplished by generating transmission downlink at 2024 MHz. The data were received by NASA's Deep Space Network. The spacecraft was temperature-controlled between 25 and 25 deg C and plus 36 deg C. Fifty experiments were carried to study the interplanetary and planet magnetic fields, interplanetary plasma parameters, cosmic rays, transition region of the heliosphere, neutral hydrogen abundance, charged particles, charged particle detector, ionizing detector, non-imaging telescopes with overlapping fields of view to detect sunlight reflected from passing meteors, solar proton events in a solar system, and the earth in our galaxy. It is leaving the solar system and passing into interstellar space.

**Spacecraft Common Name:** Pioneer 5  
**Alternate Names:** Marsiner 5, Mariner Venus 67, EV-67  
**NSSDC ID:** 67-060A  
**Launch Date:** 02/25/66  
**Launch Site:** Cape Canaveral, United States  
**Launch Vehicle:** Atlas  
**Sponsoring Country/Agency:** United States  
**Initial Orbit Parameters:**  
**Object Type:** Mars Flyby  
**Personnel:**  
**PM:** F. Schneiderman  
**PS:** T. Pakker (planetary)  
**PS:** D. Johnson (NAS Headquaters)  
**PS:** C.W. Snyder  
**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 was mounted behind a 2.7-m-diameter parabolic dish antenna that was 46 cm deep. The dish-like structure was a 26-ft-long flat equipment compartment, the top and bottom being regular hexagon. Its sides held the scientific equipment, while a smaller compartment that carried the scientific experiments, the high-gain antenna feed was 11-ft-long and held the equipment compartment and was mounted above the high-gain antenna. Power for the spacecraft was obtained by four SNAP-19 radioisotope thermoelectric generators (RTG), which were held about 3.4 m from the center of the spacecraft by two three-ring trusses 102 deg apart. A third boom extended 4.6 m from the equipment compartment to hold the magnetometer away from the spacecraft. The four RTG's generated about 155 watts at launch and decayed to approximately 146 watts by the time the spacecraft reached Jupiter on December 3-1975-21 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 by the known direction to Canopus as a backup. Three gates of rocket thrusters provided spin-rate control (maintained at 4.6 rpm) and charged the velocity of the spacecraft. Additional sensors and experiments were connected to other spacecraft. These sensors could be interrogated by command to provide some precursors. Two spacecraft, Pioneer 3 and Pioneer 4, were attached to the rotating-waves tube amplifiers, produced 6 watts at 2024 MHz each. UHF was accomplished by generating transmission downlink at 2024 MHz. The data were received by NASA's Deep Space Network. The spacecraft was temperature-controlled between 25 and 25 deg C and plus 36 deg C. Fifty experiments were carried to study the interplanetary and planet magnetic fields, interplanetary plasma parameters, cosmic rays, transition region of the heliosphere, neutral hydrogen abundance, charged particles, charged particle detector, ionizing detector, non-imaging telescopes with overlapping fields of view to detect sunlight reflected from passing meteors, solar proton events in a solar system, and the earth in our galaxy. It is leaving the solar system and passing into interstellar space.
SPACECRAFT COMMON NAME - VOYAGER 2
ALTERNATE NAMES - MARINER JUPITER/SATURN A, OUTER PLANETS B, MANGER TTA, NAS A-797
NASDC ID- 77-060A

LAUNCH DATE-1977/09/05
WEIGHT- 700 KG
LAUNCH SITE- CAPE CANAVERAL, UNITED STATES
LAUNCH VEHICLE- TITAN III

SPONSORING COUNTRY/AGENCY
UNITED STATES NASA-056

INITIAL ORBIT PARAMETERSTYPE- SATURN FLIGHT
PERSONNEL
PM - J.K. CASANVAL
NAS A/JPL 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 5- and 3-meter RF receiver, an IR interferometer and radiometer, a UV spectrometer/fluorescence spectrometers, a charged particle analyzer, plasma-wave radio receiver/cosmic-ray telescopes, photopolarimeters and a variety of detectors. Voyager 1 had its closest encounter with Jupiter on March 5, 1979 and with Saturn on November 21, 1980.

SPACECRAFT COMMON NAME- VOYAGER 2
ALTERNATE NAMES - MARINER JUPITER/SATURN B, OUTER PLANETS C, MANGER TTA, NAS A-797
NASDC ID- 77-060A

LAUNCH DATE-1977/09/05
WEIGHT- 700 KG
LAUNCH SITE- CAPE CANAVERAL, UNITED STATES
LAUNCH VEHICLE- TITAN III

SPONSORING COUNTRY/AGENCY
UNITED STATES NASA-056

INITIAL ORBIT PARAMETERS
PERSONNEL
PM - J.K. SIMPSON
U OF CHICAGO

BRIEF DESCRIPTION
A set of three silicon surface barrier detectors was used in the form of a g/doctor as range telescope to determine the flux of protons in the energy intervals 15 to 370 MeV and alpha particles in the energy range 15 to 78 MeV/nucleon and above 78 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 12-channels 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 in the energy range 15 to 78 MeV/nucleon and above 78 MeV/nucleon. Two count rates and two pulse-height analysis windows were available. The 18 s according to whether the spacecraft transmission rate was 4-1/2 or 33-1/2 hps. The experiment performed normally from launch until October 1979, when the spacecraft was turned off in the continuous power, when the mission was completed. After a later time, the detector did not respond. For further details see O'Sulllver Ac. J., v. 158, p. 679, 1977.
This experiment (on both Pioneers 10 and 11) consisted of a broadband photometer sensitive between 200 and 800 Å. During the cruise phase of the mission, this experiment was used to search for the superthermal-to-subthermal 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 atmosphere, and to find the ratio of hydrogen to helium in the Jovian atmosphere. Evidence of helium was found in the interplanetary region indicating interactions between charged particles and neutral hydrogen.

--- PIONEER 11, SOEBERMAN ---

INVESTIGATION NAME: ASTEROID/METEOROIDS ASTROMONY
NSDC ID: 73-3214-03 INVESTIGATIVE PROGRAM
CODE EL+4, SCIENCE
INVESTIGATION DISCIPLINE(S)
ASTRONOMY
INVESTIGATION DISCIPLINE(S)
PLANETARY ATMOSPHERES
PERSONNEL
PI - R.L. JUDGE
OI - R.A. Zook
NAVY-SC

BRIEF DESCRIPTION
This experiment consisted of a broadband photometer sensitive between 200 and 800 Å. During the cruise phase of the mission, this experiment was used to search for the superthermal-to-subthermal 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 atmosphere, and to find the ratio of hydrogen to helium in the Jovian atmosphere. Evidence of helium was found in the interplanetary region indicating interactions between charged particles and neutral hydrogen.

--- PIONEER 10, SOEBERMAN ---

INVESTIGATION NAME: ULTRAVIOLET PHOTOMETRY
NSDC ID: 72-3214-03 INVESTIGATIVE PROGRAM
CODE EL+4, SCIENCE
INVESTIGATION DISCIPLINE(S)
ASTRONOMY
INVESTIGATION DISCIPLINE(S)
PLANETARY ATMOSPHERES
PERSONNEL
PI - H.A. SOEBERMAN
OI - R.A. Zook
NAVY-SC

BRIEF DESCRIPTION
This experiment (also on Pioneer 10) investigated 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 impact. The objectives were to determine distance, trajectory, velocity, relative size, and mass of particles ranging in size from dust to meteoroids. The second experiment examined the reflection of light from a pulsed light source. The equipment used to detect reflection consisted of non-diluting Ritchey-Chretien telescopes with primary mirrors of 24-cm (0.97") diameter and 25-cm (10") focal length. A second experiment examined the reflection of light from particles. The equipment used to detect reflection consisted of 32 panels, each containing 10 solar cells, mounted on a solar array of 50 m high by 50 m wide at the back of the main antenna. The equipment used to detect reflection consisted of a pulsed light source, and a photomultiplier tube. The equipment used to detect reflection consisted of a pulsed light source, and a photomultiplier tube. The equipment used to detect reflection consisted of a pulsed light source, and a photomultiplier tube. The equipment used to detect reflection consisted of a pulsed light source, and a photomultiplier tube.
PERSONNEL
PI - J.L. ALVAREZ
01 - M.S. HANER

GENERAL ELECTRIC CO
NASA-JPL

BRIEF DESCRIPTION
The Pioneer 11 experiment was designed to determine the range in mass of small particles on both the inner and outer boundaries and within the asteroid belt.

INVESTIGATION NAME - ZODIACAL-LIGHT TWO-COLOR
INVESTIGATIVE PROGRAM
CODE 64-9, SCIENCE
INVESTIGATION DISCIPLINE(S)
ZODIACAL LIGHT
PLANETARY ATMOSPHERES

PERSONNEL
PI - J.L. ALVAREZ
01 - M.S. HANER

NASA-JPL

BRIEF DESCRIPTION
The Zodiocal-Light Photometer (ZLP) experiment was designed to determine the range in mass of small particles on both the inner and outer boundaries and within the asteroid belt.
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 Makutov 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 parallel channeltron detectors (blue = bladel 1-55 photocathodes, red = 5-20 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
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.
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.
The Pioneer 5 spacecraft was designed to study solar-wind parameters, solar particles, and interstellar medium characteristics during its interplanetary mission. The spacecraft carried scientific instruments that measured solar energetic particles, galactic cosmic rays, and interstellar medium conditions. The spacecraft was launched on April 1, 1960, and its mission was highly successful, providing valuable data on the interplanetary environment.

**Spacecraft Common Name:** Pioneer 5

**Alternate Names:** Pioneer 5

**NSSDC ID:** 10-60-003

**Launch Date:** 03/27/60

**Launch Site:** Cape Canaveral, United States

**Weight:** 45.6 kg

**Sponsoring Country/Agency:** United States

**Launch Vehicle:** Thor

**Initial Orbit Parameters:**
- **Orbit Type:** Geocentric
- **Orbit Period:** 311.6 days
- **Epoch:** 04/13/60
- **inclination:** 1.15 deg
- **perigee:** 1.170 AU
- **apogee:** 2.061 AU

**Personnel:**
- **PM:** C. F. Hall (NL)
- **PS:** D. Bal (NL)

**Brief Description:**

Pioneer 5 was a spin-stabilized, solar-cell and battery-powered satellite designed to study solar-wind parameters and interstellar medium characteristics during its interplanetary mission. The spacecraft carried scientific instruments that measured solar energetic particles, galactic cosmic rays, and interstellar medium conditions. The spacecraft was launched on April 1, 1960, and its mission was highly successful, providing valuable data on the interplanetary environment.
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 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) random 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 four and in 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 39 hr as limited by the bit-storage capacity. In the random-read mode, data were read out at whatever bit rate was appropriate to the satellite distance from the earth.

************** SPACECRAFT COMMON NAME- PIONEER 9 **************
ALTERNATE NAMES- PIONEER-9, PL-856

ORBIT PARAMETERS

ORBIT TYPE- HELIOCENTRIC
EPOCH DATE- 02/27/76
INCLINATION- 0.086 DEG
PERIHELION- 0.983 AU RAD
APOHELION- 8.095 AU RAD

PERSONNEL
PM - R. L. HALL
PS - H. POESEL
PM - J. H. TRAEBER

BRIEF DESCRIPTION

This spacecraft was one of a pair of deep space probes developed by the Federal Republic of Germany (FRG). It was part of the 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 boom antennas and a 25 kW 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 protons and extending to 1 MeV; a occultation-light experiments and a microdosimetric experiment. The purpose of the mission was to take pioneering measurements of the interplanetary medium from the vicinity of the earth's orbit to 8.095 AU. The spacecraft was capable of being operated at bit rates from 400 bps to 8 bps, variable by factors of two, while the spacecraft was moving to perihelion. It was generally operated at 64 bps and 256 bps; secondarily at 1024 bps, and at bit rates selected. Because of a deployment of the side by one axis of the 32 MHz, tip-to-tip, dipole antenna, one axis was shortened causing the antenna to function as a monopole. The primary objective of the mission was to increase the effective instrument thresholds, and to introduce additional understanding of the instrument antenna length. Instrument descriptions written by the experimenters were published (some in German, some in English) in the Journal "Annafrforchung" v. 19, n. 5, 1975.

************** HELIOS-B **************

ORBIT PARAMETERS

ORBIT TYPE- HELIOCENTRIC
EPOCH DATE- 07/21/76
INCLINATION- 0.085 DEG
PERIHELION- 0.979 AU RAD

PERSONNEL
PM - A. KUZEL
PM - C. W. DUESK
PS - H. POESEL
PM - J. H. TRAEBER

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 boom antennas and a 25 kW dipole 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 protons and extending to 1 MeV; occultation-light experiments and a microdosimetric experiment. The purpose of the mission was to take pioneering measurements of the interplanetary medium from the vicinity of the earth's orbit to 8.095 AU. The spacecraft was capable of being operated at bit rates from 400 bps to 8 bps, variable by factors of two, while the spacecraft was moving to perihelion. It was generally operated at 64 bps and 256 bps; secondarily at 1024 bps, and at bit rates selected. Because of a deployment of the side by one axis of the 32 MHz, tip-to-tip, dipole antenna, one axis was shortened causing the antenna to function as a monopole. The primary objective of the mission was to increase the effective instrument thresholds, and to introduce additional understanding of the instrument antenna length. Instrument descriptions written by the experimenters were published (some in German, some in English) in the Journal "Annafrforchung" v. 19, n. 5, 1975.
This experiment utilized measurements of the solar wind plasma faraday rotation to obtain measurements of the relative faraday rotation due to the interplanetary medium and the earth's ionosphere.

INVESTIGATION NAME: SOLAR WIND PLASMA FARADAY CUP
NSDC ID: 65-105A-02
INVESTIGATIVE PROGRAM CORE EL-4, SCIENCE
INVESTIGATION DISCIPLINE(S) PARTICLES AND FIELDS
INVESTIGATIVE CODE SPACE PLASMAS
PERSONNEL
PI - J. S. BRIDGE
Co-PI - N. L. MASS
MASS INST OF TECH
O1 - F. SCHRÖD
U OF WISCONSIN
BRIEF DESCRIPTION
A multipole Faraday cup with two semicircular coplanar collectors was used to study solar wind electrons and ions. The instrument had 14 continuous energy charge channels between 105 and 1600 V for positive ions and four energy-charge channels between 115 and 1600 V for electrons. The five collectors had a semicircular spin axis perpendicular to the ecliptic plane. The Faraday rotation was measured when the sun-earth line was perpendicular to the solar wind flux direction. The collectors were separated by a known fixed length and the electron and ion fluxes were measured by the collectors. The experiment was called the solar wind plasma, Faraday rotation experiment and was conducted by NASA-JPL personnel.

INVESTIGATION NAME: SOLAR WIND PLASMA DETECTOR
NSDC ID: 66-075A-02
INVESTIGATIVE PROGRAM CORE EL-4, SCIENCE
INVESTIGATION DISCIPLINE(S) PARTICLES AND FIELDS
INVESTIGATIVE CODE SPACE PLASMAS
PERSONNEL
PI - J. S. LEVY
Co-PI - J. B. HICKMEN
NASA-JPL
BRIEF DESCRIPTION
This experiment utilized measurements of the solar wind plasma to obtain measurements of the relative faraday rotation due to the interplanetary medium and the earth's ionosphere.

INVESTIGATION NAME: SUPERIOR CONJUNCTION FARADAY ROTATION
NSDC ID: 66-075A-08
INVESTIGATIVE PROGRAM CORE EL-4, SCIENCE
INVESTIGATION DISCIPLINE(S) HIGH ENERGY ASTROPHYSICS
INVESTIGATIVE CODE SPACE PLASMAS
PERSONNEL
PI - J. S. LEVY
NASA-JPL
BRIEF DESCRIPTION
This experiment utilized measurements of the solar wind plasma to obtain measurements of the relative faraday rotation due to the interplanetary medium and the earth's ionosphere.

INVESTIGATION NAME: PLASMA DETECTORS
NSDC ID: 74-077A-07
INVESTIGATIVE PROGRAM CORE EL-4, SCIENCE
INVESTIGATION DISCIPLINE(S) PARTICLES AND FIELDS
INVESTIGATIVE CODE SPACE PLASMAS
PERSONNEL
PI - H. A. ROSENBAUM
NASA-JPL
BRIEF DESCRIPTION
This experiment utilized measurements of the solar wind plasma to obtain measurements of the relative faraday rotation due to the interplanetary medium and the earth's ionosphere.
This experiment (E1) employed three plasma analyzers for positive ions and one for electrons. All detectors were mounted normal to the spin axes. Ions with energy per charge within the range 0.155 to 15.32 keV/e for energy in charge within the range 0.155 to 15.32 keV/e were measured in two angular dimensions using a combination of a hemispherically a quadrant electrostatic analyzer. Electrons with energy from 0.5 to 25 keV/e were measured with a hemispherical electrostatic analyzer in one dimension. The experiment operated in several modes with differing time resolution depending on detailed 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 01-06 or 01-07, the high-time-resolution plasma data for a period starting before and after the event was recorded into spacecraft memory for later transmission. Because the spacecraft body was coated with a conductive coating, the high-time-resolution potential were about 1 keV, causing far less degradation in the usefulness of data than for lower levels than on the HELIOS-A spacecraft, and almost no effect on the ion data. For more detailed information, see p. 226 of Raullfahrtforschung, v. 19, n. 5, 1975.

INVESTIGATION NAME: PLASMA DETECTORS

PERSONNEL
01 - H. R. ROSENBREUER
01 - E. R. PELLEGER
01 - J. M. WOLFE

BRIEF DESCRIPTION
This experiment (E1) employed three plasma analyzers for positive ions and one for electrons. All detectors were mounted normal to the spin axes. Ions with energy per charge within the range 0.155 to 15.32 keV/e with energy in charge within the range 0.155 to 15.32 keV/e were measured in two angular dimensions using a combination of a hemispherically a quadrant electrostatic analyzer. Electrons with energy from 0.5 to 25 keV/e were measured with a hemispherical electrostatic analyzer in one dimension. The experiment operated in several modes with differing time resolution depending on detailed 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 01-06 or 01-07, the high-time-resolution plasma data for a period starting before and after the event was recorded into spacecraft memory for later transmission. Because the spacecraft body was coated with a conductive coating, the high-time-resolution potential were about 1 keV, causing far less degradation in the usefulness of data than for lower levels than on the HELIOS-A spacecraft, and almost no effect on the ion data. For more detailed information, see p. 226 of Raullfahrtforschung, v. 19, n. 5, 1975.

INVESTIGATION NAME: SOLAR WIND PLASMA WAVE

NSSDC ID: 76-0324-09

INVESTIGATIVE PROGRAM
ECE-SCI/JOPL-SCIENCE

INVESTIGATION DISCIPLINES
PARTICLES AND FIELDS

PERSONNEL
01 - R. A. GUINNET
01 - E. R. PELLEGER
01 - J. M. WOLFE

BRIEF DESCRIPTION
This experiment (E1) employed three plasma analyzers for positive ions and one for electrons. All detectors were mounted normal to the spin axes. Ions with energy per charge within the range 0.155 to 15.32 keV/e with energy in charge within the range 0.155 to 15.32 keV/e were measured in two angular dimensions using a combination of a hemispherically a quadrant electrostatic analyzer. Electrons with energy from 0.5 to 25 keV/e were measured with a hemispherical electrostatic analyzer in one dimension. The experiment operated in several modes with differing time resolution depending on detailed 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 01-06 or 01-07, the high-time-resolution plasma data for a period starting before and after the event was recorded into spacecraft memory for later transmission. Because the spacecraft body was coated with a conductive coating, the high-time-resolution potential were about 1 keV, causing far less degradation in the usefulness of data than for lower levels than on the HELIOS-A spacecraft, and almost no effect on the ion data. For more detailed information, see p. 226 of Raullfahrtforschung, v. 19, n. 5, 1975.

INVESTIGATION NAME: SOLAR WIND PLASMA WAVE

NSSDC ID: 76-0324-09

INVESTIGATIVE PROGRAM
ECE-SCI/JOPL-SCIENCE

INVESTIGATION DISCIPLINES
PARTICLES AND FIELDS

PERSONNEL
01 - P. J. KELLOGG
01 - J. W. BAUER
01 - S. J. BAUER

BRIEF DESCRIPTION
This experiment (E1) employed three plasma analyzers for positive ions and one for electrons. All detectors were mounted normal to the spin axes. Ions with energy per charge within the range 0.155 to 15.32 keV/e with energy in charge within the range 0.155 to 15.32 keV/e were measured in two angular dimensions using a combination of a hemispherically a quadrant electrostatic analyzer. Electrons with energy from 0.5 to 25 keV/e were measured with a hemispherical electrostatic analyzer in one dimension. The experiment operated in several modes with differing time resolution depending on detailed 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 01-06 or 01-07, the high-time-resolution plasma data for a period starting before and after the event was recorded into spacecraft memory for later transmission. Because the spacecraft body was coated with a conductive coating, the high-time-resolution potential were about 1 keV, causing far less degradation in the usefulness of data than for lower levels than on the HELIOS-A spacecraft, and almost no effect on the ion data. For more detailed information, see p. 226 of Raullfahrtforschung, v. 19, n. 5, 1975.

INVESTIGATION NAME: ELECTRIC FIELD DETECTOR

NSSDC ID: 76-0324-09

INVESTIGATIVE PROGRAM
ECE-SCI/JOPL-SCIENCE

INVESTIGATION DISCIPLINES
PARTICLES AND FIELDS

PERSONNEL
01 - H. R. ROSENBREUER
01 - J. M. WOLFE

BRIEF DESCRIPTION
This experiment (E1) employed three plasma analyzers for positive ions and one for electrons. All detectors were mounted normal to the spin axes. Ions with energy per charge within the range 0.155 to 15.32 keV/e with energy in charge within the range 0.155 to 15.32 keV/e were measured in two angular dimensions using a combination of a hemispherically a quadrant electrostatic analyzer. Electrons with energy from 0.5 to 25 keV/e were measured with a hemispherical electrostatic analyzer in one dimension. The experiment operated in several modes with differing time resolution depending on detailed 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 01-06 or 01-07, the high-time-resolution plasma data for a period starting before and after the event was recorded into spacecraft memory for later transmission. Because the spacecraft body was coated with a conductive coating, the high-time-resolution potential were about 1 keV, causing far less degradation in the usefulness of data than for lower levels than on the HELIOS-A spacecraft, and almost no effect on the ion data. For more detailed information, see p. 226 of Raullfahrtforschung, v. 19, n. 5, 1975.

INVESTIGATION NAME: ELECTRIC FIELD DETECTOR

NSSDC ID: 76-0324-09

INVESTIGATIVE PROGRAM
ECE-SCI/JOPL-SCIENCE

INVESTIGATION DISCIPLINES
PARTICLES AND FIELDS

PERSONNEL
01 - P. J. KELLOGG
01 - J. W. BAUER
01 - S. J. BAUER

BRIEF DESCRIPTION
This experiment (E1) employed three plasma analyzers for positive ions and one for electrons. All detectors were mounted normal to the spin axes. Ions with energy per charge within the range 0.155 to 15.32 keV/e with energy in charge within the range 0.155 to 15.32 keV/e were measured in two angular dimensions using a combination of a hemispherically a quadrant electrostatic analyzer. Electrons with energy from 0.5 to 25 keV/e were measured with a hemispherical electrostatic analyzer in one dimension. The experiment operated in several modes with differing time resolution depending on detailed 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 01-06 or 01-07, the high-time-resolution plasma data for a period starting before and after the event was recorded into spacecraft memory for later transmission. Because the spacecraft body was coated with a conductive coating, the high-time-resolution potential were about 1 keV, causing far less degradation in the usefulness of data than for lower levels than on the HELIOS-A spacecraft, and almost no effect on the ion data. For more detailed information, see p. 226 of Raullfahrtforschung, v. 19, n. 5, 1975.
During the low mode alone was the electron mode of operation in which electrons were measured in 16 logarithmically equally spaced energy per unit charge (E/Q) steps of 200 to 16,000 E/Q, ranging from 2 to 500 V. The eight collectors measured particles incident from a wide angular sector (2-13/16-deg resolution) of the spacecraft equatorial plane (same as the ecliptic plane). There were four 15-deg angular intervals for each E/Q step, sampled 20 times in 31-deg intervals. At this time, the spacecraft was spinning, fluxes were measured every spacecraft revolution, and the maximum flux mode alone was used. Thus, no pristinal distributions were observed. At the 15-bit rate, it took 22 s for a complete set of ion measurements and 16 s for a complete set of electron measurements. At 8 bps, the ion and electron measurements were taken and telemeasured every 64 s. At 16 bps, they were taken in an alternating sequence of 32 s. At 32 bps, they were taken and telemeasured every 4 s.

INVESTIGATION NAME: ELECTROSTATIC ANALYZER

NSSDC ID: 66-0754-03
INVESTIGATIVE PROGRAM CORE EL+4; SCIENCE
INVESTIGATION DISCIPLINE(S): PARTICLES AND FIELDS
SPACE PLASMAS
PERSONNEL
PI - J.H. WOLFE NASA-HKG
01 - R.W. SILVA TRW SYSTEMS GROUP

BRIEF DESCRIPTION

A truncated hemispherical electrostatic analyzer (120-deg total, parallel, or solar light) was used to study the directional intensity of the electrons and positive ions in the solar wind. Ions were detected in 16 logarithmically equally spaced energy per unit charge (200 to 16,000 E/Q) steps. The electron mode of operation in which electrons were measured in 16 logarithmically equally spaced energy per unit charge (E/Q) steps of 200 to 16,000 E/Q, ranging from 2 to 500 V. The eight collectors measured particles incident from a wide angular sector (2-13/16-deg resolution) of the spacecraft equatorial plane (same as the ecliptic plane). There were four 15-deg angular intervals for each E/Q step, sampled 20 times in 31-deg intervals. At this time, the spacecraft was spinning, fluxes were measured every spacecraft revolution, and the maximum flux mode alone was used. Thus, no pristinal distributions were observed. At the 15-bit rate, it took 22 s for a complete set of ion measurements and 16 s for a complete set of electron measurements. At 8 bps, the ion and electron measurements were taken and telemeasured every 64 s. At 16 bps, they were taken in an alternating sequence of 32 s. At 32 bps, they were taken and telemeasured every 4 s.

--- PIONEER 6 WOLFE ---

INVESTIGATION NAME: ELECTROSTATIC ANALYZER

NSSDC ID: 65-159-06
INVESTIGATIVE PROGRAM CORE EL+4; SCIENCE
INVESTIGATION DISCIPLINE(S): PARTICLES AND FIELDS
SPACE PLASMAS
PERSONNEL
PI - J.H. WOLFE NASA-HKG
01 - R.W. SILVA TRW SYSTEMS GROUP

BRIEF DESCRIPTION

A truncated hemispherical electrostatic analyzer (120-deg total, parallel, or solar light) was used to study the directional intensity of the electrons and positive ions in the solar wind. Ions were detected in 16 logarithmically equally spaced energy per unit charge (E/Q) steps of 200 to 16,000 E/Q, ranging from 2 to 500 V. The eight collectors measured particles incident from a wide angular sector (2-13/16-deg resolution) of the spacecraft equatorial plane (same as the ecliptic plane). There were four 15-deg angular intervals for each E/Q step, sampled 20 times in 31-deg intervals. At this time, the spacecraft was spinning, fluxes were measured every spacecraft revolution, and the maximum flux mode alone was used. Thus, no pristinal distributions were observed. At the 15-bit rate, it took 22 s for a complete set of ion measurements and 16 s for a complete set of electron measurements. At 8 bps, the ion and electron measurements were taken and telemeasured every 64 s. At 16 bps, they were taken in an alternating sequence of 32 s. At 32 bps, they were taken and telemeasured every 4 s.
rates (46, 16, and 8 bps), the maximum flux was noted at each 1/2 scale, followed by either (1) or (3) for layers; a polar scan and an azimuth scan at each 1/2 scale. A peak flux measurement during the maximum flux was obtained, or (2) for electrons, a polar scan at each 1/2 scale.

In the maximum flux mode, only the central collector was observed. The peak flux obtained and the azimuth direction were measured at 213\(\times\)16 degrees of the observation were recorded. A complete set of measurements consists of a set of electron measurements at each 1/2 scale, and at the high flux rates (46, 16, and 8 bps), a complete set of electron measurements was taken. At 64 bps, it took 16.3 s, and at 0 bps it took 3225 s.

------ HELIOS-A, KEPLER------

INVESTIGATION NAME: ELECTRON AND PROTON DETECTOR

NSSDC ID: 74-097A-10

INVESTIGATIVE PROGRAM
CORE EL-4/CP-OP. SCIENCE

INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS

PERSONNEL
PI - C. KEPLER
01 - R. WILKIN
02 - J. WILLIAMS
NASS-ARC

BRIEF DESCRIPTION
The objective of the experiment (KE) was to study the origin, acceleration, and distribution of low-energy electrons and protons. The instruments, a magnetic spectrometer, consisted of a spectrometer detector with the field of view in the plane of the ecliptic. The separation was achieved by the electron energy at energy perpendicularly to the particle path. Four electron and two proton detectors measured electrons from 10to 1000 keV and protons from 0 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.

------ PIONEER 6, NESS------

INVESTIGATION NAME: FLUORESCENT MAGNETOMETER

NSSDC ID: 65-054A-06

INVESTIGATIVE PROGRAM
CORE EL-4/SC. SCIENCE

INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS

PERSONNEL
PI - N. F. NESS
01 - C. J. SONET
02 - J. R. COLEMAN
NASS-ARC

BRIEF DESCRIPTION
A simple, bent, two-detector, uniaxial, fluorescent magnetometer, with a dynamic range of plus or minus 64 mT and plus or minus 0.25 mT resolution, obtained a complete set of magnetic field measurements by means of three measurements taken at equal time intervals during each spacecraft spin period (approximately 3.2 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 Ness et al., J. Geophys. Res., v. 76, p. 3553-1971. Ness et al. has all the useful data that exist from this investigation.

------ 7-NESS------

INVESTIGATION NAME: SINGLE-AXIS MAGNETOMETER

NSSDC ID: 65-097A-08

INVESTIGATIVE PROGRAM
CORE EL-4/CP. SCIENCE

INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS

PERSONNEL
PI - N. F. NESS
NASS-ARC

BRIEF DESCRIPTION
A single, bent, uniaxial, fluorescent magnetometer, with a dynamic range of plus or minus 32 mT and plus or minus 0.25 mT resolution, obtained a vector magnetic field measurement by means of three measurements taken at equal time intervals during each spacecraft spin period (approximately 3.2 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 Marini et al., J. Geophys. Res., v. 74, p. 5033-1971. Ness et al. has all the useful data that exist from this investigation.

------ PIONEER 9, NESS------

INVESTIGATION NAME: TRIAXIAL MAGNETOMETER

NSSDC ID: 67-123A-01

INVESTIGATIVE PROGRAM
CORE EL-4/CP-OP. SCIENCE

INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS

PERSONNEL
PI - N. F. NESS
01 - R. W. C. P. WERNER
02 - F. W. MARINI
03 - R. BERG
NASS-ARC

BRIEF DESCRIPTION
A single, bent, uniaxial, fluorescent magnetometer, with a dynamic range of plus or minus 32 mT and plus or minus 0.25 mT resolution, obtained a vector magnetic field measurement by means of three measurements taken at equal time intervals during each spacecraft spin period (approximately 3.2 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 Marini et al., J. Geophys. Res., v. 74, p. 5033-1971. Ness et al. has all the useful data that exist from this investigation.
PERSONNEL
PI - W. MESS
OI - F. HABERANG
01 - L. R. EULAGA
OI - L. R. EULAGA
01 - L. R. EULAGA
01 - S. T. EULAGA

INVESTIGATION NAME- FLUXGAUGE MAGNETOMETER FOR AVERAGE FIELDS
NSSEC ID- 74-0034-CO
INVESTIGATIVE PROGRAM
CODE EL-4/C0-OP, SCIENCE
INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS
PERSONNEL
PI - W. MESS
OI - F. HABERANG
01 - L. R. EULAGA
01 - S. T. EULAGA

INVESTIGATION NAME- FLUXGAUGE MAGNETOMETER FOR FIELD FLUCTUATIONS
NSSEC ID- 74-0034-C0
INVESTIGATIVE PROGRAM
CODE EL-4/C0-OP, SCIENCE
INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS
PERSONNEL
PI - W. MESS
01 - A. MAIER

INVESTIGATION NAME- FLUXGAUGE MAGNETOMETER FOR FIELD FLUCTUATIONS
NSSEC ID- 74-0034-C0
INVESTIGATIVE PROGRAM
CODE EL-4/C0-OP, SCIENCE
INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS
PERSONNEL
PI - F. M. NEUBAUER
01 - G. DEMEL

INVESTIGATION NAME- FLUXGAUGE MAGNETOMETER FOR FIELD FLUCTUATIONS
NSSEC ID- 76-0034-01
INVESTIGATIVE PROGRAM
CODE EL-4/C0-OP, SCIENCE
INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS
PERSONNEL
PI - F. M. NEUBAUER
01 - A. MAIER

INVESTIGATION NAME- FLUXGAUGE MAGNETOMETER FOR FIELD FLUCTUATIONS
NSSEC ID- 76-0034-01
INVESTIGATIVE PROGRAM
CODE EL-4/C0-OP, SCIENCE
INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS
PERSONNEL
PI - F. M. NEUBAUER
01 - A. MAIER

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 150 and 450 nT with resolutions of plus or minus 0.2 or 2 nT, respectively. The instrument was equipped with a flipper mechanism, which reoriented each sensor by 90° perpendicularly. For detailed information, see p. 232 of Raumfahrtforschung, v. 19, n. 5, 1975.

-------- NEUBAUER----------

INVESTIGATION NAME- SEARCH COIL MAGNETOMETER
NSSEC ID- 76-0034-01
INVESTIGATIVE PROGRAM
CODE EL-4/C0-OP, SCIENCE
INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS
PERSONNEL
PI - F. M. NEUBAUER
01 - G. DEMEL

BRIEF DESCRIPTION
This experiment (E3) was designed to investigate the magnetic components of electromagnetic waves in the solar wind from 0.5 to 10 AU. By means of its waveform channel (WFC), the rapid variations of the magnetic field were measured up to plus or minus 8.5 nT in 10 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 3200 Hz. Because of the large amount of data produced by this experiment, a further reduction was applied. For interesting time intervals selected by the fluxgate magnetometer (fltrs2) and omnichannel (fltrs2), waveform data could be read into an onboard memory at a rapid rate to be transmitted slowly for more detailed interpretation, see p. 241 in Raumfahrtforschung, v. 19, n. 5, 1975.

-------- NEUBAUER----------

INVESTIGATION NAME- SEARCH COIL MAGNETOMETER
NSSEC ID- 76-0034-03
INVESTIGATIVE PROGRAM
CODE EL-4/C0-OP, SCIENCE
INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS
PERSONNEL
PI - F. M. NEUBAUER
01 - G. DEMEL

BRIEF DESCRIPTION
This experiment (E4) was designed to investigate the magnetic components of electromagnetic waves in the solar wind from 0.5 to 10 AU. By means of its waveform channel (WFC), the rapid variations of the magnetic field were measured up to plus or minus 8.5 nT in 10 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 3200 Hz. Because of the large amount of data produced by this experiment, a further reduction was applied. For interesting time intervals selected by the fluxgate magnetometer (fltrs2) and omnichannel (fltrs2), 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 Rezefaftorschung v. 19, n. 5, 1975.

----- PIONEER 5, WINKLER

INVESTIGATION NAME: ION CHAMBER AND GM TUBE

NSSDC 10- 63-0014-03 INVESTIGATIVE PROGRAM CODE EL-4 SCIENCE

INVESTIGATION DISCIPLINE(S) PARTICLES AND FIELDS

PERSONNEL PI - J.R. WINKLER U OF MINNESOTA
01 - R.J. HOFFMAN NASA/GSFC

BRIEF DESCRIPTION

This experiment consisted of a hodoscope integrating ionization chamber and an Anton 382 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-synchronously to protons greater than about 25 MeV while the Geiger counter responded quasi-synchronously to protons greater than about 70 MeV. The energy thresholds for quasi-synchronous responses to events were 2.4 to 52 MeV for the ion chamber and 360 MeV for the 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, 1962. Telemetry noise limited the transmission of useful data to the period from launch through April 29, 1962.

----- PIONEER 6, SIMPSON

INVESTIGATION NAME: PROPORTIONAL COUNTER TELESCOPE

NSSDC 10- 62-0014-01 INVESTIGATIVE PROGRAM CODE EL-4 SCIENCE

INVESTIGATION DISCIPLINE(S) PARTICLES AND FIELDS

MAGNETIC PHYSICS

PERSONNEL PI - J.A. SIMPSON U OF CHICAGO
01 - C.Y. FAN U OF ARIZONA
02 - P. HEYER U OF CHICAGO

BRIEF DESCRIPTION

A wide acceptance conical proportional counter telescope was used to observe terrestrial trapped radiation and solar particles (protons E>75 MeV electrons E>125 MeV). Measurements were obtained for about 2 months during which a week of questionable 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, 1962.

----- PIONEER 7, SIMPSON

INVESTIGATION NAME: COSMIC-RAY TELESCOPE

NSSDC 10- 65-0014-05 INVESTIGATIVE PROGRAM CODE EL-4 SCIENCE

INVESTIGATION DISCIPLINE(S) PARTICLES AND FIELDS COSMIC RAYS

PERSONNEL PI - J.A. SIMPSON U OF CHICAGO
01 - J.E. BARTELL U OF CHICAGO

BRIEF DESCRIPTION

This experiment used a charged-particle telescope comprised 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 175 MeV to 295 MeV, and E>295 MeV. The time resolution ranged from about one measurement per 0.6 s to about one measurement per 28 s depending on the telemetry bit rate. The detector was mounted such that it made a 360-degree scan in the ecliptic plane about once per second. Pulse-height analysis of detector 01 output (225 x 125) and 01 output (125 x 125) was accomplished for the last event prior to each telemetry readout for the entire period. Further details, see Fan et al., J. Geophys. Res. v. 73 p. 1597-1600.

----- PIONEER 8, WEBBER

INVESTIGATION NAME: COSMIC-RAY TELESCOPE

NSSDC 10- 66-0014-06 INVESTIGATIVE PROGRAM CODE EL-4 SCIENCE

INVESTIGATION DISCIPLINE(S) PARTICLES AND FIELDS COSMIC RAYS

PERSONNEL PI - J.R. WEBBER U OF NEW HAMPSHIRE

BRIEF DESCRIPTION

This experiment used a charged particle telescope comprised 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>295 MeV. The time resolution ranged from about one measurement per 0.6 s to about one measurement per 28 s depending on the telemetry bit rate. The detector was mounted such that it made a 360-degree scan in the ecliptic plane about once per second.

----- PIONEER 9, MCCABE

INVESTIGATION NAME: COSMIC-RAY TELESCOPE

NSSDC 10- 66-0014-05 INVESTIGATIVE PROGRAM CODE EL-4 SCIENCE

INVESTIGATION DISCIPLINE(S) PARTICLES AND FIELDS COSMIC RAYS

PERSONNEL PI - K.C. MCCABE U OF ARIZONA
01 - W.C. GAFFETY U OF ARIZONA
02 - U.R. RAD ISRO HEADQUARTERS

BRIEF DESCRIPTION

This experiment was designed primarily to measure the directional characteristics of galactic and solar cosmic-ray fluxes. Protons from a Csl (I) scintillator crystal that was set into an anticoincidence plastic scintillator calorimeter. Separate phototube detectors viewed the two scintillators. Pulses from the Csl crystal were passed through a three-pulse-height analyzer. The windows corresponding to energy depositions of 7.4 to 44.2 MeV, and 225.2 to 255.0 MeV. Counts in the lower energy window were due mainly to protons with the window energies, while only particles of > 0.6 greater than about 0.6 s contributed to the highest energy window. Protons above 90 MeV gave anticoincidence pulses.) For each energy window, the number of events recorded was divided by the number of counts (in the calorimeter) to obtain an energy correction factor. For each energy window, the number of events recorded was divided by the number of counts (in the calorimeter) to obtain an energy correction factor. For each energy window, the number of events recorded was divided by the number of counts (in the calorimeter) to obtain an energy correction factor. For each energy window, the number of events recorded was divided by the number of counts (in the calorimeter) to obtain an energy correction factor.

----- PIONEER 10, SIMPSON

INVESTIGATION NAME: COSMIC-RAY TELESCOPE

NSSDC 10- 66-0014-06 INVESTIGATIVE PROGRAM CODE EL-4 SCIENCE

INVESTIGATION DISCIPLINE(S) PARTICLES AND FIELDS COSMIC RAYS

PERSONNEL PI - J.A. SIMPSON U OF CHICAGO
01 - J.E. BARTELL U OF CHICAGO

BRIEF DESCRIPTION

This experiment used a charged particle telescope comprised 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>295 MeV. The time resolution ranged from about one measurement per 0.6 s to about one measurement per 28 s depending on the telemetry bit rate. The detector was mounted such that it made a 360-degree scan in the ecliptic plane about once per second. Pulse-height analysis of detector 01 output (225 x 125) and 01 output (125 x 125) was accomplished for the last event prior to each telemetry readout for the entire period. Further details, see Fan et al., J. Geophys. Res. v. 73 p. 1597-1600.
and for the cosindirectional mode varied between $14^\circ$ and $112^\circ$. Each telescope spin period was about $1.2$ sec depending on the telemetry bit rate. See Bartley et al., Rev. Sci. Instrum., v. 38, p. 266, 1967, for a more detailed experiment description.

INVESTIGATION NAME: COSMIC-RAY ANISOTROPY

NSDC ID: 68-075A-05

INVESTIGATIVE PROGRAM
CORE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)
PARTICLES AND FIELDS
COSMIC RAYS

PERSONNEL
PI - R.G. McKENZIE
01 - W.L. BARTLEY
02 - L.R. HOKO
03 - S. HOKO
COSMIC RAYS EFFECTS CENTER

BRIEF DESCRIPTION
This experiment was designed primarily to measure the directional characteristics of galactic and solar cosmic rays fluxes. For each telescope, there was a Csl plastic scintillator which was set into an anticoincidence plastic scintillator calorimeter cup. Separate photomultiplier tubes viewed the two scintillators. Pulses from the Csl 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 deposition in the Csl between $4.7$ and $47.4$ to $65.5$ and $81.2$ MeV. No positive selection window was cut at either. Particles in the Csl window were then classified as protons and electrons. For each telescope, solid-state detectors were subsequently sorted into several angular sectors as the spacecraft spun. Each angular sector was normal to the spin axis and was subdivided, in the middle of the sector, by a 112.5 deg in width, with the spin axis normal to a 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 spin axis in a sector. The midpoint between the spin axis and at least three telescopes were 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 solid-state telescopes was a telescope with the fourth detector. Each of the three telescopes thus formed had an acceptance angle of $112.5$ deg in width. The main direction of the telescopes were in the ecliptic plane and 10 deg above and below that plane, respectively. Two concurrent modes of counting were applied. 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 accumulated in the first mode, the telescope separately measured particles with energies in the range 7.4 to 21.7 MeV/nucleon and 19.7 to 63.2 MeV/nucleon (two species detected in the first mode). In the second mode, the telescope separately measured particles in six contiguous energy intervals between 4.7 to 8.5 MeV/nucleon and 19.7 to 63.2 MeV/nucleon, while each of the solid-state telescopes was subdivided into two equal-energy sectors at each of the telescope spin periods. For a more detailed investigation description, see J. Geophys. Res., v. 109, n. 38, p. 1605, 1971.
ranges 1.5-2.3 and 6.21-2.2 MeV, and electrons in four ranges between 0.32 and 2.5 MeV. For a rd of coincidence mode, counting-rate data were collected into eight 45-degree sectors. The data cycle time was dependent on the spacecraft telemetry rate (variable between 40 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 end of each of the eight bit sets and formats, a complete data cycle required about 2.5 hr. See IEEE Trans. on Nucl. Sci., 22-22, p. 576, 1975, and Raumfahrtforschung, v. 19, n. 5, pp. 253-257, 1975 for further details.

-------- HELIOS-A, TERNOR ---------------

INVESTIGATION NAME- GALACTIC AND SOLAR COSMIC RAYS

NSSDC 10- 7E-003A-03

INVESTIGATIVE PROGRAM

CORE CL-GO-DP, SCIENCE

INVESTIGATION DISCIPLINE(S)

PARTICLES AND FIELDS

COSMIC RAYS

PERSONNEL

PI - J.H. TERNOR NASA-GSFC

01 - J.C. BOLLER APPLIED PHYSICS LAB

01 - R.J. BEEMER NASA-GSFC

01 - E.G. MECRECKEN CSIO

BRIEF DESCRIPTION

The detector component of this experiment (27) consisted of three separate delta E/delta x vs 8 telescopes and a proportional counter for monitoring solar X rays in the range 2-50 kev. The high-energy telescope had a geometric factor of 0.23 cm²/°-s and measured electrons in three ranges between 2 and 8 MeV, and protons and alpha particles in three ranges in between 21 and 56 MeV. Protons above 35 MeV were also measured. The first low-energy telescope (geometric factor was 0.105 cm²/°-s) measured protons and three delta E/delta x telescopes in three ranges between 21 and 210 MeV. The second low-energy telescope (geometric factor was 0.105 cm²/°-s) measured protons in several ranges between 0.12 and 2.1 MeV, alpha particles in the range from 2.1 to 10 MeV, and electrons in five ranges between 3.2 and 2.5 MeV. For a number of coincidence mode, counting-rate data were collected into eight 45-degree sectors. The data cycle time was dependent on the spacecraft telemetry rate (variable between 40 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 end of each of the eight bit sets and formats, a complete data cycle required about 2.5 hr. For further details see IEEE Trans. on Nucl. Sci., 22-22, p. 576, 1975, and Raumfahrtforschung, v. 19, n. 5, pp. 253-257, 1975.

-------- HELIOS-A, KUNOW ---------------

INVESTIGATION NAME- COSMIC-RAY PARTICLES

NSSDC 10- 7E-003A-07

INVESTIGATIVE PROGRAM

CORE CL-GO-DP, SCIENCE

INVESTIGATION DISCIPLINE(S)

PARTICLES AND FIELDS

COSMIC RAYS

PERSONNEL

PI - H. KUNOW U OF KIEL

01 - D.W. WIDORENEG U OF KIEL

01 - G. GREEN U OF KIEL

01 - G. MOLLER-MELLIN U OF KIEL

01 - M. WITTE U OF KIEL

01 - H. HEMPE U OF KIEL

BRIEF DESCRIPTION

The objective of the experiment (37) was to study high-energy charged cosmic-ray particles of solar, planetary, and galactic origin in interplanetary space. Protons and alpha particles with energies 0.1-3 MeV/nucl. and electrons 0.1-5 MeV were measured within interplanetary space over the range 0.3 to 1.0 Au. The instrument, a particle telescope with a 55-degree field of view, consisted of five scintillation 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 (0.1-0.8, 0.8-2, 2-3.3, 3.3-13, 13-27, 27-37, and 37-45 MeV), and electrons in five energy ranges (0.1-0.5, 0.5-1, 1-2.5, 2.5-4, and >4 MeV). For more details see pp. 253-257 of Raumfahrtforschung, v. 19, n. 5, 1975.

-------- PIONEER 6, ANDERSON ---------------

INVESTIGATION NAME- CELESTIAL MECHANICS

NSSDC 10- 65-105A-07

INVESTIGATIVE PROGRAM

CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)

CELESTIAL MECHANICS

PERSONNEL

PI - J.P. ANDERSON NASA-JPL

BRIEF DESCRIPTION

The purpose of this experiment was to use the tracking data from the satellite to obtain primary determinations of the masses of the earth and moon, the astronomical units, and the disturbing elements of the earth's orbit in the solar system. This was appropriate because of the absence of midorbital orbit corrections and near-planetary encounters. Also, solar radiation pressure effects were minimal. The experiment used the onboard receiver and transmitter equipment in conjunction with Deep Space Network station equipment to obtain Doppler measurements.

-------- PIONEER 6, ESCHKAM ---------------

INVESTIGATION NAME- TWO-FREQUENCY BEACON RECEIVER

NSSDC 10- 65-105A-08

INVESTIGATIVE PROGRAM

CODE EL-4, SCIENCE

INVESTIGATION DISCIPLINE(S)

IONSOPHYSICS AND RADIO PHYSICS

PARTICLES AND FIELDS

PERSONNEL

PI - V.F. ESCHKAM STANFORD U

01 - T.A. CROFT SKI INTERNATIONAL

01 - R.L. LEEDHAN SKI INTERNATIONAL

01 - O.W. GARRODE NASA-JSC

01 - A.M. PETERSON STANFORD U

BRIEF DESCRIPTION

Both 425.5-MHz and its 217 MHz subharmonics 49.5-MHz signals were transmitted from a 46-MHz 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 best 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 telemeasured 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 65-105A-09, 67-123A-05, 66-105A-04, and 67-105A-92. More detailed descriptions of the experiment can be found in J. Geophys. Res., v. 71, pp. 3325-3332, and Radio Sci., v. 6, pp. 55-63.
Frequency settings separated by about 8 percent and covered the range 80 to 800 kHz. The low-frequency receiver has 24 settings with 10% separation and covered the range 0.1 Hz to 30 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 300 Hz. The response time of the spacecraft telemetry format, bit rate, and experiment operational mode, when the solar array 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, 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. 246 of Radiation Research, v. 19, n. 5, 1975.

--- HELIOS-A, Gurnett ---

INVESTIGATION NAME: MEASUREMENT OF INTERPLANETARY PHASE DISPLACEMENTS
INVESTIGATION CODE: 1E-47CO-OP, SPACE
INVESTIGATION DISCIPLINE(S): RADIO PHYSICS, PARTICLES AND FIELDS, SOLAR PHYSICS

PERSONNEL
PI - J.A. Gurnett
DI - J.P. Kellogg
DI - R.G. Stone

BRIEF DESCRIPTION
The experiment (E5c) shared the 32-watt, tip-to-tip dipole antenna with experiments 1A and 2A. A dual frequency (16) low-frequency channel-triangulation experiment, logarithmically spaced channels, was used to detect type III radio emissions associated with solar flares events in the frequency band 45 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 possibility channel was one every 2.53 of a satellite spin period or about 0.5 s. A typical sampling frequency channel was selected for one 32-sectored 35 frequency channel to be sampled, chosen for 16 sectors (1/2 revolution). The scan rate, one half of the 32-sectored channel, was designed to cover all sectors in a spacecraft spin period. The receiver was designed to cover all frequencies from 0.1 Hz to 30 Hz 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 at 35 kHz decreasing with increasing frequency. In that above 200 kHz it produced no detectable interference. For further details about the instrument and modes of operation, see p. 255 of Kauffhorschung, v. 19, n. 5, 1975.

--- HELIOS-B, Fuchs ---

INVESTIGATION NAME: INTERPLANETARY PARTICLES
INVESTIGATION CODE: 1E-47CO-OP, SCIENCE
INVESTIGATION DISCIPLINE(S): INTERPLANETARY PHYSICS

PERSONNEL
PI - J. Fuchs
DI - J. Weinreich

BRIEF DESCRIPTION
The purpose of the experiment (E6b) was to determine the interstellar dust including whether or not (i) the number of particles, (ii) the orbit of the sun, and the sun's distance from the Earth, because solar pressure, and (iii) the number density of particles changes near the orbits of planets. The objective was hit with high velocity (0.5 keV) causing the material to vaporize and become partially ionized. The generated plasma cloud was then separated by appropriate voltage into its negative (electron) and positive ions. This mass and energy of the dust particles was determined from the impulse height. A time-of-flight mass spectrometer in connection with the target allowed the small ion cloud to be analyzed. In this way, the integration of the chemical composition of the dust particles became possible. The threshold for the detection of a particle was about 1×10^6. Mass and energy determination was possible for particles larger than about 1×10^4. For particles larger than 1×10^5 the mass spectrum was gathered for further details. See pp. 208-209 of Kauffhorschung, v. 19, n. 5, 1975.

--- HELIOS-C, Leinert ---

INVESTIGATION NAME: ZODIACAL LIGHT PHOTOMETER
INVESTIGATION CODE: 1E-46CO-OP, SCIENCE
INVESTIGATION DISCIPLINE(S): INTERPLANETARY PHYSICS

PERSONNEL
PI - C. Leinert
DI - E. Pittz

BRIEF DESCRIPTION
This experiment (E7b) consisted of three photometers looking at 15 deg, 30 deg, and 90 deg from the ecliptic. The photometers observed the intensity and polarization of the zodiacal light. In UV, blue, and white light, the purpose of this experiment was to obtain information about the spatial distribution, size, and nature of interstellar dust particles. For further details, see pp. 264-267 of Kauffhorschung, v. 19, n. 5, 1975.

--- HELIOS-D, Leinert ---

INVESTIGATION NAME: ZODIACAL LIGHT PHOTOMETER
INVESTIGATION CODE: 1E-46CO-OP, SCIENCE
INVESTIGATION DISCIPLINE(S): INTERPLANETARY PHYSICS

PERSONNEL
PI - C. Leinert
DI - E. Pittz

BRIEF DESCRIPTION
This experiment (E9b) 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 white light. The purpose of this experiment was to obtain information about the spatial distribution, size, and nature of interstellar dust particles. For further details, see pp. 264-267 of Kauffhorschung, v. 19, n. 5, 1975.
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*Experiment aborted
*Experiment failed
*X no data at NSSDC
*All or partial data at NSSDC

**Legend:**  
- X: No data at NSSDC  
- ☐: Experiment failed  
- ☑: All or partial data at NSSDC  

*Note: Missions also included.*
*Excluded with threatened data.*
*Excluded with threat and failure data.*

**Table 3. U.S. Lunar Mission Data**
Appendixes
## APPENDIX A

### INDEX TO PLANETARY INVESTIGATIONS

WITH DATA AVAILABLE AT NSSDC

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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.
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.