

Office of Space Science
& Applications

Flight Project Data Book

1991 Edition



National Aeronautics and
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OFFICE OF SPACE SCIENCE AND APPLICATIONS 1991 FLIGHT PROJECT DATA BOOK

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Introduction

The Office of Space Science and Applications

The Office of Space Science and Applications (OSSA) is responsible for planning, managing, and executing NASA programs which use the unique characteristics of space to conduct scientific activities. OSSA programs span the full spectrum of scientific disciplines, including study of the physical universe, investigation of solutions to practical problems on Earth, and development of the scientific foundation necessary for human exploration of the solar system.

OSSA is responsible for the development of NASA's space science and applications flight instrumentation, including free-flying spacecraft, payloads that will be flown on the Space Shuttle and/or Space Station Freedom, suborbital sounding rockets, balloons, and aircraft programs. OSSA also sponsors analysis of the data collected from these missions, maintains an extensive research and analysis program, and is responsible for the management of the Goddard Space Flight Center and the Jet Propulsion Laboratory.

This document summarizes planned flight missions, including those approved and under development and those that appear in the OSSA strategic plan. In addition, this edition also includes on-going missions.





Flight Projects Planned or In Development

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Advanced Communications Technology Satellite (ACTS)

Objective

The objectives of the Advanced Communications Technology Satellite (ACTS) include: maintaining U.S. leadership in satellite communications; providing advanced communications technology for NASA missions and other government agencies; testing and verifying advanced technologies including: 1) high power, fast hopping spot-beam antennas; 2) Ka Band (30/20 GHz) components; 3) on-board processing and switching; and 4) testing and demonstrating technologies through an experiment program with participation by telecommunications users, service and product providers.

Description

The ACTS spacecraft will be deployed from the Space Shuttle and then propelled into a geostationary orbit using a Transfer Orbit Stage (TOS). Following launch and checkout, a 2- to 4-year program is planned for user-funded experiments.

Launch Date:	August 1992
Payload:	Communications
Orbit:	Geostationary orbit, 0 degree inclination, 100 degrees West longitude
Design Life:	2 years (4 years of station keeping fuel)
Length:	9 m
Weight:	2,733 kg (ACTS cargo element)
Diameter:	4.3 m (static payload envelope)
Launch Vehicle:	Space Shuttle, Transfer Orbit Stage
Foreign Participation:	None

Instruments

Communications Electronics Package (CEP) with Multi-Beam Antenna (MBA) - General Electric*

**The experiments are determined by ground terminal configuration.*

Mission Events

Design and fabrication: 1984-1992

Experiment period: 1992-1994

Management

NASA Headquarters

D. Olmstead, ACTS Manager

D. Olmstead, Experiments Program Manager (Acting)

Lewis Research Center

R. Gedney, Project Manager

R. Schertler, Experiments Manager

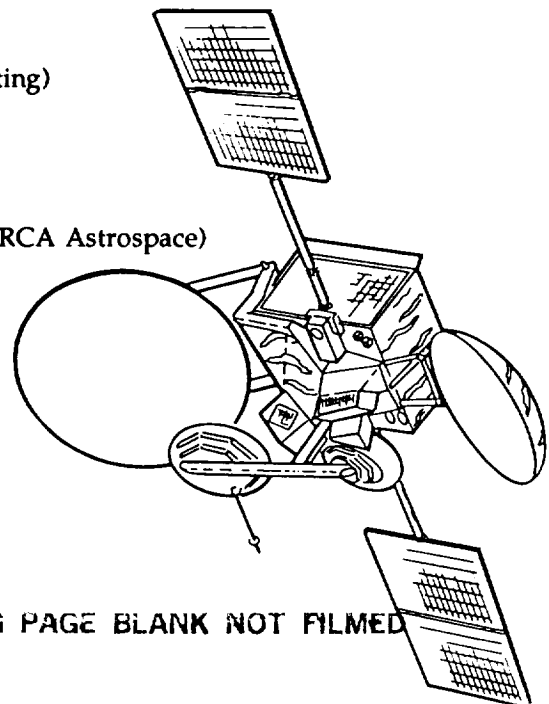
Major Contractors

General Electric, AstroSpace Division (Formerly RCA AstroSpace)

COMSAT Laboratories

Motorola, Inc.

Harris



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Advanced Communications Technology Satellite (ACTS) (Continued)

Status

General Electric's AstroSpace Division's predecessor, RCA AstroSpace, was awarded the prime contract for development of the ACTS system in August 1984. Current major contractors are GE AstroSpace, with Motorola as a major subcontractor, COMSAT Laboratories, and Harris.

Lewis Research Center (LeRC) is responsible for the overall system design and integration between the flight system (GE) and the ground based system (COMSAT). It will also directly manage the contracts for NASA's ground station and master control station development being conducted at COMSAT Laboratories, and for a prototype experimenter ground terminal being conducted by Harris.

The Jet Propulsion Laboratory (JPL) is responsible for developing a prototype ground terminal for mobile vehicle communications.

Advanced X-ray Astrophysics Facility (AXAF)

Objective

The objectives of the Advanced X-ray Astrophysics Facility (AXAF) are: to obtain high resolution x-ray images and spectra in the 0.1 to 10 thousand electron volts (keV) wavelength range; to investigate the existence of stellar black holes; to study the contribution of hot gas to the mass of the universe; to investigate the existence of dark matter in galaxies; to study clusters and superclusters of galaxies; to investigate the age and ultimate fate of the universe; to study mechanisms by which particles are accelerated to high energies; to confirm validity of basic physical theory in neutron stars; and, to investigate details of stellar evolution and supernovae.

Description

AXAF is the x-ray element of the Great Observatories program. It is a free-flying observatory with a goal for a 15-year operational lifetime. The AXAF telescope consists of a nested array of grazing incidence mirrors, up to four focal plane science instruments, two sets of objective gratings, and a Principal Investigator-developed science payload unit. This telescope, with a geometric collecting area of 1,700 square centimeters and an 0.5 arcsecond angular resolution, will provide at least a 100-fold increase over its predecessor, the High Energy Astronomy Observatory (HEAO-2, Einstein Observatory).

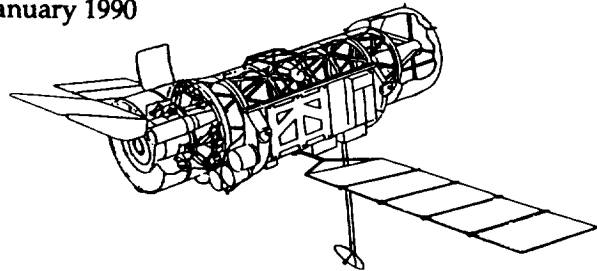
Launch Date:	1997 (Under Review)
Investigations:	Up to 4 focal plane instruments and 2 non-focal plane instruments
Orbit:	600 km altitude, 28.5 degree inclination, circular
Design Life:	15 years with servicing
Length:	14 m
Weight:	14,545 kg
Diameter:	Approx. 4 m
Launch Vehicle:	Space Shuttle
Foreign Participation:	Germany, Netherlands, United Kingdom

Instruments

AXAF CCD Imaging Spectrometer (ACIS) - G. Garmire (Pennsylvania State University)
High Resolution Camera (HRC) - S. Murray (Smithsonian Astrophysics Observatory)
Low Energy Transmission Grating Spectrometer (LETGS) - A. Brinkman (University of Utrecht)
High Energy Transmission Grating Spectrometer (HETGS) - C. Canizares (Massachusetts Institute of Technology)
X-ray Spectrometer (XRS) - S. Holt (GSFC)
Bragg Crystal Spectrometer (BCS) - C. Canizares (Massachusetts Institute of Technology)

Mission Events

TRW Phase C/D contract initiation: January 1989
Initiation of science instrument development: January 1990
Completion of largest mirror pair: June 1991
Launch date: Under review



Advanced X-ray Astrophysics Facility (AXAF) (Continued)

Management

NASA Headquarters

A. Fuchs, Program Manager

A. Bunner, Program Scientist

Marshall Space Flight Center

F. Wojtalik, Project Manager

M. Weisskopf, Program Scientist

Major Contractors

TRW, Inc.

Hughes Danbury Optical Systems

Status

Mirror technology program is underway. Development of the first mirror pair is on schedule to meet the August 1991 optical metrology milestone. Instrument Phase C/D contracts were signed in May 1990. Work on the High Resolution Mirror Assembly (HRMA) has been initiated and a low level of spacecraft definition work is also underway.

Astro-D Mission Spectroscopic X-ray Observatory (SXO)

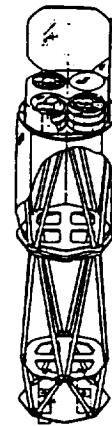
Objectives

The Astro-D Mission will perform Spectroscopic X-ray Astronomy in the wavelength band from less than 1 thousand electron volts (keV) to 12 keV, with particular emphasis on the iron K band.

Description

Astro-D is a cooperative mission with Japan's Institute of Space and Astronautical Sciences (ISAS) in which the Goddard Space Flight Center (GSFC) will provide four conical, grazing incidence, thin foil mirrors and the Massachusetts Institute of Technology (MIT) will provide two Charge Coupled Device (CCD)-based detectors. Japan will provide the balance of the science payload including two other detectors, the spacecraft and the launch vehicle. In return for its scientific instrument contribution, NASA will be allocated approximately 25 percent of the science data.

Launch Date:	February 1993
Payload:	4 x-ray instruments
Orbit:	500 km altitude, inclination TBD
Duration:	> 3 years
Length:	4 m (deployed)
Weight:	220 kg (entire satellite)
Diameter:	TBD
Launch Vehicle:	M3S-II (Japan)
Foreign Participation:	Japan



Instruments

X-ray Telescopes - ISAS
Gas Scintillation Imaging System (GSIS) - ISAS
Conical Grazing Incidence Mirrors (CGIM's) - P. Serlemitsos (GSFC)
CCD-based Detectors - G. Ricker (Massachusetts Institute of Technology)

Mission Events

Delivery of Engineering Units (CCD-based Detectors) to Japan: November 1989
Delivery of Engineering Units (CGIM's) to Japan: March 1990
CCD-based Detectors Critical Design Review: February 1991
Delivery of Flight Hardware (CCD-based Detectors and CGIM) to Japan: Fall 1991
Launch: February 1993

Management

NASA Headquarters
J. Lintott, Program Manager
A. Bunner, Program Scientist
Goddard Space Flight Center (GSFC)
G. Ousley, Program Manager
S. Holt, Program Scientist
Major Contractor
Massachusetts Institute of Technology

Status

Engineering units for both the CCD-based Detectors and CGIM's have been delivered to Japan and are undergoing testing. Flight hardware is scheduled for delivery to Japan during Fall 1991 in preparation for a February 1993 launch.

Astro-SPAS Program

Objective

The Astro-SPAS program will provide flight opportunities for selected scientific payloads that can contain a one-meter class telescope or equivalent equipment. The instruments will address specific scientific objectives in astrophysics and Earth sciences.

Description

Astro-SPAS is a joint scientific program between NASA and DARA, the German Space Agency. The program employs a reusable science satellite, the Astro-SPAS carrier, that is being developed by DARA for short-duration missions. Science instruments will be provided by both parties. After being transported to low-Earth orbit by the Space Shuttle, Astro-SPAS will be deployed from the cargo bay using the Remote Manipulator System (RMS). For the next 4 to 6 days, Astro-SPAS will execute a pre-programmed series of mission operations. The carrier is a semi-autonomous system powered by batteries with data being stored on tape. The on-board star tracker and cold gas thrusters can achieve 5 to 10 arcseconds pointing accuracy for 80 to 250 targets. At the end of the mission, the Astro-SPAS carrier will be retrieved by the RMS and placed in the Shuttle cargo bay and returned to Earth for reuse on other missions. Two missions have been selected for the Astro-SPAS Program; brief descriptions of the selected missions follow:

The Orbiting and Retrievable Far and Extreme Ultraviolet Spectrometer (ORFEUS) consists of a combination of spectrometers/telescopes capable of sensing and measuring ultraviolet radiation. The primary telescope, provided by DARA, houses the Echelle spectrometer and the Rowland spectrometer. The Rowland spectrometer is a NASA-provided instrument being developed by the University of California - Berkeley. The Interstellar Medium Absorption Profile Spectrograph (IMAPS) is mounted on the keel of the Astro-SPAS carrier and utilizes the same star acquisition and tracking systems as the primary telescope. IMAPS is also a NASA-provided instrument being developed by Princeton University.

The Cryogenic Infrared Spectrometer Telescope for Atmosphere (CRISTA) consists of a German telescope/cryostat assembly sensitive in the 4 to 70 micrometer spectral range, and containing U.S. experiments including the Infrared Measurements of the Atmosphere (IRMA, 50 to 60 micrometers) and Airglow Measurements of Infrared Measurements Emissions (AMIE, 1 to 2 micrometers). The payload operates at a distance of approximately 4 kilometers from the Shuttle following deployment from the cargo bay using the RMS. CRISTA contains onboard batteries, cryogenic and N² cold-gas maneuvering subsystems. CRISTA will be retrieved at the end of the mission and returned to Earth with the Shuttle. CRISTA, along with its co-manifested NASA payload (ATLAS-2), will constitute a joint science mission with a single set of science objectives managed by a single management structure.

	<u>ORFEUS</u>	<u>CRISTA</u>
Launch Date:	January 1993	February 1994
Investigations:	3 ultraviolet spectrometers	1 instrument/ 3 investigation regions
Orbit:	Deployed from/ retrieved by Space Shuttle	250 km altitude, 57 degree inclin. Deployed from/retrieved by Space Shuttle
Duration:	Up to 7 days	7 - 10 days
Length:	Approx. 9.2 m	TBD
Weight:	Approx. 6,400 kg	6,400 kg (planned)
Diameter:	TBD	457 cm
Launch Vehicle:	Space Shuttle	Space Shuttle
Foreign Participation:	Germany	Germany

Astro-SPAS Program (Continued)

Instruments

Orbiting and Retrievable Far and Extreme Ultraviolet Spectrometer (ORFEUS) - G. Kramer (Astronomical Institute of Tubingen); S. Bowyer (University of California, Berkeley)
Interstellar Medium Absorption Profile Spectrograph (IMAPS) - E. Jenkins (Princeton University)

Mission Events

Mission concept, feasibility studies: Completed
Mission definition studies: Completed
Mission implementation: Ongoing
ORFEUS delivery to Kennedy Space Center: Early 1992
CRISTA delivery to Kennedy Space Center: Early 1993

Management

NASA Headquarters

E. Reeves, Astro-SPAS Program Manager (Acting)
W. Huddleston, ORFEUS Program Manager
R. Stachnik, ORFEUS Program Scientist
E. Montoya, CRISTA Program Manager
D. Butler, CRISTA Program Scientist

Germany

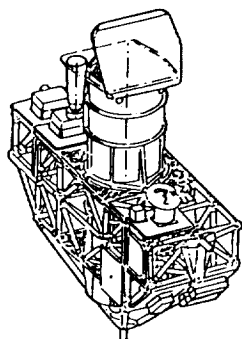
M. Otterbein, Astro-SPAS Program, DARA
G. Hartmann, Astro-SPAS Mission Manager, DARA
G. Kraeher, ORFEUS Project Scientist, University of Tubingen
D. Offermann, CRISTA Project Scientist, University of Wuppertal

Major Contractors

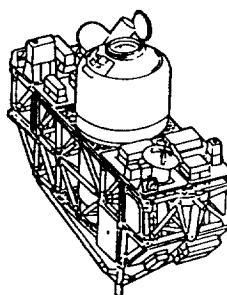
University of California at Berkeley
Princeton University Observatory

Status

Memorandum of Understanding (MOU) and Letter Agreements for ORFEUS have been developed and reviewed with the German Space Agency (DARA). These documents are currently under review by the State Department. The ORFEUS Payload Integration Plan (PIP) review was held at the Johnson Space Center (JSC) on October 24-25, 1990. An Astro-SPAS program review was held at NASA Headquarters on November 5, 1990. Manufacturing of the ORFEUS instruments and the Astro-SPAS carrier were ongoing. A Technical Exchange Meeting (TEM) for CRISTA was held on October 18-19, 1990 at the Marshall Space Flight Center (MSFC). Payload Integration Plan meetings for CRISTA were held on October 22-23, 1990 at JSC.



ORFEUS



CRISTA

Atmospheric Laboratory for Applications and Science (ATLAS)

Objective

The Atmospheric Laboratory for Applications and Science (ATLAS) will measure long-term changes in the total energy radiated by the Sun, determine the variability in the solar spectrum, and measure the global distribution of key molecular species in the middle atmosphere. Such measurements are needed because even small changes in the Sun's total irradiance or its spectral distribution can have a significant impact on the Earth's climate and environment. Additional objectives are to differentiate man-made from natural perturbations in the Earth's atmosphere and to provide absolute calibrations for solar monitoring instruments on free-flying spacecraft.

Description

The first of the ATLAS missions will use two Spacelab pallets and an igloo to accommodate a core payload of six solar and atmospheric monitoring instruments plus reflights of six Spacelab investigations. Later missions at roughly 1-year intervals will have a single pallet. The Space Shuttle's orientation will either be inertially fixed so that selected instruments are pointed at the Sun or the nadir for observations of the Earth's atmosphere. The orbit must have solar occultations so that absorptions in the solar spectrum caused by trace molecules in the atmosphere can be detected by the Atmospheric Trace Molecules Observed by Spectroscopy (ATMOS) instrument and infrared spectrometer with a mirror system to track the Sun. Command, control and data handling support for the experiments are provided by Spacelab's avionics located in the igloo. The crew will work in the aft flight deck, which has the displays and controls needed to conduct the ATLAS investigations.

Launch Date:	ATLAS-1: April 1992 ATLAS-2: April 1993 ATLAS-3: 1994 (planned) ATLAS-4: 1995 (planned)
Investigations:	12 instrument complement for ATLAS-1
Orbit:	300 km altitude, 57 degree inclination
Duration:	7-10 days
Length:	9.2 m
Weight:	ATLAS-1: 9,090 kg ATLAS-2: 6,400 kg (planned) ATLAS-3: 6,400 kg (planned)
Diameter:	Approx. 4.6 m
Launch Vehicle:	Space Shuttle
Foreign Participation:	Germany, Belgium, France, Japan

Investigations

Active Cavity Radiometer (ACR) - R. Wilson (Jet Propulsion Laboratory)
Solar Constant Radiometer (SOLCON) - D. Crommelynck (Institut Royal Meteorologique, Belgium)
Solar UV Spectral Irradiance Monitor (SUSIM) - G. Brueckner (Naval Research Laboratory)
Solar Spectrum (SOLSPEC) - G. Thuiller (Service D'Aeronomie du CNRS, France)
Atmospheric Trace Molecule Spectroscopy (ATMOS) - M. Gunson (Jet Propulsion Laboratory)
Imaging Spectrometric Observatory (ISO) - M. Torr (MSFC)
Microwave Atmospheric Sounder (MAS) - Hartman (Max Planck Institute)
Space Experiments with Particle Accelerators (SEPAC) - T. Obayashi (University of Tokyo, Japan)
Atmospheric Emission Photometric Imaging (AEPI) - S. Mende (Lockheed Palo Alto Research Laboratories)

Atmospheric Laboratory for Applications and Science (ATLAS) (Continued)

Investigations (Continued)

Shuttle Solar Backscatter Ultraviolet Experiment (SSBUV)*- Hilsenrath (GSFC)
Far Ultraviolet Astronomy (FAUST) - C. Bowyer (University of California, Berkeley)
Grille Spectrometer - M. Ackerman (Institut d'Aeronomie Spatiale de Belgique)
Investigation on Atmospheric H and D Through the Measurement of Lyman Alpha (ALAE) -
J. Bertaux (CNRS, France)

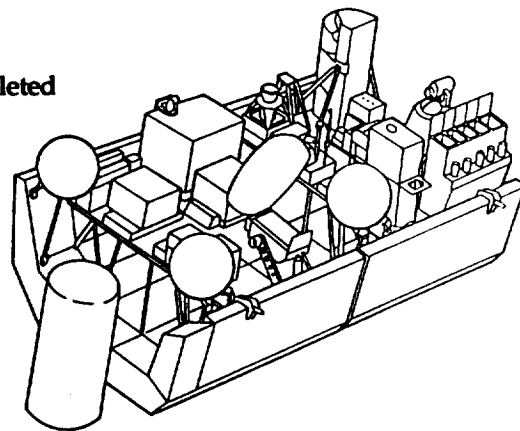
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Mission Events

Preliminary experiment design: Completed
Mission concept, feasibility studies: Completed
Mission definition studies: Completed
Mission implementation: Ongoing
Instrument delivery to Kennedy Space Center: Completed
Launch readiness date: March 1992

Management

NASA Headquarters
E. Montoya, Program Manager
D. Butler, Program Scientist
Marshall Space Flight Center
A. O'Neil, Mission Manager
M. Torr, Mission Scientist
T. Vanhooser, Deputy Mission Manager
Major Contractors
Teledyne Brown



Status

All ATLAS-1 instruments were delivered to Kennedy Space Center by the end of September 1990 for integration onto the pallets for launch. Mission has completed its Cargo Integration Review (CIR) with all engineering aspects declared completed or in process for completion. This mission is ready to be launched as soon as the instruments are integrated onto the pallets, which is expected by May 1991.

Centrifuge Facility Program

Objective

The Centrifuge Facility Program provides a suite of equipment designed to provide accurately-controlled artificial gravity acceleration levels to support a broad spectrum of NASA Life Sciences research activities, including: 1) on-board experiments with 1-g controls to separate the effects of microgravity from those of other environmental factors; 2) threshold gravity level studies requiring accurately controlled variable gravity; 3) countermeasure studies using regimens of varying artificial gravity levels on human surrogates; 4) determining artificial gravity requirements for long duration spaceflight, e.g. extended Lunar and manned Mars missions; 5) assessing the impact of long exposure to fractional gravity levels; 6) fundamental biological studies in which the parameter of interest, gravity, is accurately controlled; 7) studying the adaptation of experiment specimens to the spacecraft/spaceflight environment under 1-g conditions; and, 8) validating extrapolated data from ground-based hypergravity studies.

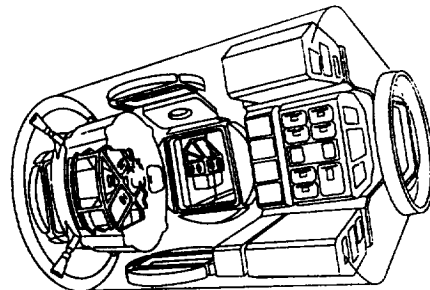
Description

The Centrifuge Facility is comprised of the following flight hardware: 1) Centrifuge will be 2.5 meters in diameter supporting a number of habitats, and will be able to produce gravity levels between .01 and 2 g's; 2) Two Habitat Holding Units (2), each a double-rack in size, are support systems for the habitats in the microgravity environment; 3) Modular Habitats will, in conjunction with the Habitat Holding Units and the Centrifuge, provide life support for rats, mice, squirrel monkeys and plants; 4) Life Sciences Glovebox one double-rack in size, will provide a bio-isolated work area where specimens can be manipulated and transferred into and out of habitats; and, 5) Specimen Chamber Service Unit one double rack in size, will provide for refurbishment of habitats at regular intervals.

Launch Date: TBD
Payload: 1 instrument/Space Station Freedom
Orbit: 28.5 degree inclination
Duration: Extended
Length: TBD
Weight: 1,909 kg
Diameter: 2.5 m (Centrifuge Motor)
Launch Vehicle: Space Shuttle
Foreign Participation: International participation is anticipated

Mission Events

Phase B Start: October 1989
NASA Research Announcement: July 1991
Phase C/D Start: March 1992
Preliminary Requirements Review: November 1992
Preliminary Design Review: May 1993
Critical Design Review: August 1994
Phase C/D Complete: December 1995
Centrifuge Launch (Node 2): TBD
Habitat Holding Unit #1 Launch: TBD
Habitat Holding Unit #2 Launch: TBD



Centrifuge Facility Program (Continued)

Management

NASA Headquarters

L. Chambers, Program Manager

J. Wolfe, Program Scientist

Ames Research Center

J. Sperans, Project Manager

A. Hargens, Project Scientist

Major Contractors

TBD

Status

Two competitive Phase B studies are underway. A formal review of Part 1 of the Phase B studies was held in June 1990. Part 2 of the Phase B studies started in July 1990.

Collaborative Solar-Terrestrial Research (COSTR) Program: Cluster Mission

Objective

The Cluster Mission will perform three-dimensional studies of the microphysical properties of different plasma states in the Earth's magnetosphere.

Description

The Cluster Mission consists of four identically instrumented, spin-stabilized spacecraft built and launched by the European Space Agency (ESA). These spacecraft will be launched into a 4 x 22 Earth radii elliptical polar orbit with a full range of shared ESA/NASA plasma physics fields and particles instrumentation.

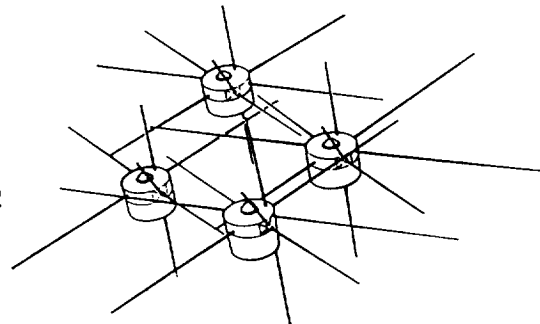
Launch Date:	December 1995
Payload:	11 instruments
Orbit:	4 x 22 Earth radii elliptical, polar orbit
Design Life:	2 years
Length:	4 m
Weight:	4,000 kg
Diameter:	2.9 m
Launch Vehicle:	Ariane-V
Foreign Participation:	European Space Agency

Instruments

- Active Spacecraft Potential Control (ASPOC) - W. Riedler (Institute fur Weltraumforschung)
- Cluster Ion Spectrometry (CIS) - H. Reme (Centre d'Etude Spatiale des Rayonnements, University of Toulouse)
- Digital Wave Processor (DWP) - L. Woolliscroft (University of Sheffield)
- Electric Fields and Waves (EFW) - G. Gustafsson (Swedish Institute of Space Physics)
- Electron Drift Instrument (EDI) - G. Paschmann (Max Planck Institute)
- Fluxgate Magnetometer (FGM) - A. Balogh (Imperial College)
- Plasma Electron and Current Analyzer (PEACE) - A. Johnstone (Mullard Space Science Laboratory)
- Research with Adaptive Particle Imaging Detectors (RAPID) - B. Wilken (Max Planck Institute)
- Spatio-Temporal Analysis of Field Fluctuations (STAFF) - N. Cornilleau (Centre de Recherche en Physique d'Environnant Terrestres et Planetaires/Centre National d'Etude des Telecommunications)
- Waves of High Frequency and Sounder for Probing of Density by Relaxation (WHISPER) - P. Decreau (Lab de Physique et Chimie de l'Environ)
- Wide Band Data (WBD) - D. Gurnett (University of Iowa)

Mission Events

- Announcement of Opportunity released: March 1987
- Investigations confirmed: December 1989
- Initiate instrument development: 1989
- Initiate spacecraft development: 1990
- Instrument Critical Design Review: 2nd quarter 1991
- Instrument delivery: 2nd quarter 1992
- Spacecraft Critical Design Review: 4th quarter 1992



Collaborative Solar-Terrestrial Research (COSTR) Program: Cluster Mission (Continued)

Management

NASA Headquarters

M. Calabrese, Program Manager

E. Whipple, Program Scientist

Goddard Space Flight Center

K. Sizemore, Project Manager

M. Acuna, Project Scientist

European Space Research and Technology Center (ESTEC)

D. Dale, Program Manager

R. Reinhard, Program Scientist

J. Credland, Project Manager

R. Schmidt, Project Scientist

Major Contractor

Dornier

Status

Investigation development initiated. Spacecraft contract awarded to Dornier in October 1989. Memorandum of Understanding signed November 1989. Program plan signed December 1989. Phase B studies underway. Phase C/D initiated in February 1991.

Collaborative Solar-Terrestrial Research (COSTR) Program: Geotail Mission

Objective

The Geotail Mission will characterize the energy stored in the Earth's geotail and mid-magnetosphere region including measurements in the tail plasma sheet and measurements of plasma entry and transport in the magnetosphere boundary layer for the Global Geospace Science (GGS) program.

Description

Geotail is a spin-stabilized spacecraft provided by Japan's Institute of Space and Astronautical Sciences (ISAS) with a full range of shared ISAS/NASA plasma physics field and particles instrumentation. Geotail will be launched by a Delta II into a night side double lunar swingby orbit to 8 x 250 Earth radii and later reduced to an 8 x 32 Earth radii equatorial orbit.

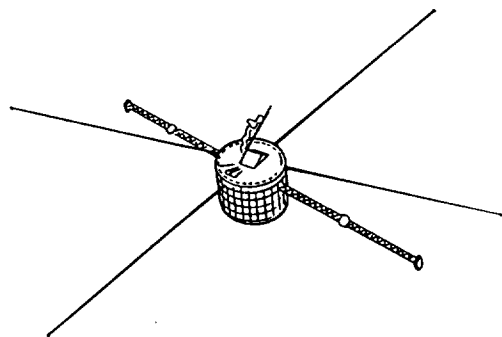
Launch Date:	July 1992
Investigations:	8 instruments
Orbit:	Double lunar swingby to a 8 x 220 Earth radii, reduced to an 8 x 30 Earth radii equatorial orbit, 7.5 degree inclination
Design Life:	3 years
Length:	1.6 m
Weight:	970 kg
Diameter:	2.2 m
Launch Vehicle:	Delta II
Foreign Participation:	Japan

Instuments

Comprehensive Particles Investigation (CPI) - L. Frank (University of Iowa)
Electric Field Detector (EFD) - K. Tsuruda (ISAS)
Energetic Particle and Ion Composition (EPIC) - D. Williams (Applied Physics Laboratory)
High Energy Particle Experiment (HEP) - M. Doke (Waseda University)
Low Energy Particle Experiment (LEP) - T. Mukai (ISAS)
Magnetic Field Experiment (MGF) - S. Kokobun (University of Tokyo)
Plasma Waves Investigation (PWI) - H. Matsumoto (Kyoto University)

Mission Events

Announcement of Opportunity released: October 1979
Confirmation of investigations: September 1987
Engineering unit integration test: Completed
U.S. instrument flight model deliveries: 1989
Detailed system design: Completed
Spacecraft Critical Design Review (CDR): April 1990
Spacecraft delivery: May 1992



Collaborative Solar-Terrestrial Research (COSTR) Program: Geotail Mission (Continued)

Management

NASA Headquarters

M. Calabrese, Program Manager

E. Whipple, Program Scientist

Goddard Space Flight Center

K. Sizemore, Project Manager

M. Acuna, Project Scientist

Institute of Space and Astronautical Science (Japan)

A. Nishida, Program Manager, Program Scientist

K. Uesugi, Project Manager

T. Mukai, Project Scientist

Major Contractor

NEC

Status

Memorandum of Understanding signed December 1989. Spacecraft Critical Design Review completed April 1990. Flight Spacecraft under development. U.S. instruments development schedule will support delivery of flight models to Japan in 1991.

Collaborative Solar-Terrestrial Research (COSTR) Program: Solar and Heliospheric Observatory Mission (SOHO)

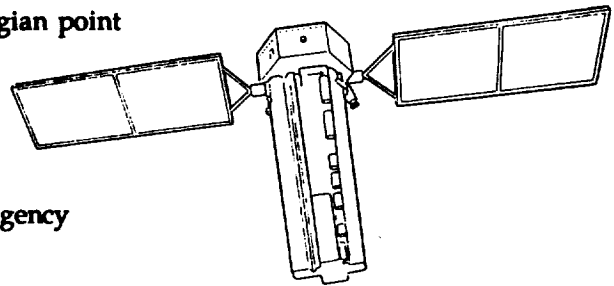
Objective

The Solar and Heliospheric Observatory Mission (SOHO) will perform remote measurements of the sun and *in situ* measurements of the solar wind abundance to characterize the structure of the solar interior and the dynamics of coronal plasma.

Description

SOHO is a three-axis stabilized European Space Agency (ESA) spacecraft with shared ESA and NASA solar physics and plasma physics field and particles instrumentation. SOHO will be launched by NASA into a halo orbit at the Sun-Earth L₁ Lagrangian point.

Launch Date:	July 1995
Orbit:	Halo at L ₁ Lagrangian point
Design Life:	2 years
Length:	3.6 m
Weight:	1,850 kg
Diameter:	3.6 m
Launch Vehicle:	Atlas II AS
Foreign Participation:	European Space Agency



Instruments

Charge, Element and Isotope Analysis (CELIAS) - D. Hovestadt (Max Planck Institute)

Coronal Diagnostic Spectrometer (CDS) - B. Patchett (Rutherford Appleton Laboratory)

Energetic Particle Analyzer (ERNE) - J. Torsti (University of Turku)

Extreme Ultraviolet Imaging Telescope (EIT) - J. Delaboudiniere (Lab de Physique Stellaire et Planetaire)

Global Oscillations at Low Frequencies (GOLF) - A. Gabriel (Lab de Physique Stellaire et Planetaire)

Large Angle and Spectrometric Coronagraph (LASCO) - G. Brueckner (Naval Research Laboratory)

Michelson Doppler Imager (MDI) - P. Scherrer (Stanford University)

Solar Ultraviolet Measurements of Emitted Radiation (SUMER) - K. Wilhelm (Max Planck Institute)

Solar Wind Anisotropies (SWAN) - J. Bertaux (Service d'Aeronomie du CNRS)

Suprathermal and Energetic Particle Analyzer (COSTEP) - H. Kunow (University of Kiel)

Ultraviolet Coronagraph Spectrometer (UVCS) - J. Kohl (Smithsonian Astrophysical Observatory)

Variability of Solar Irradiance (VIRGO) - C. Frohlich (PMOD/WRC)

Mission Events

Announcement of Opportunity released: March 1987

Investigations confirmed: December 1989

Initiate instrument development: 1990

Initiate spacecraft development: 1990

Proto-flight model delivery: June 1993

**Collaborative Solar-Terrestrial Research (COSTR) Program:
Solar and Heliospheric Observatory Mission (SOHO)
(Continued)**

Management

NASA Headquarters

M. Calabrese, Program Manager

W. Wagner, Program Scientist

Goddard Space Flight Center

K. Sizemore, Project Manager

M. Acuna, Project Scientist

European Space Research and Technology Center (ESTEC)

D. Dale, Program Manager

R. Reinhard, Program Scientist

P. Logalbo, Project Manager

V. Domingo, Project Scientist

Major Contractor

MATRA

Status

Spacecraft contract awarded in October 1989. Atlas II AS selected as launch vehicle. Memorandum of Understanding (MOU) signed November 1989. Program plan signed December 1989. Phase B studies underway. Phase C/D will begin March 1991. Phase C/D instrument contracts signed for U.S. instruments in 1st quarter Fiscal Year 1991.

Comet Rendezvous Asteroid Flyby (CRAF)/Cassini

Objectives

The CRAF/Cassini Program, building on the discoveries made by the Pioneer and Voyager missions, will provide unprecedented information on the origin and evolution of our solar system and will help tell how the necessary building blocks for the chemical evolution of life are formed elsewhere in the universe.

CRAF

The objectives of the CRAF mission are to: 1) determine composition and character of the nucleus of a comet; characterize changes that occur as functions of time and orbital position; 2) characterize cometary atmosphere and ionosphere; characterize development of coma as a function of time and orbital position; 3) determine comet tail formation processes; characterize interaction of comets with solar wind and radiation; 4) characterize physical and geological structure of asteroid; and 5) determine major mineralogical phases and distribution on surface of asteroid.

Cassini

The Cassini mission will conduct a detailed exploration of the Saturnian system including: 1) the study of Saturn's atmosphere, rings and magnetosphere; 2) remote and *in situ* study of Titan; 3) the study of Saturn's icy moons; and, 4) an asteroid and Jupiter flyby to expand our knowledge of these bodies.

Description

CRAF

This free-flying mission will rendezvous with a short-period comet Kopff near aphelion and study the comet in detail for over 3 years, continuing through perihelion. During this time, the mission will 1) image the entire comet nucleus at high resolution; 2) determine its chemical, isotopic, and mineral composition; 3) observe the evolution of the coma and its interaction with the solar wind and magnetic field; 4) collect dust boiled off from the comet and examine it. After launch in 1996, the CRAF spacecraft will use a combination of Venus and Earth gravity assists to gain additional energy. CRAF will fly past its target asteroid in 1999 making detailed observations, and will arrive at its comet in the year 2003. The spacecraft will remain in its vicinity through perihelion passage in 2005. Following perihelion, the spacecraft will make a long excursion down the comet's tail and then return to the nucleus. Nominal mission end is 3 months after perihelion.

Launch Date:	February 1996
Payload:	12 instruments
Orbit:	Interplanetary-Venus/Earth Gravity Assist, Comet Rendezvous
Design Life:	13 years
Weight:	1,920 kg
Launch Vehicle:	Titan IV/Centaur
Foreign Participation:	Germany, Italy, 43 Foreign Investigators

Cassini

This free-flying mission will spend 4 years in orbit around the planet Saturn conducting a detailed exploration of the Saturnian system. At the conclusion of this mission, we will have a better understanding of the origin and evolution of the solar system including elemental and isotopic abundances; the internal structure of Saturn, Titan and icy satellites; the surface morphology of Titan, icy satellites, and asteroids; and the structure, dynamics, and evolution of Saturn's rings and magnetosphere. Our understanding will also increase regarding the chemical evolution in the solar system by studying the surface state and atmospheric chemistry of Titan and the composition of dark material on the icy satellites. Cassini will also study processes in cosmic plasma physics

Comet Rendezvous Asteroid Flyby (CRAF)/Cassini (Continued)

Description (Continued)

Cassini (Continued)

including the interaction of flowing plasma with icy solid bodies, plasma impact processing of surfaces and atmospheres, and interaction of energetic plasma, gas and dust. After launch in 1995, the Cassini spacecraft will use a combination of Venus, Earth and Jupiter gravity assists to gain energy. Cassini will fly past its asteroid in 1998 and the planet Jupiter in 2000, making detailed observations at each close approach. The spacecraft will arrive at Saturn in the year 2004 and will be inserted into a loose elliptical orbit. The European Space Agency's (ESA) Titan probe, called "Huygens," will be dropped into the atmosphere of Titan during the first orbit. The Cassini orbiter will then make approximately 40 revolutions to study Saturn, its rings, satellites and magnetosphere.

Launch Date:	November 1995
Payload:	12 instruments on orbiter, 6 instruments on probe
Orbit:	Interplanetary-Venus/Earth/Jupiter Gravity Assist, Saturn orbit
Design Life:	13 years
Weight:	2,050 kg
Launch Vehicle:	Titan IV/Centaur
Foreign Participation:	European Space Agency, Germany, Italy, 59 Foreign Co-Investigators

Instruments

CRAF

Imaging Science Subsystem (ISS) - J. Veverka (Cornell University)
Visual and Infrared Mapping Spectrometer (VIMS) - T. McCord (University of Hawaii)
Thermal Infrared Radiometer Experiment (TIREX) - F. Valero (ARC)
Cometary Matter Analyzer (COMA) - J. Kissel (Max Planck Institute)
Comet Ice/Dust Experiment (CIDEX) - G. Carle (ARC)
Comet Dust Environment Monitor (CODEM) - M. Alexander (Baylor University)
Neutral Gas and Ion Mass Spectrometer (NGIMS) - H. Niemann (GSFC)
Comet Retarding Potential Analyzer (CRIMS) - T. Moore (MSFC)
Suprathermal Plasma Investigation of Cometary Environments (SPICE) - J. Burch (Southwest Research Institute)
Magnetometer (MAG) - B. Tsurutani (Jet Propulsion Laboratory)
Coordinated Radio, Electrons, and Waves Experiment (CREWE) - J. Scudder (GSFC)
Radio Science (RS) - D. Yeomans (Jet Propulsion Laboratory)

CASSINI Saturn Orbiter

Infrared Composite Spectrometer (CIRS) - V. Kunde (GSFC)
Cosmic Dust Analyzer (CDA) - E. Grün (Max Planck Institute)
Radio and Plasma Wave System (RPWS) - D. Gurnett (University of Iowa)
Cassini Plasma Spectrometer (CPS) - D. Young (Southwest Research Institute)
Ultraviolet Imaging Spectrograph (UVIS) - L. Esposito (University of Colorado)
Magnetospheric Imaging Instrument (MIMI) - S. Krimigis (Johns Hopkins University)
Dual Technique Magnetometer (DTMAG) - D. Southwood (Imperial College, United Kingdom)
Titan Radar Mapper (RADAR) - C. Elachi (Jet Propulsion Laboratory)
Imaging Science Subsystem (ISS) - C. Porco (University of Arizona)
Radio Science Subsystem (RSS) - A. Kliore (Jet Propulsion Laboratory)
Ion and Neutral Mass Spectrometer (INMS) - TBD
Visual and Infrared Mapping Spectrometer (VIMS) - R. Brown (Jet Propulsion Laboratory)

Comet Rendezvous Asteroid Flyby (CRAF)/Cassini (Continued)

Mission Events

CRAF

Venus Flyby #1: July 1997
Venus Flyby #2: June 1998
Asteroid Flyby: February 1999
Earth Flyby: June 2000
Arrival at Comet: January 2003
Comet Perihelion: February 2005
Nominal End-of-Mission: June 2003

Cassini

Venus Flyby: December 1996
Earth Flyby: July 1998
Asteroid Flyby: November 1998
Jupiter Flyby: April 2000
Saturn Arrival: May 2004
Probe Deployment: August 2004
Nominal End-of-Mission: May 2008

Management

NASA Headquarters

H. Wright, Program Manager
H. Brinton, Program Scientist

Jet Propulsion Laboratory

J. Casani, Project Manager
M. Neugebauer, CRAF Project Scientist
D. Matson, Cassini Project Scientist

European Space Agency (ESA)

H. Hassan, Huygens Project Manager
J-P. LeBreton, Huygens Project Scientist

Major Contractors

Martin Marietta Aerospace
General Dynamics Corporation

Status

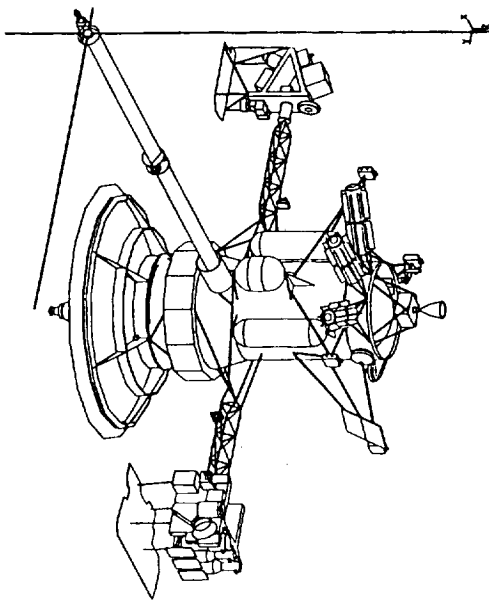
The CRAF/Cassini Program was approved as a new start in NASA's Fiscal Year 1990 budget. As of this printing, 12 CRAF science investigations have been tentatively selected. Confirmation of these investigations is scheduled to occur in November 1991. The CRAF Project Science Group continues to refine its implementation of CRAF science investigations and to work with the project on related spacecraft and mission design issues. NASA and the Jet Propulsion Laboratory (JPL) are working with the German Federal Ministry for Science and Technology (BMFT) on the design of the propulsion subsystem.

In February 1988, the Cassini mission was combined with the CRAF mission to form a single initiative. As a result, the Saturn Orbiter segment of Cassini inherits significant design features from the CRAF spacecraft. ESA has competitively selected Aerospaziale for design and development of the Huygens Probe segment of Cassini.

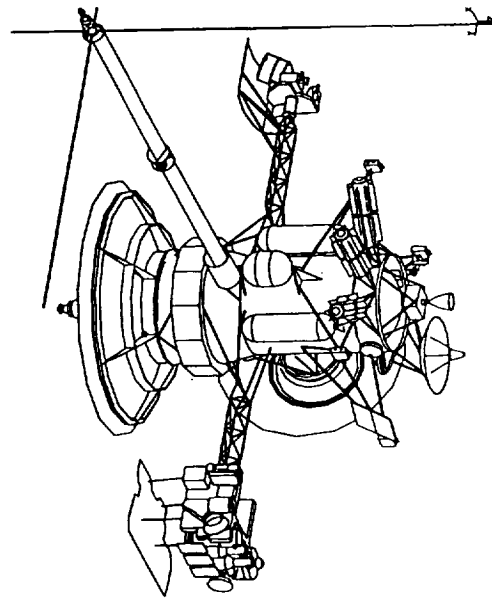
Comet Rendezvous Asteroid Flyby (CRAF)/Cassini (Continued)

Status (Continued)

Separate but coordinated Announcements of Opportunity for Cassini science investigations were released by NASA (Saturn Orbiter) and ESA (Huygens Probe) in October 1989. Selection of investigations has been announced by both parties, and the Cassini Project Science Group has been formed. NASA's selection for the Saturn Orbiter is tentative, with confirmation scheduled to occur in November 1991.



CRAF



Cassini

COSMOS Program

Objectives

The objectives of the COSMOS program include: 1) investigating the areas of rodent and primate physiology, general biology, radiation biology and dosimetry; 2) identifying the physiological, developmental, biochemical, and behavioral changes associated with microgravity; and 3) identifying and evaluating potential hazards during long-duration space flight.

Description

COSMOS is a joint U.S. - U.S.S.R. program including U.S. investigators that conduct scientific investigations aboard unmanned Soviet Biological Satellite Missions. Since the biosatellite program began over 15 years ago, the U.S. has participated on seven missions, and flown experiments involving plants, insects, rodents, fish and rhesus monkeys.

Launch Date:	Fall 1992
Payload:	2 rhesus monkeys and radiation dosimetry experiment
Orbit:	294 km apogee, 216 km perigee, 89.3 degree inclination
Duration:	14 - 19.5 days
Length:	488 cm (16 feet [approx.])
Weight:	900 kg (2,000 lbs.)
Diameter:	244 cm (8 ft)
Launch Vehicle:	VOSTOK (U.S.S.R.)
Foreign Participation:	U.S.S.R.

Investigations

Velocity Storage: Space Adaptation of Optokinetic Nystagmus and After-nystagmus to Microgravity - B. Cohen (Mt. Sinai School of Medicine)

Studies of Vestibular Nuclei Responses in Normal, Hyper- and Hypogravity - J. Correia (University of Texas Medical Branch)

Adaptation to Microgravity of Oculomotor Reflexes - D. Tomko (ARC)

Functional Neuromuscular Adaptation to Spaceflight - V. Edgerton (University of California, Los Angeles)

Rhesus Monkey Immunology Experiment - G. Sonnenfeld (University of Louisville)

Biological Rhythm and Temperature Regulation (A) and Metabolism (B) - C. Fuller (University of California, Davis)

Bone Response to Spaceflight in Rhesus Monkey - TBD

Mission Events

NASA has flown seven COSMOS missions since 1975. Currently negotiating for a mission in 1992.

Management

NASA Headquarters

L. Chambers, Program Manager

F. Sulzman, Program Scientist

Ames Research Center

J. Connolly, Project Manager

R. Ballard, Project Scientist

Status

Final results for the experiments conducted on COSMOS 2044 (1989 Mission) are being prepared. Preparations for the 1992 mission are underway.

Diffuse X-ray Spectrometer (DXS)

Objective

The objectives of the Diffuse X-ray Spectrometer (DXS) include measuring the spectral distribution of diffuse x-rays in the "Local" Interstellar Medium to help confirm or disprove theories on how the present state of our galaxy came to be and how galaxies evolve when remnants of supernovae form the source material for new stars. DXS will also test the theory that diffuse soft x-rays are emitted from invisible plasma which is a remnant from a star that exploded eons ago.

Description

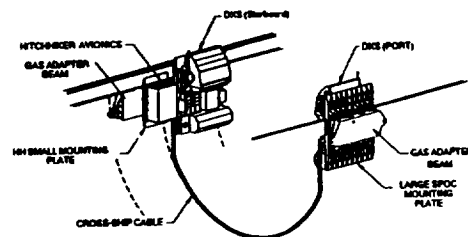
The two DXS instruments used for the mission will be identical in configuration. Each consists of six major elements: a rotating detector; an electronic interface box; a control electronics assembly; a power control subsystem; a gas tank; and a gas system manifold box. The detector will sort out x-rays according to wavelength and direction as they enter the opening and reflect off a curved surface made of x-ray reflecting lead stearate crystals. The wavelength range covered by each of the instruments is 42 angstroms to 84 angstroms. The DXS spectrometers will each be mounted on a Shuttle Payload of Opportunity Carrier (SPOC) plate facing each other from opposite sides of the orbiter bay. Sky coverage is arranged through use of a motor driven shaft which rotates each detector 180 degrees backwards and forwards. The field of view of each detector above the orbiter bay is +/- 75 degrees by +/- 15 degrees. DXS will be operated from the Goddard Space Flight Center's (GSFC) Payload Operations Control Center. The DXS will require 50,000 seconds of observing time during a 6-7 day mission. Since it can operate only during orbital night, observations will be made during 60 passes averaging 14 minutes per pass. This mission was originally a part of the Shuttle High Energy Astrophysics Laboratory (SHEAL-2).

Launch Date:	May 1992
Payload:	2 instruments
Orbit:	28.5 degree inclination, 160 nm altitude
Duration:	6-7 days
Length:	1.52 m
Weight:	1,181 kg (2,625 lbs)
Diameter:	1.27 m
Launch Vehicle:	Space Shuttle
Foreign Participation:	None

Principal Investigator - W. Sanders (University of Wisconsin)

Management

NASA Headquarters
W. Huddleston, Program Manager
L. Kaluziensi, Program Scientist
Goddard Space Flight Center
F. Volpe, Payload Manager
C. Dunker, Mission Manager
F. Marshall, Mission Scientist
Major Contractors
University of Wisconsin



Status

DXS has been selected to fly as a Space Shuttle Attached Payload and is currently under development in preparation for a Spring 1992 launch. The DXS instrument is completing development.

Earth Observing System (EOS)

Objective

The Earth Observing System (EOS) will constitute a space-based observatory system that will provide long term (15-year) data sets for Earth system science to gain an understanding of the global hydrological cycle, the global biogeochemical cycle, and global climate processes. Specific areas of study will include hydrology, oceanography, atmospheric chemistry and dynamics, geology, forestry, snow and ice observations, ozone depletion and greenhouse gases. Each observatory will consist of an integrated platform and instrument payload complement. In addition, instruments may be flown on platforms provided by the European Space Agency (ESA) and Japan.

The EOS Program will also include development of a comprehensive Earth Observing System (EOS) Data and Information System (EOSDIS). The EOSDIS will be designed to maximize the Earth science research community's access to, and processing of, the necessary data through an open data policy.

In addition to the traditional disciplinary science approach, EOS will create a science program focused on the interdisciplinary evaluation of EOS data. This includes funding of post-graduate fellowships, interdisciplinary science team grants, and Principal Investigator research grants.

Description

The EOS program contains three primary components:

The **EOS Scientific Research Program** is already underway, building on and complementing Earth science research efforts of NASA, other U.S. research agencies and their international counterparts. Existing satellite data are being used to determine the requirements for the instruments, platforms and EOSDIS. The Scientific Research Program will focus on defining the state of the Earth system, understanding its basic processes, and developing and applying predictive models of those processes.

The **EOSDIS** will provide computing and network facilities supporting EOS research activities, including data interpretation and modeling; processing, distribution and archiving of EOS data; and command and control of the observatories and instruments. EOSDIS will be developed in an evolutionary manner, with extensive input from and testing by the research community and will be on-line and tested prior to the launch of the first EOS-A Series platform. After the first launch, the system will continue to evolve in response to scientific research needs.

The EOS platforms will focus primarily on global observations from sun-synchronous polar orbits. A system of three polar-orbiting platform programs will operate simultaneously, with two platform series (EOS A and B) provided by NASA and a platform series provided by the European Space Agency (ESA) and by the National Space Development Agency (NASDA) of Japan.

Launch Date:	EOS-A first observatory: 1998 EOS-B first observatory: 2001
Payload:	Instruments and associated payloads (TBD)
Orbit:	705 km , sun-synchronous, 1:30 p.m. ascending node crossing
Design Life:	5 years per platform, designed for acceptable but degraded performance for 7.5 years
Length:	EOS-A: 12 m
(Launch Config.)	EOS-B: TBD

Earth Observing System (EOS) (Continued)

Description (Continued)

Weight: 3,500 kg payload (capability),
7,300 kg platform,
2,500 kg propellant
(13,300 kg total)

Diameter: 4.2 m

Launch Vehicle: Titan IV for U.S. platforms

Foreign Participation: European Space Agency, Japan, Canada

Mission Events

Phase A: June 1983 - October 1988

Instrument Announcement of Opportunity: January 1988 - March 1989

EOS-A Instrument Phase B Awards: February 1989

Phase B: October 1988 - September 1991

EOS-A Phase C/D Instrument Confirmation: December 1990

EOS-B Phase C/D Instrument Confirmation: December 1991

Award EOSDIS Phase C/D contract: August 1992

Management

NASA Headquarters

R. Roberts, Program Manager

S. Wilson, Program Scientist

D. Butler, EOSDIS Program Manager

R. Felice, EOS Platform Program Manager

Goddard Space Flight Center

J. Madden, Project Manager

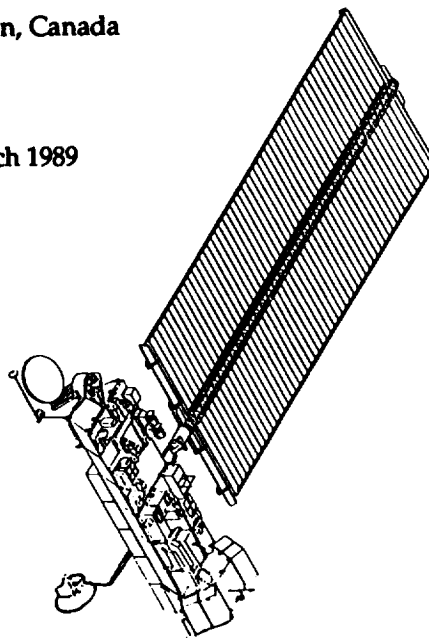
J. Dossier, Project Scientist

T. Taylor, EOSDIS Project Manager

C. Scolese, EOS Platform Project Manager

Major Contractors

General Electric for first platform of EOS-A series



Status

EOS is an approved Fiscal Year 1991 new start.

Earth Probes

Objective

The Earth Probes Program is composed of a series of small- and moderate-sized missions that will address highly focused problems in Earth science. This Explorer-class program will provide a pre-Earth Observing System (EOS) start/continuation of long-term data sets, and will capture measurements that are not possible with EOS or other instrument suites. Each free flyer/instrument has a specific purpose, providing critical measurements of particular phenomenon, but requiring a unique orbit or configuration not available from EOS precursor missions.

Description – Proposed Missions

The **Total Ozone Mapping Spectrometer (TOMS)** measures total ozone concentrations. Information gathered on atmospheric composition will continue the long-term data set being gathered by the TOMS instrument on Nimbus-7 (1978-present). These data will allow time series evaluations to establish trends, with the goal of studying the question of global and regional changes in the ozone. Ancillary data products will reveal lower stratosphere/tropopause dynamics and allow detection of sulfur dioxide clouds resulting from major volcanic eruptions. TOMS serves as a precursor to NOAA instrumentation in the EOS timeframe.

	Meteor-3*	Scout	ADEOS
Launch Date:	August 1991	September 1993	February 1995
Payload:	1 instrument	1 instrument	1 instrument
Orbit:	900 km	900 km	900 km
Design Life:	3 years	3 years	3 years
Satellite Bus:	Meteor-3 (U.S.S.R.)	Scout-class	ADEOS (Japan)
Weight:	2.6 kg	2.6 kg	2.6 kg
Dimensions:	15 x 30 x 27 cm	15 x 30 x 27 cm	15 x 30 x 27 cm
Launch Vehicle:	Cyclone (U.S.S.R.)	Scout-class	H-II (Japan)
Foreign Participation:	U.S.S.R.	None	Japan

* *The TOMS flight on Meteor-3 is not considered part of the Earth Probes program.*

NASA Scatterometer (NSCAT) will measure ocean surface wind velocity and provide data on air-sea interactions. NSCAT measurements will allow, for the first time, calculation of large-scale fluxes of momentum, heat, and moisture between the atmosphere and ocean; thereby, contributing essential information to studies on air-sea coupling and interannual variability of the Earth's climate. This instrument has been selected for flight on the Japanese Advanced Earth Observing Satellite (ADEOS) in 1995.

Launch Date:	February 1995
Payload:	1 instrument
Orbit:	796 km altitude, nominally circular, 98.6 degrees inclination (sun-synchronous)
Design Life:	3 years
Satellite Bus:	ADEOS
Weight:	237 kg (excluding antenna deployment hardware)
Dimensions:	50 x 47 x 55 cm
Launch Vehicle:	H-II (Japan)
Foreign Participation:	Japan

Earth Probes (Continued)

Description – Proposed Missions (Continued)

Tropical Rainfall Measuring Mission (TRMM) will measure diurnal variation of precipitation and evaporation in the tropics, providing increased understanding of how substantial rainfall affects global climate patterns. The goal of this mission is to obtain a minimum of 3 years of climatologically significant observations of rainfall in the tropics, and, in tandem with cloud models, to provide accurate estimates of the vertical distributions of latent heating in the atmosphere. TRMM is a joint venture with Japan, and will be launched on their H-2 rocket in the mid-to-late 1990's.

Launch Date:	Mid-to-late 1990's
Payload:	4 instruments
Orbit:	350 km altitude, circular; 35 degree inclination
Design Life:	3 years
Weight:	TBD
Dimensions	2,195 kg
Launch Vehicle:	H-II (Japan)
Foreign Participation:	Japan

Instruments

TRMM

Advanced Very High Resolution Radiometer (AVHRR) - NASA/GSFC
Special Sensor Microwave/Imager (SSM/I) - NASA/GSFC
Electrically Scanning Microwave Radiometer (ESMR) - NASA/GSFC
Precipitation Radar (PR) - NASDA/Communication Research Laboratory (Japan)
Clouds and Earth's Radiant Energy System (CERES) - NASA/LaRC

Management

NASA Headquarters

L. Jones, Earth Probes Program, NSCAT and TRMM Program Manager
G. Esenwein, TOMS/Meteor-3 Program Manager
R. Watson, TOMS Program Scientist
W. Patzert, NSCAT Program Scientist

J. Theon, TRMM Program Scientist

Goddard Space Flight Center

C. Cote, TOMS/Meteor-3 Project Manager
D. Margolies, TOMS Project Manager (Scout/ADEOS)
J. Hraster, TRMM Project Manager
A. Krueger, TOMS Instrument Scientist
J. Simpson, TRMM Project Scientist

Jet Propulsion Laboratory

F. Naderi, NSCAT Project Manager
M. Freilich, NSCAT Project Scientist

Status

TOMS/Meteor-3

The U.S./U.S.S.R. agreement to permit TOMS to fly on Meteor-3 was signed in July 1990. State Department clearance for an export license for the TOMS instrument and the required Interface Adapter Module (IAM) was granted in September 1990. TOMS is on schedule to ship instrument to U.S.S.R. in October 1990 for checkout and return. Instrument would be returned to U.S.S.R. in March 1991 for flight preparations and spacecraft integration.

Earth Probes (Continued)

Status (Continued)

TOMS/Scout/ADEOS

New Start for Earth Probes approved in Fiscal Year 1991 budget.

NSCAT

Confirmed for flight aboard Japanese ADEOS in 1990. New Start for Earth Probes approved in Fiscal Year 1991 budget.

TRMM

Phase A studies completed in May 1988, with Phase B study initiated in September 1989. TRMM a potential candidate for a new start Earth Probe in the Fiscal Year 1992 budget.

Explorer Program

Objective

The Explorer Program is composed of a series of moderate-sized missions that will address highly focused problems in various disciplines of space physics and astronomy. Explorer missions provide the following benefits: a modestly scaled option for scientific research; a quick response to new scientific opportunities; extended observing period; hands-on experience for university researchers and students; opportunities for international collaboration; a first step for defining and guiding the requirements for major missions; and, complementary extension of the science of the major missions.

Description

One mission was approved for design/development and two others were selected for definition studies during 1989. Brief descriptions of the selected mission follow:

The X-ray Timing Explorer (XTE) has commenced its design and development phase and will be the second mission to use the Explorer Platform spacecraft. It is designed to study temporal variability in compact x-ray emitting objects. It will include a large area Proportional Counter Array (PCA), an All-Sky Monitor (ASM), and High-Energy X-ray Experiment (HEXTE). The XTE payload module will be launched on the Space Shuttle and will replace the Extreme Ultraviolet Explorer (EUVE) payload module on the explorer platform. XTE will have a 6 arcminute pointing accuracy with a 10 degree/minute slew rate. XTE will be able to observe cosmic x-ray sources with temporal resolution of 10 microseconds and perform spectral-temporal correlations and burst searches to the sub-millisecond level. The PCA will have a collection area of 6,250 square centimeters, covering the energy range from 2 to 60 thousand electron Volts (keV), and an energy resolution of 6 percent at 6 keV. XTE's All-Sky Monitor will provide a full-time alarm for x-ray novae and flares while it compiles an all-sky encyclopedic record of variable x-ray sources.

The Advanced Composition Explorer (ACE) mission will observe particles of solar, interplanetary, interstellar, and galactic origins, spanning the energy range from that of the solar wind (approximately 1 keV/nucleon) to galactic cosmic ray energies (several hundred MeV/nucleon). Definitive studies will also be made of the abundance of essentially all isotopes from Hydrogen to Zinc, with exploratory isotope studies extending to Zirconium. The ACE study payload includes six high-resolution spectrometers, each designed to provide optimum charge, mass, or charge-state resolution in its particular energy range, and each having a geometry factor optimized for the expected flux levels, so as to provide a collecting power a factor of 10 to 1,000 times greater than previous or planned experiments.

The Far Ultraviolet Spectroscopic Explorer (FUSE) mission will conduct high resolution spectroscopy of faint sources at wavelengths from 912 to 1,200 angstroms and moderate resolution spectroscopy down to 100 angstroms. It will measure the amount of cold, warm, and hot plasma in objects ranging from planets to quasars. The instrument elements include a telescope, grazing-incidence spectrographs, detectors and supporting subsystems. Science characteristics will include: simultaneous measurement of temperatures ranging from a few thousands to millions of degrees Kelvin; grazing incidence optics (approximately 10 degrees); low and high-dispersion spectroscopy in two key wavelength regimes (100 to 912 angstroms and 912 to 1,200 angstroms); one-meter aperture telescope, spectrograph, and detector system; spectral resolving power near 30,000 and sensitivity of approximately 100 square centimeters for the wavelength range above 912 angstroms; stigmatic imaging; approximately 1 arcsecond angular resolution; detector with photon counting capability, high quantum efficiency, and two-dimensional format (e.g., using a microchannel plate); and, absolute pointing errors of less than 0.3 arcseconds. The FUSE Mission is currently planned to replace the XTE Mission on the Explorer Platform through in-orbit change-out.

Explorer Program (Continued)

Description (Continued)

	<u>XTE</u>	<u>ACE</u>	<u>FUSE</u>
Launch Date:	1st Quarter 1995	1996 (Under Review)	Under Review
Payload:	3 types of Instruments	6 major Science Instruments	High Resolution Spectrograph
Orbit:	500 km, circular 28.5 degree inclination	Libration Point (L ₁) TBD	Low Earth Orbit, 28.5 degree inclin.
Design Life:	2 years	TBD	5 years
Length:	TBD	2.5 m	TBD
Weight:	1,820 kg	633 kg	Approx. 1,045 kg
Diameter:	Approx. 3 m (10 ft)	2m	TBD
Launch Vehicle:	Space Shuttle	Delta II	Space Shuttle
Foreign Participation:	None	Switzerland, Germany	Canada, United Kingdom

Instruments

XTE

High-Energy X-ray Timing Experiment (HEXTE) - R. Rothchild (University of California, San Diego)

All-Sky Monitor (ASM) - H. Brandt (Massachusetts Institute of Technology)

Proportional Counter Array (PCA) - J. Swank (GSFC)

ACE

Principal Investigator - E. Stone (California Institute of Technology)

Solar Wind Ion Mass Spectrometer (SWIMS) - G. Gloeckler (University of Maryland)

Solar Wind Ion Composition Spectrometer (SWICS) - G. Gloeckler (University of Maryland)

Ultra-low Energy Isotope Spectrometer (ULEIS) - G. Gloeckler (University of Maryland)

Solar Energetic Particle Ionic Charge Analyzer (SEPICA) - D. Hovestadt (Max Planck Institute)

Solar Isotope Spectrometer (SIS) - R. Mewaldt (California Institute of Technology)

Cosmic Ray Isotope Spectrometer (CRIS) - R. Mewaldt (California Institute of Technology)

FUSE

High Resolution Spectrograph (HRS) - W. Moos (Johns Hopkins University)

Mission Events

XTE Phase C/D start - October 1989

XTE System Concept Review (SCR) - November 1989

XTE Preliminary Design Review (PDR) - June 1991

ACE Phase B Study start - June 1990

ACE Phase C/D start - July 1992

ACE launch - 1996

FUSE Phase A Completed - July 1989

FUSE Spectrograph Impartial Review - July 1990

FUSE Phase C/D start - FY 1992

FUSE Launch - TBD

Explorer Program (Continued)

Management

NASA Headquarters

J. Lintott, XTE Program Manager
L. Kaluziński, XTE Program Scientist
G. Newton, FUSE Program Manager
E. Weiler, FUSE Program Scientist
M. Kaplan, ACE Program Manager
V. Jones, ACE Program Scientist

Goddard Space Flight Center

D. Schulz, XTE Project Manager
J. Swank, XTE Project Scientist
G. Anikis, FUSE Project Manager
G. Sonneborn, FUSE Project Scientist
F. Volpe, ACE Project Manager
J. Ormes, ACE Project Scientist

Major Contractors

University of California, San Diego (XTE)
Massachusetts Institute of Technology (XTE)
Johns Hopkins University (FUSE)
Stanford University (FUSE)
University of Colorado (FUSE)
University of California, Berkeley (FUSE)
California Institute of Technology (ACE)
Johns Hopkins University/Applied Physics Laboratory (ACE)

Status

XTE entered Phase C/D during October 1989 and its instruments are currently under development. ACE was proposed during 1987 and selected for Phase A study as a Delta-class Explorer in 1988. It is currently in Phase B study. FUSE is currently in extended Phase A. Telescope program will be managed by Johns Hopkins University under contract with the GSFC.

Extreme Ultraviolet Explorer (EUVE)

Objective

The objectives of the Extreme Ultraviolet Explorer are: 1) to produce a highly sensitive survey of the sky in the 80 to 800 angstroms range; 2) to survey a portion of the sky with extremely high sensitivity; 3) to perform follow-up spectroscopic observations on bright extreme ultraviolet point sources; 4) to study stellar evolution and the local stellar population; 5) to perform spectral emission physics; 6) to investigate energy transport in stellar atmospheres; and, 7) to study ionization and opacity of the interstellar medium.

Description

The Extreme Ultraviolet Explorer (EUVE) consists of four grazing incidence telescopes and a variety of optical filters housed on an Explorer Platform. Approximately 95 percent of the sky will be mapped in 0.1 degree increments for the all-sky survey. The deep survey will scan a region 2 degrees wide by 180 degrees long along the ecliptic, again in 0.1 degree increments. After a 6-month survey, EUVE will carry out spectroscopic observations of bright sources. The mission duration is at least 39 months. At the end of its lifetime this payload will be exchanged for the X-ray Timing Explorer (XTE), via on-orbit servicing. The primary responsibility for this science payload resides with the University of California at Berkeley.

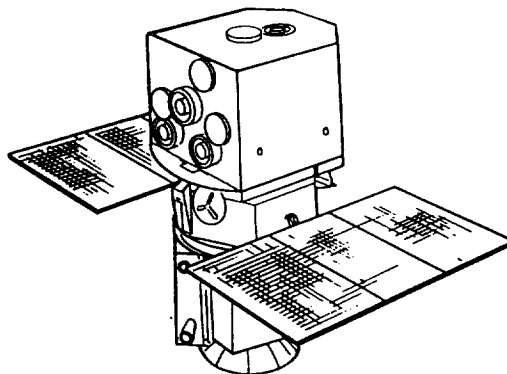
Launch Date:	December 1991
Payload:	4 telescopes
Orbit:	550 km altitude, 28.5 degree inclination, circular
Design Life:	2.5 years
Length:	2.1 m
Weight:	1,681 kg
Diameter:	3 m
Launch Vehicle:	Delta II 6920
Foreign Participation:	None

Investigations/Instruments

Principal Investigator - S. Bowyer (University of California, Berkeley)
Scanning Extreme Ultraviolet Telescopes (3) - R. Malina (University of California, Berkeley)
Deep Scanning/Spectrometer Telescope - R. Malina (University of California, Berkeley)

Mission Events

Mission Preliminary Design Review: June 1988
Mission Critical Design Review: June 1989
Flight Readiness Review: July 1991
Headquarters Mission Readiness Review: July 1991
Launch: December 1991



Extreme Ultraviolet Explorer (EUVE) (Continued)

Management

NASA Headquarters

J. Lintott, Program Manager

R. Stachnik, Program Scientist

Goddard Space Flight Center

J. Barrowman, Project Manager

Y. Kondo, Project Scientist

Major Contractors

University of California - Berkeley

Fairchild Space Company

General Electric Company

McDonnell Douglas Astronautics Company

Status

The instrument complement has been delivered to the Goddard Space Flight Center (GSFC). A Multi-Mission Spacecraft bus, with a 10-year lifetime, is under development.

Gamma-Ray Observatory (GRO)

Objective

Scientific objectives of the Gamma-Ray Observatory (GRO) include: 1) studying gamma ray emitting objects in our galaxy and beyond; 2) investigating evolutionary forces in neutron stars and black holes; 3) searching for evidence of nucleosynthesis; and 4) searching for primordial black hole emissions.

Description

GRO is the gamma-ray element of the Great Observatories program. It is a free-flying astrophysical observatory with a 2-year operational lifetime that can be extended to 10 years through occasional altitude reboost with its on-board propulsion system. GRO will examine the gamma ray wavelength range from 0.05 to 30,000 million electron volts (MeV) and its 15,634 kilogram mass will orbit the Earth at an altitude of 450 km with an inclination of 28.5 degrees. The GRO payload consists of four science instruments, the Oriented Scintillation Spectrometer Experiment (OSSE), the Imaging Compton Telescope (COMPTEL), the Energetic Gamma Ray Experiment (EGRET), and the Burst And Transient Source Experiment (BATSE). The COMPTEL instrument was developed in Germany.

Launch Date:	April 1991
Payload:	4 science instruments
Orbit:	450 km altitude, 28.5 degree inclination, circular orbit
Design Life:	2 years
Length:	7.62 m (stowed)
Weight:	15,634 kg
Width:	4.57 m (stowed)
Launch Vehicle:	Space Shuttle
Foreign Participation:	Germany, Netherlands, United Kingdom, European Space Agency

Instruments

Burst and Transient Source Experiment (BATSE) - G. Fishman (MSFC)

Oriented Scintillation Spectrometer Experiment (OSSE) - J. Kurfess (Naval Research Laboratory)

Imaging Compton Telescope Experiment (COMPTEL) - V. Schonfelder (Max Planck Institute)

Energetic Gamma Ray Experiment (EGRET) - C. Fichtel (GSFC); R. Hofstadter (Stanford)*;
K. Pinkau (Max Planck Institute)

* Deceased November 1990.

Mission Events

Observatory Preliminary Design Review (PDR): May 1984

Observatory Critical Design Review (CDR): June 1985

Thermal Vacuum Testing Complete: August 1989

Delivery to Kennedy Space Center: February 1990

Launch: April 1991

Gamma-Ray Observatory (GRO) (Continued)

Management

NASA Headquarters

D. Broome, Program Manager

N. Rasch, Deputy Program Manager

A. Bunner, Program Scientist

Goddard Space Flight Center

J. Hraster, Project Manager

T. LaVigne, Deputy Project Manager

D. Kniffen, Project Scientist

Major Contractors

TRW

Fairchild/IBM

Ball Aerospace

McDonnell Douglas

Status

The GRO spacecraft has completed all system level integration and test activities and is currently at the Kennedy Space Center in final preparation for launch. GRO is currently scheduled for an April 1991 launch.

Geostationary Operational Environmental Satellites (GOES I-M)

Objective

Continuous environmental observations of cloud cover, atmospheric temperatures and moisture profiles, plus severe storm warnings and Search and Rescue Operations.

Description

Under a 1973 Basic Agreement between NASA and the National Oceanic and Atmospheric Administration (NOAA), NOAA establishes the observational requirements for both the polar and geostationary weather satellites. Acting as NOAA's agent, NASA procures the spacecraft and instruments required to meet NOAA's objectives, and provides for their launch. NASA also conducts an on-orbit checkout before handing the satellites over to NOAA for routine operations. The requirement to replace spacecraft on an as-needed basis is determined by NOAA.

Launch Dates:	1992-2000
Payload:	Weather Satellite
Orbit:	Geostationary
Design Life:	5 years
Length:	2.6 m
Weight:	980 kg
Diameter:	2.6 m
Launch Vehicle:	Atlas-I
Foreign Participation:	None

Instruments

GOES 1-7

Visible Infrared Spin-Scan Radiometer (VISSR) Atmospheric Sounder (VAS) - Hughes/Santa Barbara Research Corporation
Space Environment Monitor (SEM) - Bell Aerospace/Panametrics
Search and Rescue Transponder

GOES I-M

GOES Imager - ITT
GOES Sounder - ITT

Mission Events

GOES-6 launched April 1983, failed 1989
GOES-7 launched February 1987; still functioning
Spacecraft Preliminary Design Review: March 1987
Spacecraft Critical Design Review: February 1988
GOES-I Launch: Early 1992
GOES-J Launch: Late 1992
GOES-K Launch: July 1995
GOES-L Launch: February 1997
GOES-M Launch: July 2000

Geostationary Operational Environmental Satellites (GOES I-M) (Continued)

Management

NASA Headquarters

J. Greaves, Program Manager

Goddard Space Flight Center

R. Obenschain, Project Manager

Major Contractors

Space Systems/Loral

Status

GOES is an operational satellite system, and a reimbursable program funded by NOAA.

Global Geospace Science (GGS) Program: Polar Mission

Objective

The objectives of the Polar Mission of the Global Geospace Science (GGS) Program are: 1) to characterize the energy input to the ionosphere; 2) to determine the role of the ionosphere in substorm phenomena and in the overall magnetosphere energy balance; 3) to measure complete plasma, energetic particles, and fields in the high latitude polar regions, energy input through the dayside cusp; 4) to provide global multispectral auroral images of the footprint of the magnetospheric energy disposition into the ionosphere and upper atmosphere; and, 5) to determine characteristics of ionospheric plasma outflow.

Description

Spin-stabilized NASA spacecraft characterizing polar ionospheric region energy input with a full range of plasma physics fields and particles *in situ* and remote sensing instrumentation.

Launch Date:	June 1993
Payload:	11 auroral imaging and plasma physics instruments
Orbit:	1.8 x 9 Earth radii polar orbit
Design Life:	3 years
Length:	2.0 m
Weight:	1,200 kg
Diameter:	2.8 m
Launch Vehicle:	Delta II
Foreign Participation:	Approximately 25 percent of instruments supplied through foreign co-investigators

Instruments

Charge and Mass Magnetospheric Ion Composition Experiment (CMMICE) - T. Fritz (Los Alamos National Lab)

Comprehensive Energetic Particle Pitch Angle Distribution (CEPADD) - B. Blake (Aerospace Corporation)

Electric Fields Instrument (EFI) - F. Mozer (University of California, Berkeley)

Fast Plasma Analyzer (HYDRA) - J. Scudder (GSFC)

Magnetic Fields Experiment (MFE) - C. Russell (University of California, Los Angeles)

Plasma Wave Instrument (PWI) - D. Gurnett (University of Iowa)

Polar Ionospheric X-Ray Imaging Experiment (PIXIE) - W. Imhoff (Lockheed Palo Alto Research Lab)

Thermal Ion Dynamics Experiment (TIDE) - C. Chappell (MSFC)

Toroidal Ion Mass Spectrograph (TIMAS) - E. Shelley (Lockheed Palo Alto Research Lab)

UltraViolet Imager (UVI) - M. Torr (MSFC)

Visible Imaging System (VIS) - L. Frank (University of Iowa)

Mission Events

Announcement of Opportunity release: October 1979

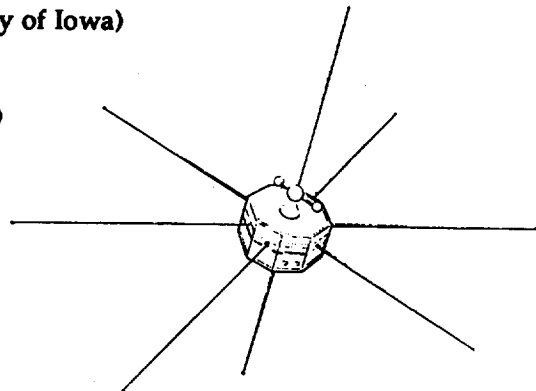
Confirmation of investigations: December 1988

Instrument Critical Design Review: Completed

Spacecraft Critical Design Review: Completed

Spacecraft assembly complete: February 1991

Deliver instruments: January 1992



Global Geospace Science (GGS) Program: Polar Mission (Continued)

Management

NASA Headquarters

M. Calabrese, Program Manager

E. Whipple, Program Scientist

Goddard Space Flight Center

K. Sizemore, Project Manager

M. Acuna, Project Scientist

Major Contractor

General Electric's AstroSpace Division

Status

General Electric's AstroSpace Division is the spacecraft mission contractor. Spacecraft is under development. Instrument development is underway.

Global Geospace Science (GGS) Program: Wind Mission

Objective

Determine solar wind input properties including plasma waves, energetic particles, electric, and magnetic fields for magnetospheric and ionospheric studies in the Global Geospace Science (GGS) Program.

Description

Spin-stabilized NASA spacecraft located at dayside double lunar swingby and Sun-Earth (L_1) Lagrangian point orbits to characterize solar wind input with a full range of plasma physics fields and particles instrumentation.

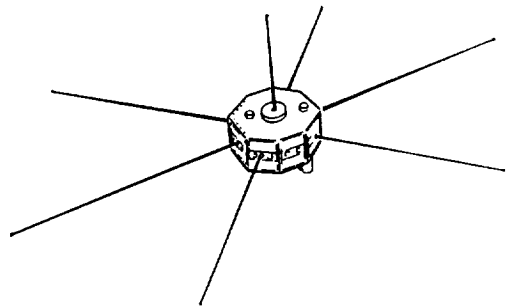
Launch Date:	December 1992
Payload:	Plasma Physics Instrumentation
Orbit:	Lunar swingby, 250 Earth radii apogee followed by 3×10^5 km radius halo orbit at the L_1 libration
Design Life:	3 years
Length:	2.0 m
Weight:	1,200 kg
Diameter:	2.8 m
Launch Vehicle:	Delta II
Foreign Participation:	Approximately 25 percent of instruments supplied through foreign co-investigators

Instruments

Energetic Particles Acceleration Composition Transport (EPACT) - T. Von Rosenvinge (GSFC)
Energetic Particles and 3-D Plasma Analyzer (3-D PLASMA) - R. Lin (University of California, Berkeley)
Magnetic Fields Investigation (MFI) - R. Lepping (GSFC)
Radio/Plasma Wave Experiment (WAVES) - J. Bougeret (Meudon Observatory)
Solar Wind and Suprathermal Ion Composition Studies (SMS) - G. Gloekler (University of Maryland)
Solar Wind Experiment (SWE) - K. Ogilvie (GSFC)
Soviet Gamma Ray Spectrometer (KONUS) - E. Mazets (Ioffe Institute)
Transient Gamma Ray Spectrometer (TGRS) - B. Teegarden (GSFC)

Mission Events

Announcement of Opportunity released: October 1979
Confirmation of investigations: December 1988
Instrument Critical Design Review: Completed
Spacecraft Critical Design Review: Completed
Structural assembly complete: October 1990
Deliver Instruments: September 1991



Global Geospace Science (GGS) Program: Wind Mission (Continued)

Management

NASA Headquarters

M. Calabrese, Program Manager

E. Whipple, Program Scientist

Goddard Space Flight Center

K. Sizemore, Project Manager

M. Acuna, Project Scientist

Major Contractor

General Electric's AstroSpace Division

Status

General Electric's AstroSpace Division is the spacecraft mission contractor. Spacecraft is under development. Instrument development is underway.

Gravity Probe B (GP-B)

Objective

Gravity Probe B will test predictions of Einstein's general theory of relativity. Mission objectives will include: measurement of Einstein-Schiff frame-dragging effect to precision between 0.1 and 1 percent; measurement of geodetic effect (Fermi-Walker transport) to precision between 1 part in 1,000 and 1 part in 10,000; recheck to 1 percent of Einstein starlight deflection effect; check of parameters in nonmetric theories of gravitation by use of gyro as precision clock; and as part of the Geodesy co-experiment to determine from precision orbit tracking data Earth harmonics to order 60×60 , producing a two order of magnitude improvement in Earth model up to order 30×30 and significant improvements for higher orders.

Description

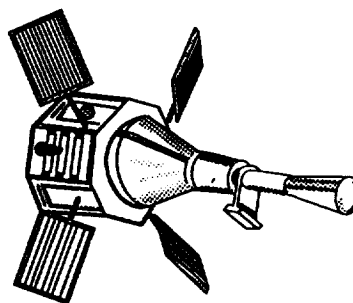
Gravity Probe B will provide novel, high precision tests of Einstein's general theory of relativity as well as a geodesy co-experiment. This free-flyer, launched on a medium-class ELV, will follow a Shuttle engineering test (Shuttle Test of Relativity Experiment - STORE) of the science instrument. It will be a symmetric spacecraft that will roll about the line of sight to the guide star with a 10 minute period. The gyro spin axes will be compared to the guide star by observations with the reference telescope and the gyro spin axes will be measured to 0.1 milliarcsecond by means of superconducting readout of the gyro's magnetic "London moment." The optically contacted reference telescope will also have 0.1 milliarcsecond precision and be cooled with the superfluid helium at 1.8 degrees Kelvin (K) held in a 1,580 liter dewar which is planned to have a two-year lifetime. The four electrically suspended and also cryogenically cooled spherical gyroscopes (38 mm diameter) will spin at 170 Hertz and operate at a pressure of 10^{-11} torr. A drag-compensation system will reduce the mean gyro acceleration to below 10^{-10} g. In order to achieve the desired objectives, extensive in-flight verification tests will need to be performed.

Launch Date:	Under Review
Payload:	GP-B
Orbit:	600 kilometers, polar, circular
Design Life:	2 years
Length:	3.5 m
Weight:	1,600 kg
Diameter:	1 m
Launch Vehicle:	Medium-class ELV
Foreign Participation:	None

Principal Investigator - C. Everitt (Stanford University)

Management

NASA Headquarters
D. Gilman, Program Manager
R. Stachnik, Program Scientist
Marshall Space Flight Center
R. Ise, Project Manager
P. Peters, Project Scientist
Major Contractors
Stanford University
Lockheed
Fairchild Space



Gravity Probe B (GP-B) (Continued)

Status

Developing prototypes of probe and dewar. Designing Shuttle Test of Relativity Experiment (STORE). STORE will be flown as part of the third flight of the U.S. Microgravity Payload (USMP-3) complement. STORE is also planned for reflight on USMP-4.

International Microgravity Laboratory Series (IML)

Objective

The objectives of the International Microgravity Laboratory (IML) series are to conduct high quality scientific investigations for disciplines that require access to the microgravity environment of Space; and to offer scientists access to flight hardware developed independently by NASA and other nations, and to give the international scientific community access to Spacelab and its capabilities. NASA provides the flight opportunities, defines the integrated payload and maintains responsibility for mission management.

Description

IML-1 is a Spacelab mission with international participation that will focus on material and life sciences, two disciplines needing access to a laboratory in reduced gravity. IML missions will fly at 18- to 24-month intervals so scientists may build upon results from previous investigations, thus preparing for the Space Station era. IML is derived from a concept whereby multiple application instruments in complementary fields fly together frequently with minimal disassembly and rework between missions. The payload crew will be actively involved in many investigations as trained scientists performing experiments in orbit and providing immediate scientific assessment of experiment progress to investigators on the ground. The essential low-gravity environment is maintained with a minimum number of thruster firings by using a gravity-gradient stabilized orientation with the Space Shuttle's tail pointing toward the Earth. IML-2 is scheduled for launch during the third quarter of fiscal year 1994.

	<u>IML-1</u>	<u>IML-2</u>
Launch Date:	December 1991	3rd Quarter FY 1994
Orbit:	306 km altitude, 57 degree inclin.	Approx. 265 km altitude, 28.5 degree inclin.
Duration:	7 days	13 days
Weight:	10,793 kg (23,985 lbs)	10,793 kg (23,985 lbs)
Diameter:	Approx. 4.6 m	Approx. 4.6 m
Launch Vehicle:	Space Shuttle	Space Shuttle
Foreign Participation:	Germany, European Space Agency, Canada, Japan, France	Germany, European Space Agency Canada, Japan, France

Investigations/Instruments

Fluids Experiment System (FES) - R. Lal, M. McCoy
Vapor Crystal Growth System (VCGS) - L. van den Berg
Mercuric Iodide Crystal Growth (MICG) - R. Cadoret
Protein Crystal Growth (PCG) - C. Bugg
Organic Crystal Growth Facility (OCGP) - Kanbayashi
Cryostat (CRY) - McPherson, W. Littke, G. Wagner
Critical Point Facility (CPF) - A. Wilkinson, D. Beyens, A. Michels
Space Acceleration Measurement System (SAMS) - R. DeLombard
Gravitational Plant Physiology Facility (GPPF) - A. Brown, D. Heathcote
Biorack Systems (BR) - D. Mesland
Space Physiology Experiments (SPE) - D. Watt, D. Thirsk, D. Brooks, P. Wing, H. Parsons,
J. McClure
Microgravity Vestibular Investigations (MVI) - M. Reschke

International Microgravity Laboratory Series (IML) (Continued)

Instruments (Continued)

Biostack (BSK) - H. Buecker

Mental Workload and Performance Evaluation (MWPE) - S. Bussolari

Radiation Monitoring Container/Dosimeter (RMCD) - S. Nagaoka

Mission Events

Payload confirmation: July 1989

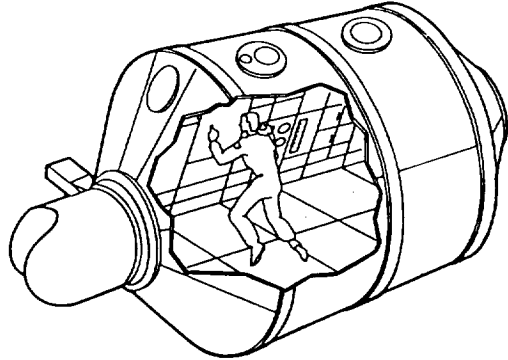
Payload specialist selected: January 1990

Start Level IV integration: January 1990

Level III/II Readiness Review: September 1990

Start Level I Integration: August 1991

Launch: December 1991



Management

NASA Headquarters

W. Richie, Program Manager

R. White, Program Scientist (IML-1)

R. Sokolowski, Program Scientist (IML-2)

R. Sokolowski, Materials Sciences Manager (IML-1)

W. Gilbreath, Life Science Program Manager

J. Stoklosa, Life Sciences Program Scientist

Marshall Space Flight Center

R. McBrayer, Mission Manager (IML-1)

A. King, Mission Manager (IML-2)

R. Snyder, Mission Scientist

Status

All hardware for the NASA-sponsored Life Sciences Investigations have been turned over to the Kennedy Space Center (KSC) for Level IV integration. A Science Status Review (SSR) for the Life and Material Sciences investigations was held during May 1990 at NASA Headquarters.

Laser Geodynamics Satellite II (LAGEOS-II)

Objective

The Laser Geodynamics Satellite II (LAGEOS-II) will promote research in Earth Sciences by providing very precise satellite geodetic measurements. Resultant data products will enhance research in regional crustal deformation and plate tectonics, Earth and ocean tides, and temporal variation in the geopotential. By providing a geodetic reference baseline, calculations of the Earth's orientation and satellite orbital perturbations can be easily derived. These data are needed to better understand earthquakes, sea-level change, and potential flood hazards.

Description

LAGEOS-II, a joint program between NASA and the Italian Space Agency (ASI), is a passive satellite designed specifically and dedicated exclusively for use as a target for laser ranging. The Italian-constructed LAGEOS-II (based on the same design as the NASA-produced LAGEOS-I) is a spherical satellite of aluminum with a brass core. It is 60 centimeters in diameter and weighs approximately 406 kilograms. The exterior surface is covered by 426 equally spaced laser corner-cube retroreflectors that reflect any incident optical signal (i.e., pulsed laser light) back to its source. After LAGEOS-II is released from the Space Shuttle, two solid fuel stages – the Italian Research Interim Stage (IRIS) and the LAGEOS Apogee Stage (LAS) – take over. The first will boost the spacecraft from 296 km to the satellite injection altitude of 6,000 km, and the latter will place it in a circular orbit with an inclination of 52 degrees, which will complement LAGEOS-I's orbit of 101 degrees. Both LAGEOS satellites will be tracked by a global network of fixed and transportable lasers from some 65 sites. By the time of LAGEOS-II launch, improvements to the laser system will yield a precision of 1 centimeter for single-shot range measurements. It has a design life of 10,000 years.

The satellite and boosters are provided by ASI, and the launch is provided by NASA. A team of 27 investigators has been assembled, representing the following six countries: U.S., Italy, Germany, France, the Netherlands, and Hungary. Selection of the international team was based on coordinated Research Announcements released by NASA and ASI, with selections announced in March 1989.

Launch Date:	September 1992
Payload:	Corner Cube Retroreflector
Orbit:	6,000 km, 52 degree inclination, circular orbit
Design Life:	10,000 years
Length:	N/A
Weight:	406 kg
Diameter:	60 cm
Launch Vehicle:	Space Shuttle
Foreign Participation:	Italy, Germany, France, Netherlands, Hungary

Mission Events

Optical characterization: Completed

Upper stage (Italian) scheduled for December 1990 delivery to Kennedy Space Center (KSC)

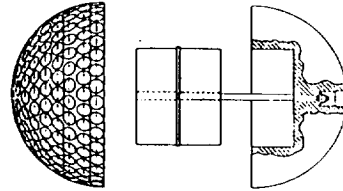
Spacecraft delivery to KSC: January 1991

Launch readiness: May 1991

Laser Geodynamics Satellite II (LAGEOS II) (Continued)

Management

NASA Headquarters
G. Esenwein, Program Manager
M. Baltuck, Program Scientist
Italian Space Agency
R. Ibba, Project Manager
Goddard Space Flight Center
G. Ousley, Project Manager
R. Kolenkiewicz, Project Scientist
University of Bologna
S. Zerbibi, Project Scientist



Status

Program activities are on schedule for the planned launch readiness date of May 1991.

LIDAR In-Space Technology Experiment (LITE)

Objective

The LIDAR In-Space Technology Experiment (LITE) will measure stratospheric and tropospheric aerosols, planetary boundary layer height, cloud deck altitude, and atmospheric temperature and density over the altitude range of 10 to 40 km. Since Light Detection And Ranging (LIDAR) is a new space measurement technique, Space Shuttle flights are needed to develop laser and detection technology, validate data processing algorithms, and provide a sound basis for further applications.

Description

LITE is both a space systems demonstration sponsored by NASA's Office of Aeronautics, Exploration and Technology (OAET) and an atmospheric science investigation supported by the Office of Space Science and Applications (OSSA). The LITE payload consists of a laser transmitter, telescope, optical receiver and associated electronics. The transmitter generates 10 laser pulses per second at three wavelengths and directs them into the Earth's atmosphere where they are backscattered from aerosols and clouds. The telescope collects the backscattered signals, which are then detected by the receiver.

Launch Date:	1st Quarter FY 1994
Payload:	Laser/Telescope system mounted on Orthogrid/Spacelab pallet carrier
Orbit:	300 km altitude, 28.5 to 57 degree inclination
Duration:	7 days
Length:	3.05 m (120 in.)
Weight:	2,295 kg (5,100 lbs.)
Diameter:	4.4 m (172 in.)
Launch Vehicle:	Space Shuttle
Foreign Participation:	None

Instrument

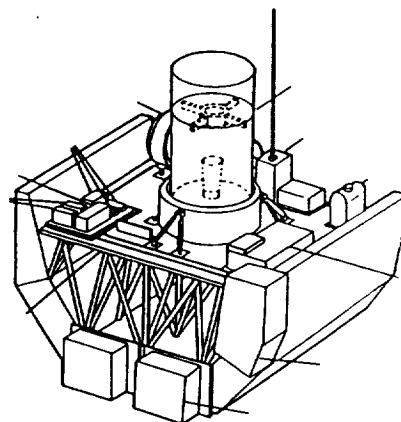
Light Intersection Direction and Ranging (LIDAR) - M. McCormick (LaRC)

Mission Events

Concept, feasibility and definition studies: Completed
Preliminary experiment design: Completed
Critical experiment design: Completed
Mission implementation: Ongoing
Experiment delivery to the Kennedy Space Center: October 1992
Launch: 1st Quarter FY 1994

Management

NASA Headquarters
R. Gualdoni, Program Manager (OAET)
J. Theon, Program Scientist
G. Esenwein, Program Manager (Reflight/OSSA)
D. Jarrett, Program Manager (Mission/OSSA)



LIDAR In-Space Technology Experiment (LITE) (Continued)

Management (Continued)

Johnson Space Center

M. Hendrix, Mission Manager

Langley Research Center

J. Harris, LITE Project Manager

R. Couch, Instrument Manager

M. McCormick, Project Scientist

Status

Instrument in development at Langley Research Center (LaRC). Subsystems design underway and fabrication started. Preliminary Design Review and Critical Design Review completed. Reflight proposal and cost estimates are under review.

Lunar Observer (LO)

Objective

The Lunar Observer (LO) mission will carry out a long-term orbital survey of the global characteristics of the Moon, including surface chemistry and mineralogy, surface geology and landforms, topography, gravity and magnetic fields, and the search for frozen volatiles in permanently shadowed polar regions. Mission data will provide a global scientific context for the character, internal structure, origin, and evolution of the Moon. The mission, especially the search for frozen volatiles, will also make major contributions to the scientific data base needed to support future human exploration of the Moon.

Description

In the currently baselined mission, LO will consist of a single Planetary Observer spacecraft launched from Earth by an Expendable Launch Vehicle (ELV) and placed into a 100 km circular near-polar lunar orbit. The nominal mission will last 1 year, permitting extensive and overlapping coverage, especially near the polar regions. Both the spacecraft and the "strawman" payload currently under study will have extensive inheritance from the Mars Observer. Candidate instruments include: Visual and Infrared Mapping Spectrometer (VIMS), X-ray/Gamma-Ray Spectrometer (XGRS), Radar (or Laser) Altimeter (ALT), Magnetometer (MAG), Thermal Emission Spectrometer (TES), Imaging System, and Radio Science.

Launch Date:	Under Review
Payload:	TBD
Orbit:	Lunar - 100 km circular, near polar
Design Life:	2 years
Length:	TBD
Weight:	TBD
Diameter:	TBD
Launch Vehicle:	Expendable Launch Vehicle
Foreign Participation:	TBD

Instruments

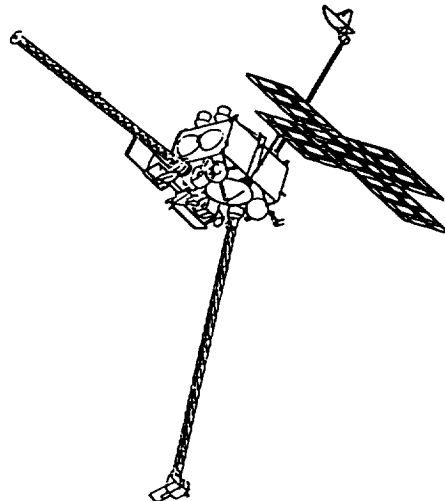
Instrument Complement to be determined.

Mission Events

None established. Mission can be initiated about 3-5 days after launch (Earth-Moon travel time).

Management

NASA Headquarters
Solar System Exploration Division
Jet Propulsion Laboratory
TBD
Major Contractors
TBD



Lunar Observer (LO) (Continued)

Status

The Lunar Observer mission is under study as a candidate New Start for FY 1994. The science goals and approaches of the LO mission were endorsed by a Space Science and Applications Advisory Committee review (May 1990). A Non-Advocate Review (June 1990) recommended more definition study prior to a new start. In the baseline mission, which uses a single Planetary Observer spacecraft, the spare instrument and spacecraft components now being obtained for Mars Observer can be applied to LO once they are no longer needed.

An alternative mission concept, which involves the use of multiple small spacecraft missions to complete the same science data set as the baseline mission, is also being studied.

Mars Observer (MO)

Objective

The objectives of the Mars Observer are: 1) to determine the global elemental and mineralogical character of the surface; 2) define globally the topography and gravitational field; 3) establish the nature of the global magnetic field; 4) determine the time and space distribution, abundance, sources and sinks of volatile-material and dust over a seasonal cycle; and, 5) explore the structure and aspects of the circulation of the atmosphere.

Description

Mars Observer will use a high-inheritance modified Earth-orbiter spacecraft as the basic bus. The mission will be launched in September 1992, using a Titan III/Transfer Orbit Stage (TOS) combination. Arriving at Mars in September 1993, Mars Observer will first enter a highly elliptical capture orbit (period of 72 hours) for 20 days. It will then be shifted into a series of less elliptical drift orbits over a period of 50 - 70 days (depending on the exact 1992 launch date). At the end of these maneuvers (about December 1993), it will be inserted into a 378 km near-polar, Martian orbit (93 degree inclination) to begin its 2-year mapping mission. In late 1995, with the arrival of the two U.S.S.R Mars-94 spacecraft, Mars Observer will begin to relay data from their deployed balloons and surface packages.

Launch Date:	September 1992
Payload:	7 instruments, 25 individual investigations
Orbit:	Martian - Circular, low orbit (approx. 378 km), near-polar (93 degree inclination to equator), sun-synchronous (2 p.m. dayside pass)
Design Life:	3 years
Length:	2.2 m
Weight:	Injected mass 2,500 kg; on-orbit dry mass 1,100 kg
Diameter:	3.5 m
Launch Vehicle:	Titan III/Transfer Orbit Stage
Foreign Participation:	Austria, Germany, France, United Kingdom, U.S.S.R

Instruments

Mars Observer Laser Altimeter (MOLA) - D. Smith (GSFC)
Mars Observer Camera (MOC) - M. Malin (Arizona State University)
Magnetometer (MAG) - M. Acuna (GSFC)
Thermal Emission Spectrometer (TES) - P. Christensen (Arizona State University)
Gamma Ray Spectrometer (GRS) - W. Boynton (University of Arizona)
Pressure Modulator Infrared Radiometer (PMIRR) - D. McCleese (Jet Propulsion Laboratory)
Mars Balloon Relay (MBR) - J. Blamont (Centre National d'Etudes Spatiales)
Radio Science (RS) - G. Tyler (Stanford University)

Mission Events

Tentative selection of investigations: April 1986
Final confirmation and selection: April 1987
Instrument Delivery: June 1991
Arrival at Mars: Launch + 1 year
End of Mission: Launch + 3 years

Mars Observer (MO) (Continued)

Management

NASA Headquarters

W. Huntress, Program Manager

J. Krehbiel, Program Engineer

B. French, Program Scientist

Jet Propulsion Laboratory

D. Evans, Project Manager

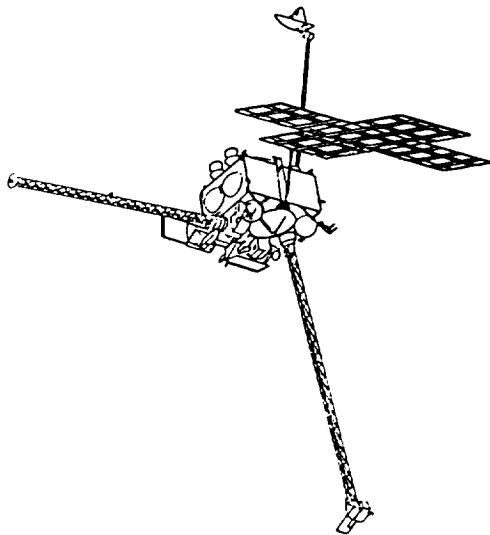
A. Albee, California Institute of Technology, Project Scientist

Major Contractors

General Electric's AstroSpace Division

Status

The project baseline is now a 1992 launch from the Titan III, using a Transfer Orbit Stage (TOS). Critical Design Reviews have been held for the spacecraft and for the instruments. Fabrication of flight hardware is in process.



Mobile Satellite (MSAT)

Objective

The objectives of the Mobile Satellite (MSAT) are: 1) to create a new service/hardware industry; 2) provide direct two-way voice and data communications for cars, trucks, boats and planes; 3) provide for unique public service needs.

Description

A joint NASA-industry program to accelerate the introduction of MSAT service in the U.S. and develop enabling technologies needed to use effectively the spectrum-orbit and ensure future growth. NASA will launch the first generation system, which will be paid for and built by industry. NASA will retain a small amount of channel capacity to carry out government experiments.

Launch Date:	September 1994
Payload:	Communications
Orbit:	Geostationary, 0 degrees inclination
Design Life:	7 years
Length:	TBD
Weight:	TBD
Diameter:	TBD
Launch Vehicle:	Expendable Launch Vehicle
Foreign Participation:	Canada

Instruments

Medium-Gain Mechanically Steered, Tilted-Array Vehicle Antenna - K. Woo (Jet Propulsion Laboratory); V. Jamnejad (Jet Propulsion Laboratory)
Medium-Gained Mechanically Steered YAGI - K. Woo (Jet Propulsion Laboratory); J. Huang (Jet Propulsion Laboratory); Poser (Jet Propulsion Laboratory)
Medium-Gained Mechanically Steered Directive Antenna - Anserlin (Jet Propulsion Laboratory); K. Woo (Jet Propulsion Laboratory); V. Jamnejad (Jet Propulsion Laboratory); Mayes (Jet Propulsion Laboratory)
Medium-Gained Phased Array Antenna - K. Woo (Jet Propulsion Laboratory); J. Huang (Jet Propulsion Laboratory); V. Jamnejad (Jet Propulsion Laboratory)
Speech Codec - S. Townes (Jet Propulsion Laboratory); T. Jedrey (Jet Propulsion Laboratory); Gersho (University of California, Santa Barbara)
Solid State High Power L-Band Linear Power Amplifier - G. Stevens (Jet Propulsion Laboratory)
L-Band Transceiver - J. Parkyn (Jet Propulsion Laboratory)
Terminal Controller - C. Cheetham (Jet Propulsion Laboratory)
Differential Phase Shift Key Trellis Coded Modem - T. Jedrey (Jet Propulsion Laboratory); N. Lay (Jet Propulsion Laboratory); D. Divsalar (Jet Propulsion Laboratory); H. Simon (Jet Propulsion Laboratory)

Mission Events

Develop and field test critical technologies: 1982-1989
Launch offer to industry: 1985
Domestic and international frequencies allocated: 1986-1987
U.S. consortium obtains license: 1989
Commercial satellite launch: 1994
Experiment period: 1994-1996

Mobile Satellite (MSAT) (Continued)

Management

NASA Headquarters

R. Arnold, Program Manager (Acting)

Jet Propulsion Laboratory

W. Weber, Project Manager (Acting)

Major Contractors

Teledyne Brown

Ball Aerospace

American Mobile Satellite Corporation

Canadian Space Agency (CSA)

TBD

Status

NASA L-Band MSAT hardware development is complete. Field testing completed in 1989. NASA has begun Ka-Band MSAT terminal development (see the Advanced Communications Technology Satellite). American Mobile Satellite Corporation (including Hughes, McCaw and six other firms) has received a license to own and operate a commercial system.

Ocean Topography Experiment (TOPEX/POSEIDON)

Objective

The objectives of the Ocean Topography Experiment are to 1) understand the global oceans' general circulation and the relationship to climate change using precise measurements of ocean surface topography; 2) to increase knowledge of interaction between atmosphere and ocean, including exchange of heat and momentum; and, 3) to make detailed maps of currents, eddies and other features of ocean circulation.

Description

TOPEX/POSEIDON is a joint NASA and French Space Agency (CNES) project using satellite radar altimetry, including two French and five NASA instruments. The mission will make substantial contributions to the understanding of global ocean dynamics. TOPEX/POSEIDON is a vital contribution to two major international ocean/atmosphere research programs: the World Ocean Circulation Experiment (WOCE) and the Tropical Ocean Global Atmospheric (TOGA) program, both of which are components of the World Climate Research Program.

Launch Date:	June 1992
Payload:	5 instruments
Orbit:	1,334 km altitude, nominally circular, 66 degree inclination
Design Life:	3 years; expendables for 5 years total
Length:	5.5 m
Weight:	2,700 kg
Diameter:	3.5 m
Launch Vehicle:	Ariane-IV
Foreign Participation:	France

Instruments

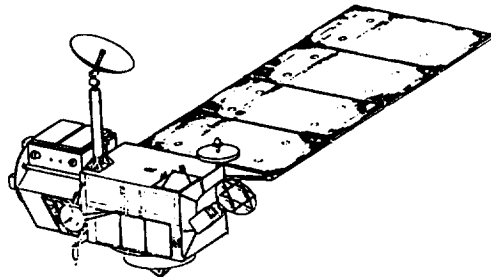
NASA Altimeter (ALT) - NASA/GSFC
Solid State Altimeter (SSALT) - CNES-CST
TOPEX Microwave Radiometer (TMR) - NASA/Jet Propulsion Laboratory
Determination d'Orbite et Radiopositionnement Integre par Satellite (DORIS) - CNES-CST
Global Positioning System Demonstration Receiver (GPSDR) Experiment - W. Melbourne
(Jet Propulsion Laboratory)

Mission Events

Program start: October 1986
Satellite contract award: June 1987
Preliminary Design Review: October 1988
Critical Design Review: May 1989
Start sensor integration: May 1991
Satellite delivery to JPL: December 1991

Management

NASA Headquarters
L. Jones, Program Manager
W. Patzert, Program Scientist
Jet Propulsion Laboratory
C. Yamarone, Project Manager
L. Fu, Project Scientist



Ocean Topography Experiment (TOPEX/POSEIDON) (Continued)

Management (Continued)

French Space Agency (CNES)

J. Fellous, Program Manager

A. Ratier, Program Scientist

M. Dorrer, Project Manager

M. Lefebuke, Project Scientist

Major Contractors

Fairchild

Status

Contract awarded to Fairchild for satellite development. All instrument contracts in place. Joint Science team confirmed. Flight hardware being fabricated. Satellite integration scheduled to begin during the first quarter Fiscal Year 1991.

Orbiting Solar Laboratory (OSL)

Objective

The Orbiting Solar Laboratory (OSL) will determine the physical structure, chemical composition and dynamics of the solar atmosphere. OSL will determine the nature of the physical processes which occur in those parts of the Sun accessible to observations, especially on temporal and spatial scales not previously attainable.

Description

OSL is a three-axis stabilized spacecraft which has a meter class telescope and two smaller co-observing telescopes. The meter class telescope is a visible light diffraction limited telescope of conventional Gregorian design. Its focal plane instrument is the Coordinated Instrument Package (CIP) which has a visible spectrograph, tunable filtergraph and photometric filtergraph. The two smaller telescopes are designed to make measurements in the ultraviolet and soft x-ray spectral regions. OSL will also carry an instrument to measure total solar output. OSL will be launched into a Sun-synchronous orbit that will provide 9 months of continuous solar observations each year.

Launch Date:	Under Review
Payload:	1 m telescope and 2 smaller telescopes with 5 major instruments
Orbit:	500 km, 94.7 degree, sun-synchronous
Design Life:	3 years
Length:	4.6 m
Weight:	1,730 kg
Diameter:	2.8 m
Launch Vehicle:	Expendable Launch Vehicle
Foreign Participation:	German cooperative, Italian cooperative and/or British cooperative

Instruments

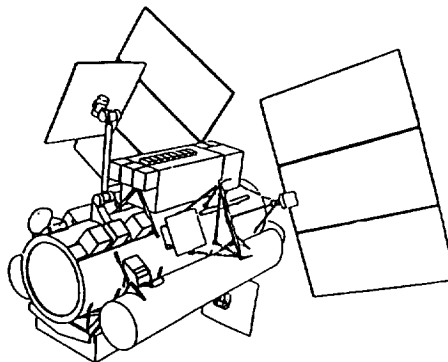
High Resolution Telescope and Spectrograph (HRTS) - G. Brueckner (Naval Research Lab)
Photometric Filtergraph - H. Zirin (Caltech)
Solar Spectrograph (KISS) - E. Schroeter (Klepenheuer Institute for Solar Physics)
Tunable Filtergraph - A. Title (Lockheed Palo Alto Research Lab)
Active Cavity Radiometer Irradiance Monitor (ACRIM) - R. Willson (Jet Propulsion Laboratories)
X-Ray Ultraviolet Imager (XUVI) - E. Antonucci (University of Turin)

Mission Events

Award Phase B Contract: January 1991

Management

NASA Headquarters
R. Howard, Program Manager
W. Wagner, Program Scientist
Goddard Space Flight Center
R. Mattson, Project Manager
D. Spicer, Project Scientist
Major Contractors
Lockheed Palo Alto Research
Hughes Danbury Optical Systems
TBD for Spacecraft & Telescope



Status

Phase A completed June 1988. Two parallel Phase B's to be conducted in Fiscal Year 1991.

Polar Orbiting Environmental Satellites (POES E-M)

Objective

Polar Orbiting Environmental Satellites (POES) will conduct global environmental observations of sea surface temperature, snow cover, cloud cover, sea ice, vegetation condition, and atmospheric temperature and moisture profiles, plus Search and Rescue Operations.

Description

A 1973 Basic Agreement between NASA and the National Oceanic and Atmospheric Administration (NOAA) establishes the observational requirements for both the polar and geostationary weather satellites. Acting as NOAA's agent, NASA procures the spacecraft and instruments required to meet NOAA's objectives, and provides for their launch. NASA also conducts an on-orbit checkout before handing the satellites over to NOAA for routine operations. The requirement to replace spacecraft on an as-needed basis is determined by NOAA.

Launch Date:	1983-1997
Payload:	Weather Satellite
Orbit:	Near-polar, 833-870 km altitude
Design Life:	> 2 years
Length:	4.2 m
Weight:	1,038 kg
Diameter:	1.9 m
Launch Vehicle:	Atlas-E through NOAA-J (Titan-II for NOAA-K, L, M)
Foreign Participation:	United Kingdom, France, Canada

Instruments

Advanced Very High Resolution Radiometer (AVHRR) - ITT
High Resolution Infrared Sounder (HIRS) - ITT
Stratospheric Sounding Unit (SSU) (Through NOAA-J) - United Kingdom
Microwave Sounding Unit (MSU) (Through NOAA-J) - Jet Propulsion Laboratories
Advanced Microwave Sounding Unit (AMSU) (starting with NOAA-K) - Aerojet
Solar Backscatter Ultraviolet Spectrometer (SBUV) (afternoon satellites only) - Ball Aerospace
Space Environment Monitor (SEM) - Ford Aerospace (Through NOAA-J); Panametrics (starting with NOAA-K)
Argos (French Data Collection and Platform Location System (DCS)) - CNES/NASA/NOAA
Search and Rescue System Instrument - Canada/France

Mission Events

NOAA-E Launch: March 1983
NOAA-F Launch: December 1984
NOAA-G Launch: September 1986
NOAA-H Launch: September 1988
NOAA-D Launch: May 1991 (NOAA-D is last of smaller "TIROS-N" spacecraft)
NOAA-I Launch: January 1992
NOAA-J Launch: December 1993
NOAA-K Launch: August 1994
NOAA-L Launch: July 1996
NOAA-M Launch: March 1997

Polar Orbiting Environmental Satellites (POES E-M) (Continued)

Management

NASA Headquarters

J. Greaves, Program Manager

Goddard Space Flight Center

C. Thienel, Project Manager

Major Contractors

General Electric's AstroSpace Division

ITT

Status

Operational series. Morning (7:30 a.m.) and afternoon (1:30 p.m.) Sun-synchronous orbits.
Reimbursable program funded by NOAA.

Radar Satellite (RADARSAT)

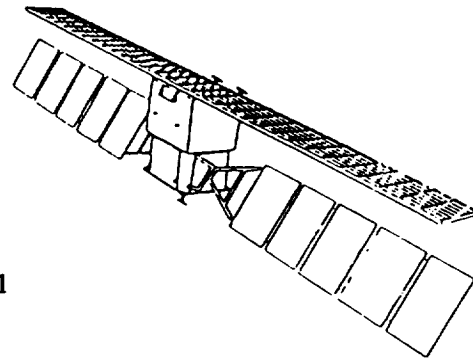
Objective

The objectives of the Radar Satellite (RADARSAT) are: 1) to provide detailed information on sea ice and terrestrial ice sheets for climate research; 2) provide radar imagery for geographical applications in oceanography, agriculture, forestry, hydrology and geology; and, 3) provide real-time products for arctic ocean navigation, including iceberg surveillance.

Description

RADARSAT is a joint NASA and Canadian Space Agency (CSA) project using Synthetic Aperture (Imaging) Radar (SAR) technology.

Launch Date:	June 1994
Payload:	Synthetic Aperture Radar
Orbit:	792 km altitude, nominally circular, 98.5 degree inclination
Design Life:	3 years
Length:	4.2 m
Weight:	3,200 kg
Diameter:	2.8 m
Launch Vehicle:	Delta 7920
Foreign Participation:	Canada



Instruments

Synthetic Aperture Radar

Mission Events

Joint U.S./Canada Study: Since 1979

Program Start: June 1987

Satellite Preliminary Design Review: February 1991

Satellite Critical Design Review: January 1992

Management

NASA Headquarters

R. Monson, Program Manager

R. Thomas, Program Scientist

Canadian Space Agency (CSA)

E. Langham, Project Manager

J. McNally, Project Director

Major Contractors

SPAR Aerospace

Ball Aerospace

McDonnell Douglas

MacDonald Dettwiler

Status

RADARSAT Project approved in June 1987 by Canadian Government. Memorandum of Understanding with Canada negotiated, but unsigned (June 1988). Alaska SAR facility (NASA Earth Receiving Station) development is in progress. Hardware development started in February 1990.

Reusable Reentry Satellite (LifeSAT)

Objective

The Reusable Reentry Satellite (LifeSAT) will enable investigations into the effects of the space radiation and gravitation environment on living systems – a capability not currently available with other spacecraft – for durations of up to 60 days. This capability supports the needs for the Space Exploration Initiative and also broader space science requirements.

Description

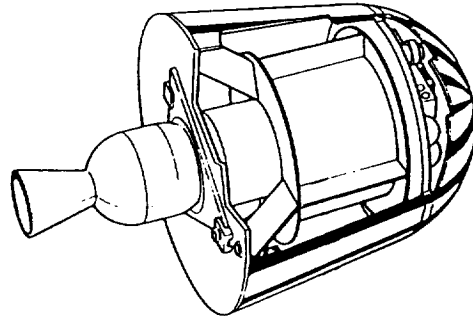
LifeSAT is a recoverable satellite that can remain in orbital operation as an unmanned laboratory for up to 60 days. The LifeSAT is configured with a large and readily accessible experiment payload module volume in which various types of payload modules can be accommodated. Payload modules can accommodate living test subjects such as cells and tissues, invertebrates, vertebrates, and rodents. Radiation monitors can be accommodated both inside and outside the satellite.

LifeSAT is approximately 2.0 meters at the base diameter, 2.3 meters in height and weighs about 1,350 kilograms with the payload. The payload module is approximately 1.0 meter in diameter and 1.3 meters in height and can support a payload mass of approximately 400 kilograms. The LifeSAT vehicle provides utility sources to the payload of electrical energy, thermal control, command signals and downlink telemetry capability. Recovery will be on command from the ground.

Launch Date:	TBD; three other launches planned
Investigations:	Study effects of radiation, microgravity, and artificial gravity on living systems
Orbit:	350 - 900 km altitude, 0-90 degree inclination
Duration:	Up to 60 days
Length:	2.3 m
Weight:	1,350 kg
Diameter:	2.0 m
Launch Vehicles:	Medium-class ELV and possibly international candidates
Foreign Participation:	TBD

Management

NASA Headquarters
W. Gilbreath, Program Manager
T. Halstead, Program Scientist
Johnson Space Center
R. Spann, Project Manager
Ames Research Center
E. Holton, Project Scientist



Status

Phase B is ongoing.

Small-Class Explorers (SMEX)

Objective

The objectives of the Small-Class Explorers (SMEX) are to enable new areas of exploration and special topic investigations in space astrophysics, and atmospheric and space plasma physics; and to provide a quick reaction research capability, through small sized missions and annual launch opportunities, suitable for university or Government research requiring fast response.

Description

SMEX payloads are modest size, modest capability payloads, which can make major contributions a number of NASA's space science and applications disciplines.

The Solar, Anomalous, and Magnetospheric Particle Explorer (SAMPEX) will be a Zenith-pointing satellite in near-polar orbit which will carry a payload of four particle detectors, each of which addresses a subset of the required measurements. The instruments can measure the electron and ion composition of energetic particle populations from approximately 0.4 million electron Volts (MeV)/nucleon to hundreds of MeV/nucleon using a coordinated set of detectors of excellent charge and mass resolution, and with higher sensitivity than previously flown instruments.

The Fast Auroral Snapshot Explorer (FAST) will collect measurements of electrical and magnetic fields from other sensors and simultaneously correlate these forces with their effects on the electron and ions at altitudes of 300 to 3,500 kilometers. These observations will be complemented by data from other spacecraft at higher altitudes, which will be observing fields and particles and photographing the aurora from above, thus placing FAST observations in global context. At the same time, auroral observatories and geomagnetic stations on the ground will provide measurements on how energetic processes that FAST observes affect the Earth.

The Submillimeter Wave Astronomy Satellite (SWAS) will be a three-axis stabilized, stellar-pointing spacecraft launched into either an equatorial or mid-inclination orbit, depending on the results of tradeoff studies between operational considerations and the desire to maximize sky coverage. It will have a 55 centimeter off-axis Cassegrain antenna, state-of-the-art heterodyne receivers cooled to 100 degrees Kelvin (K) by passive radiators, and the highest quality acousto-optical spectrometer (AOS). In less than 20 minutes of integration, SWAS will be able to measure the full range of predicted H₂O, O₂, C and ¹³CO abundances in any giant molecular cloud core within 1 kiloparsec. Of particular importance, the AOS will permit simultaneous observation of these four lines, thus maximizing the observing efficiency and substantially increasing confidence in the spatial coincidence of maps made in the various lines. Local clouds (diameter less than 1 kiloparsec), such as Orion, Taurus, Ophiuchi, and Perseus, will be mapped in each of the four lines. A survey of galactic Giant Molecular Clouds will be performed, and a number of gas rich extra-galactic sources, such as the Magellanic Clouds, will be observed.

	<u>SAMPEX</u>	<u>FAST</u>	<u>SWAS</u>
Launch Date:	June 1992	September 1994	June 1995
Payload:	4 particle detectors	7 instruments	telescope & receiver
Orbit:	580 km altitude, 82-degree inclin., circular	300 x 3,500 km 76 degree inclin., non-Sun synchronous	530 km altitude 3 degree inclin.
Design Life:	3 years	1 year	2 years
Length:	1.5 m (stowed)	1.54 m (stowed)	TBD
Weight:	158 kg	150 kg (stowed)	TBD
Diameter:	0.86 (stowed)	TBD	TBD
Launch Vehicle:	SCOUT	Small Expendable Launch Vehicle (SELV)	Small Expendable Launch Vehicle (SELV)
Foreign Participation:	Germany	None	Germany

Small-Class Explorers (SMEX) (Continued)

Instruments

SAMPEX

Principal Investigator - G. Mason (University of Maryland)
Low Energy Ion Composition Analyzer (LEICA) - University of Maryland
Heavy Ion Large Telescope (HILT) - Max Planck Institute
Mass Spectrometer Telescope (MAST) - California Institute of Technology
Proton-Electron Telescope (PET) - California Institute of Technology

FAST

Principal Investigator - C. Carlson (University of California, Berkeley)
Fast Electron Spectrograph - University of California, Berkeley
Electron Electrostatic Analyzer - University of California, Berkeley
Toroidal Ion Mass-Energy-Angle Spectrograph - Lockheed, Palo Alto Research Laboratory
Ion Electrostatic Analyzer - University of California, Berkeley
Electric and Magnetic Field Instrumentation - University of California, Los Angeles

SWAS

Principal Investigator - G. Melnick (Smithsonian Astrophysical Observatory)
Antenna, Star Tracker, Instrument Integration - Ball Aerospace
Submillimeter Heterodyne Receiver (SHR) - Millitech
Acousto-Optical Spectrometer (AOS) - University of Cologne

Management

NASA Headquarters

D. Gilman, Program Manager
V. Jones, SAMPEX Program Scientist
L. Caroff, SWAS Program Scientist
E. Whipple, FAST Program Scientist
Goddard Space Flight Center
R. Weaver, Project Manager (Acting)
D. Baker, Project Scientist
G. Colon, SAMPEX Mission Manager
W. Nagel, SWAS Mission Manager (Acting)
T. Gehringer, FAST Mission Manager

Major Contractors

University of Maryland (SAMPEX)
California Institute of Technology (SAMPEX)
Max Planck Institute (SAMPEX)
Smithsonian Astrophysical Observatory (SWAS)
Ball Aerospace (SWAS)
University of Cologne (SWAS)
Millitech (SWAS)
University of California at Berkeley (FAST)

Small-Class Explorers (SMEX) (Continued)

Status

SAMPEX

Critical Design Review (CDR) was completed in June 1990. Instrument integration is scheduled to begin in September 1991. Currently being developed for a June 1992 launch.

FAST

Concept Review was completed during September 1990. Currently being developed and built for a 1994 launch.

SWAS

Concept Review was completed during June 1990. The instruments and spacecraft are currently under development for a 1995 launch.

Solar Probe

Objective

The objectives of the Solar Probe are: 1) to explore the heliosphere inside of 0.3 AU (Astronomical Units); 2) make *in situ* measurements of fields and particles in the very near vicinity of the Sun; 3) map the structure of the solar corona; 4) determine the mechanism responsible for coronal heating; 5) determine the source of solar wind acceleration; and, 6) study transient coronal phenomena such as coronal mass ejections and solar flares.

Description

The Solar Probe mission will feature a single spacecraft designed to make measurements of local fields and particles in the very near vicinity of the Sun. In order to achieve solar orbit, it must be launched towards the planet Jupiter, and use Jupiter's gravity field to retarget the spacecraft towards the Sun. The goal is to place the spacecraft in an orbit with a perihelion radius of 4 solar radii and an inclination of 90 degrees. The primary encounter phase of the mission will take place while the spacecraft is within the orbit of Mercury (radius < 0.3 AU) and will last about 10 days. Pole to pole coverage of the Sun will take about 14 hours. It is expected that measurements will be made of the local plasma populations, AC (Alternating Current) and DC (Direct Current) electric and magnetic fields, medium and high energy particles, and neutrons. The spacecraft may also carry Extreme Ultraviolet (EUV)/white light and infrared spectrometers.

Launch Date:	Under review
Payload:	12 instruments
Orbit:	Interplanetary, Perihelion 4 solar radii, Aphelion 5 AU, 90 degree inclination
Design Life:	4 years
Length:	20 m
Weight:	TBD
Diameter:	4 m
Vehicle:	Titan-IV/Centaur
Foreign Participation:	TBD

Instruments

Instrument Complement to be determined.

Mission Events

Jupiter Flyby: No earlier than 2001

Perihelion Passage: No earlier than 2003

Management

NASA Headquarters

L. Demas, Study Manager

M. Mellott, Study Scientist

Jet Propulsion Laboratory

J. Randolph, Study Manager

B. Tsurutani, Study Scientist

Major Contractors

TBD

Status

Mission definition study is completed. The Solar Probe project may be a candidate for a Fiscal Year 1995 new start.

Space Infrared Telescope Facility (SIRTF)

Objective

The objectives of the Space Infrared Telescope Facility (SIRTF) are: 1) to carry out high sensitivity photometric, imaging and spectroscopic observations of celestial sources; 2) study the formation of galaxies, stars and planets; 3) observe new comets and other primitive bodies in the outer solar system; 4) study disks of solid material around nearby stars (planetary system development); 5) search for Brown Dwarfs and the missing mass; 6) extend the Infrared Astronomical Satellite (IRAS) studies of forming stars to earliest phases of star formation; 7) identify and study powerful infrared-emitting galaxies at the edge of the Universe; and 8) provide infrared perspective for the understanding of quasars.

Description

SIRTF, the infrared element of the Great Observatories program, will cover the wavelength range from 1.8 micrometers (μm) to 700 μm . The scientific payload will consist of a meter-class, cryogenically cooled telescope capable of diffraction-limited observations at 4 μm , with a goal of 2.50 μm . It will have a complement of three focal plane instruments: an Infrared Spectrometer (IRS), Infrared Array Camera (IRAC) and a Multiband Imaging Photometer (MIPS). Both the telescope and the instruments will be cryogenically cooled with superfluid helium. SIRTF will have an angular resolution of 14 arcseconds at 60 microns, a field of view of 7 arcminutes, and pointing stability of 0.15 arcseconds rms (root mean square). It is planned for launch by a Titan IV/Centaur expendable launch vehicle into a 100,000 km altitude, 28.5 degree inclination circular orbit. The orbit has been selected to place SIRTF well above the Earth's trapped radiation zone. Mission lifetime will be a minimum of 5 years.

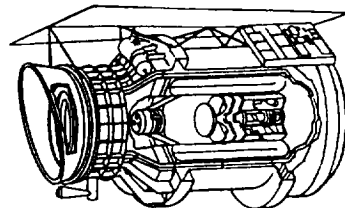
Launch Date:	Under Review
Payload:	3 instruments
Orbit:	100,000 km altitude, 28.5 degree inclination, circular
Design Life:	5 years (no servicing)
Length:	Approx. 8.5 m
Weight:	Approx. 5,500 kg
Diameter:	Approx. 3.4 m
Launch Vehicle:	Titan IV/Centaur
Foreign Participation:	None

Instruments

Infrared Spectrometer (IRS) - J. Houck (Cornell University)
Infrared Array Camera (IRAC) - G. Fazio (Smithsonian Astrophysical Observatory)
Multiband Imaging Photometer (MIPS) - G. Rieke (University of Arizona)

Mission Events

Orbit option decision: March 1989
Development Center Selected: December 1989
Initiation of Phase B study: FY 1991
Initiation of Phase C/D: No earlier than FY 1994



Space Infrared Telescope Facility (SIRTF) (Continued)

Management

NASA Headquarters

A. Fuchs, Program Manager

L. Caroff, Program Scientist

Jet Propulsion Laboratory

R. Spehalski, Project Manager

M. Werner, Project Scientist

Status

The Jet Propulsion Laboratory (JPL) was selected in December 1989 as the lead center for SIRTF development. SIRTF expertise has been transitioned from the study center, Ames Research Center (ARC), to JPL. Budgets, procurement strategies, and development schedules are being developed and aimed at a Fiscal Year 2000 launch.

Space Radar Laboratory (SRL)

Objective

The objectives of the Space Radar Laboratory (SRL) are: 1) to take radar images of the Earth's surface for Earth system sciences studies, including geology, geography, hydrology, oceanography, agronomy, and botany; 2) gather data for future radar system designs, including Earth Observing System (EOS); and, 3) take measurements of the global distribution of carbon dioxide in the troposphere.

Description

SRL carries a modified version of the Shuttle Imaging Radar (SIR-C) and the Measurement of Air Pollution from Satellites (MAPS) instruments. The Space Shuttle's orientation will have the open cargo bay facing the Earth. The radar antenna will be unfolded in orbit and used at various viewing angles. The Synthetic Aperture Radar will image a strip parallel to, but offset from, the groundtrack. Five 50-Mbps digital data channels are recorded on special high-rate recorders. Some recorded data and some real-time data will be transmitted to the ground. Preplanned experiment sequences will be initiated by commands issued via the Space Shuttle's general purpose computer. Two additional flights of this laboratory are planned at approximately 18-month intervals.

Launch Date:	SRL-1: 1st Quarter FY 1994 SRL-2: 1st Quarter FY 1995 SRL-3: 1st Quarter FY 1996
Orbit:	> 222 km altitude, 57 degree inclin.
Design Life:	Up to 10 days with reflights
Length:	14.8 m with antenna deployed
Weight:	8,547 kg
Diameter:	4.6 m
Launch Vehicle:	Space Shuttle
Foreign Participation:	Italy, Germany

Instruments

Shuttle Imaging Radar-C (SIR-C) - C. Elachi (Jet Propulsion Laboratory)

X-Band Synthetic Aperture Radar (X-SAR) - H. Öttl (Aerospace Research Establishment (Germany)), P. Pampaloni (Italian Space Agency)

Mission Events

SRL-1

Mission Preliminary Design Review: October 1989

Mission Critical Design Review: December 1991

Delivery to Kennedy Space Center: November 1992

Launch Readiness Review: 1993

Launch: 1st Quarter FY 1994

Management

NASA Headquarters

W. Piotrowski, Program Manager

M. Baltuck, Program Scientist

Johnson Space Center

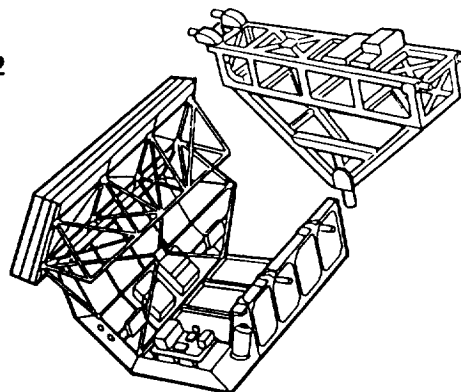
L. Wade, Mission Manager

D. Amsbury, Mission Scientist

Major Contractors

Ball Aerospace (SIR-C Antenna)

Rockwell International



Space Radar Laboratory (SRL) (Continued)

Status

Design of the Shuttle Imaging Radar (SIR-C) is well under way at the Jet Propulsion Laboratory (JPL) and the Critical Design Review has been successfully completed. Mission planning and integration activities have been started. The Critical Design Review for the X-band Synthetic Aperture Radar (X-SAR) was held in February 1990. A Mission Preliminary Design Review was held in October 1989, and the Mission Critical Design Review is scheduled for December 1991.

Spacelab-J (SL-J)

Objective

Spacelab-J (SL-J) will conduct basic and applied materials processing research and life sciences investigations that can be conducted only in the microgravity environment of space.

Description

The Spacelab-J mission is jointly sponsored by NASA and the National Space Development Agency (NASDA) of Japan. NASA will be partially reimbursed for the cost of a dedicated Space Shuttle flight, including the use of Spacelab systems. The Japanese are providing two Spacelab double racks for the materials science facilities and one double rack for life sciences experiments. The remaining space in the long module will be devoted to NASA materials sciences and life sciences experiments, Spacelab avionics (computers, environmental control, etc.), common support equipment (video recorders, fluid pumps, etc.), and storage space for materials needed for experiments. The crew of seven will include the Commander, Pilot, orbiter mission specialist, two payload mission specialists, one U.S. science mission specialist and one Japanese payload specialist. Mission and payload operations centers in the United States will support the crew in 24-hour operations.

Launch Date:	September 1992
Investigations:	Approx. 40
Orbit:	306 km altitude, 57 degree inclination, 160 nm
Duration:	7 days
Length:	Approx. 7 m
Weight:	11,153 kg (24,536 lbs.)
Diameter:	Approx. 4.8 m
Launch Vehicle:	Space Shuttle
Foreign Participation:	Japan

Instruments

Materials Science Investigations

Crystal Growth Chamber - C. Bugg (University of Alabama at Birmingham)

Space Acceleration Measurement System (SAMS) - R. DeLombard (LeRC)

Gradient Heating Furnace - T. Yamada (Nippon Telephone and Telegraph Corporation); A. Kamio (Tokyo Institute of Technology); N. Tatsumi (Sumitomo Electric Industries, Ltd.)

Image Furnace - Y. Segawa (Institute of Physical and Chemical Research); I. Nakatani (National Research Institute for Metals); N. Soga (Kyoto University), S. Takekawa (National Institute for Research)

Continuous Heating Furnace - K. Togano (National Research Institute for Metals); T. Dan (National Institute for Metals); T. Suzuki (Tokyo Institute of Technology); Y. Hamakawa (Osaka University); A. Ohnu (Chiba Institute of Technology)

Large Isothermal Furnace - A. Fukuzawa (National Research Institute for Metals); Y. Muramatsu (National Research Institute for Metals); S. Kohara (Science University of Tokyo)

Crystal Growth Experiment Facility - T. Nishinaga (University of Tokyo); N. Wada (Nagoya University)

Liquid Drop Experiment Facility - T. Yamanaka (National Aerospace Laboratory)

Bubble Behavior Experiment - H. Azuma (National Aerospace Laboratory)

Acoustic Levitation Furnace - J. Hayakawa (Government Industrial Research Institute, Osaka)

Marangoni Convection Experiment Unit - S. Enya (Ishikawajima-Harima Heavy Industries, Ltd.)

Organic Crystal Growth Facility - H. Anzai (National Electrotechnical Laboratory)

Spacelab-J (SL-J) (Continued)

Instruments (Continued)

Life Sciences Investigations

Autogenic Feedback Training Equipment - P. Cowlings (Ames)
Cell Culture Chambers - E. Holton (Ames); A. Krikorian (SUNY at Stony Brook); A. Sato (Tokyo Medical and Dental University)
Fluid Therapy System, - C. Lloyd (JSC); G. Creager (JSC)
Frog Embryology Unit - K. Souza (Ames)
Lower Body Negative Pressure (LBNP) Device, AFE and LSLE Computer - J. Charles (JSC)
MRI Unit (Pre-flight and Post-flight only) - A. LeBlanc (Baylor College of Medicine and Methodist Hospital)
Physiological Monitoring System - C. Sekiguchi (NASDA); K. Koga (Nagoya University)
Urine Monitoring System - N. Matsui (Nagoya University)
Vestibular Function Experiment Unit - S. Mori (Nagoya University)
Free Flow Electrophoresis Unit - M. Kuroda (Osaka University); T. Yamaguchi (Tokyo Medical and Dental University)
Light Impulse Stimulator - K. Koga (Nagoya University)
Crystal Growth Cell - Y. Morita (Kyoto University)
Incubator - T. Suda (Showa University)
Fly Container - M. Ikenaga (Kyoto University)
Double Integral Control Element - A. Tada (National Aerospace Laboratory)
Radiation Monitoring Container - S. Nagaoka (NASDA)
Fungi Growth Chamber - Y. Miyoshi (Tokyo University)

Mission Events

Payload Specialists Selection: October 1989
Payload Confirmation: January 1990
Investigators Working Group: April 1990
Experiment Delivery to Kennedy Space Center: September 1990
Launch Readiness Review: February 1992

Management

NASA Headquarters

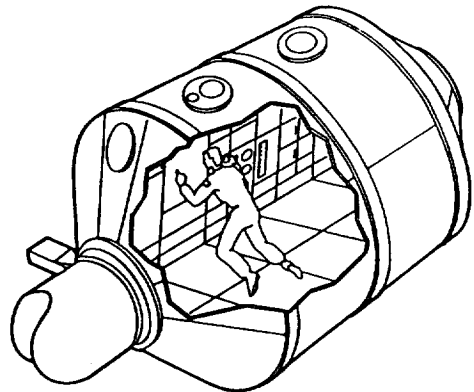
G. McCollum, Flight Systems Program Manager
G. Fogleman, Life Sciences Program Manager
T. Halstead, Life Sciences Program Scientist
R. Sokolowski, Materials Science Program Scientist

Marshall Space Flight Center

J. Cremin, Mission Manager
F. Leslie, Mission Scientist
National Space Development Agency of Japan
N. Soichi, Project Manager
Y. Fujimori, Program Scientist

Major Contractors

Teledyne Brown



Status

NASA sponsored Life Science investigations are on schedule for September 1992 launch date. Experimental Verification Tests (EVT's) have been successfully completed.

Spacelab Life Sciences (SLS) Series

Objective

The Spacelab Life Sciences (SLS) missions are devoted to research related to the future health, safety and productivity of humans in space. On each mission a set of coordinated and complementary investigations will focus on observations of the physiological responses to weightlessness. The study of existing problems associated with weightlessness, such as acute fluid shift, cardiovascular adaptation and space motion sickness, will foster new insights into the responsible physiological mechanisms. Confidence in estimates of the consequences of sustained weightlessness will be increased and attempts to manage or reduce adverse effects of microgravity will be enhanced.

Description

The **SLS-1** is the first Space Shuttle mission dedicated to life sciences research. Proposed by an international team of investigators, 20 life sciences investigations, one microgravity investigation and eight other studies or facilities tests have been selected for flight. The scientific objectives of the SLS-1 mission require data and specimen samples to be gathered from animal and human subjects. In addition to acting as test subjects, the crew will be actively involved in the acquisition and evaluation of data. Life Sciences hardware that will undergo initial flight testing include the Small Mass Measurement Instrument (SMMI), the Refrigerator/Incubator Module (RIM), the General Purpose Work Station (GPWS), the General Purpose Transfer Unit (GPTU), the Physiological Monitoring System (PMS), cardiovascular testing apparatus, and the echocardiograph. An upgraded version of the Research Animal Holding Facility (RAHF) is also manifested and will hold 20 rats.

SLS-2 is primarily a reflight of 18 of the 20 SLS-1 investigations. Two additional Research Animal Holding Facilities will be included to accommodate sufficient rodent populations to complete the investigations begun on SLS-1. This will be the first life sciences mission to use an Extended Duration Orbiter (EDO) kit to enable a 13-day stay in space. The EDO Medical Program will develop countermeasures and procedures to minimize the negative impacts of space flight and ensure the safety and success of extended duration shuttle missions.

SLS-3 has yet to be fully defined, but will be the first mission to include the NASA/French Space Agency (CNES) Rhesus facility. It will be a 16-day EDO mission.

	<u>SLS-1</u>	<u>SLS-2</u>	<u>SLS-3</u>
Launch Date:	May 1991	June 1993	Late 1995
Investigations:	20	20	TBD
Orbit:	240 km, 39 degree inclin., 150 nm	TBD	TBD
Design Life:	9 days	13 days	16 days
Length:	Approx. 7 m	Approx. 7 m	Approx. 7 m
Weight:	10,718 kg (23,580 lbs.)	TBD	TBD
Diameter:	Approx. 4.8 m	Approx. 4.8 m	Approx. 4.8 m
Launch Vehicle:	Space Shuttle	Space Shuttle	Space Shuttle
Foreign Participation:	Switzerland, Australia, France and U.S.S.R.	Switzerland, Australia, France and U.S.S.R.	Switzerland, Australia, France and U.S.S.R.

Spacelab Life Sciences (SLS) Series (Continued)

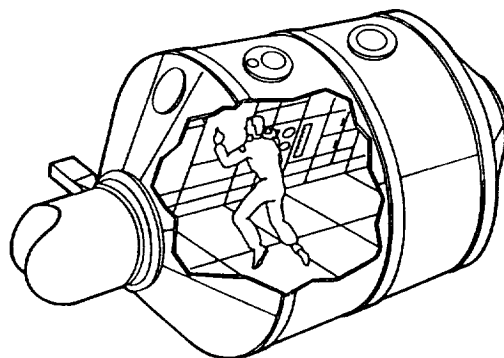
Investigations (SLS-1)

- Cardiovascular Adaptation to Zero Gravity - C. Blomqvist (University of Texas)
Inflight Study of Cardiovascular Deconditioning - L. Farhi (SUNY)
Pulmonary Function During Weightlessness - J. West (University of California, San Diego)
Influence of Weightlessness Upon Human Autonomic Cardiovascular Control - D. Eckberg (McGuire Veterans Administration Medical Center, and Medical College of Virginia)
Fluid-Electrolyte Regulation During Space Flight - C. Leach (JSC)
The Influence of Space Flight on Erythrokinetics in Man - C. Alfrey (Baylor College of Medicine)
Regulation of Blood Volume During Space Flight - C. Alfrey (Baylor College of Medicine)
Regulation of Erythropoiesis in Rats During Space Flight - R. Lange (University of Tennessee Medical Center)
Lymphocyte Proliferation in Weightlessness - A. Cogoli (Gruppe Weltraum Biologie, Switzerland)
Protein Metabolism During Space Flight - T. Stein (University of Medicine and Dentistry of New Jersey)
Effects of Zero Gravity on Biochemical and Metabolic Properties of Skeletal Muscle in Rats - K. Baldwin (University of California, Irvine)
Effects of Microgravity on the Electron Microscopy, Histochemistry, and Protease Activities of Rat Hindlimb Muscle - D. Riley (Medical College of Wisconsin)
Skeletal Myosin Isoenzymes in Rats Exposed to Zero Gravity - J. Hoh (University of Sydney, Australia)
Pathophysiology of Mineral Loss During Space Flight - C. Arnaud (Veterans Administration)
Bone, Calcium, and Space Flight - E. Holton (ARC)
Vestibular Experiments in Spacelab - L. Young (Massachusetts Institute of Technology)
A Study of the Effects of Space Travel on Mammalian Gravity Receptors - M. Ross (ARC)
Effects of Microgravity-Induced Weightlessness on Aurelia Ephyra Differentiation and Statolith Synthesis - D. Spangenberg (Eastern Medical School of Virginia)
Particulate Containment Demonstration Test - NASA
Small Mass Measurement Test - NASA
Surgical Work Station - D. Brandwell, B. Houtchens (JSC, University of Texas)
Intravenous Pump - D. Brandwell (JSC)
Airborne Particles - D. Russo (JSC)
Noninvasive Central Venous Pressure - J. Charles (JSC)
Space Acceleration Measurement System - LeRC
Solid Surface Combustion Experiment - R. Altenkirch (Mississippi State University)

Mission Events

SLS-1

- Preliminary equipment design: Completed
Mission concept, feasibility studies: Completed
Mission definition studies: Completed
Mission implementation: Completed
Experiment delivery to Kennedy Space Center: Completed
Launch readiness review: April 1991
Launch: May 1991



Spacelab Life Sciences (SLS) Series (Continued)

Mission Events (Continued)

SLS-2

Preliminary equipment design: Completed
Mission concept, feasibility studies: Completed
Mission definition studies: Completed
Preliminary Design Review: Completed
Mission implementation: Ongoing
Experiment delivery to Kennedy Space Center: August 1992
Launch: June 1993

SLS-3

Preliminary equipment design: Ongoing
Mission concept and feasibility studies: Ongoing
Mission definition studies: Ongoing

Management

NASA Headquarters

G. McCollum, Flight Systems Program Manager
W. Gilbreath, Life Sciences Program Manager
R. White, Life Sciences Program Scientist (SLS-1)
F. Sulzman, Life Sciences Program Scientist (SLS-2 & 3)

Johnson Space Center

W. Womack, Mission Manager (SLS-1 & 3)
H Schneider, Mission Scientist
K. Newkirk, Mission Manager (SLS-2)

Major Contractors

General Electric
Lockheed

Status

- SLS-1: Level III/II integration and Cargo Integration Test Equipment (CITE) activities complete; crew training, and baseline data collection are underway.
- SLS-2: Project Offices at the Johnson Space Center and the Ames Research Center are preparing for the November 1991 Critical Design Review.
- SLS-3: Investigations tentatively selected for definition in 1984 are being prioritized for flight and some initial work on required hardware has begun.

Tethered Satellite System (TSS)

Objective

The objectives of the Tethered Satellite System (TSS) are to verify the engineering performance of the TSS, to determine and understand the electromagnetic interaction between the tether/satellite/Space Shuttle system and the ambient space plasma, to investigate and understand the dynamical forces acting upon a tethered satellite, and to develop the capability for future tether applications on the Space Shuttle and Space Station Freedom.

Description

TSS is a cooperative program between NASA and the Italian Space Agency (ASI). NASA is responsible for the TSS deployer and systems integration, while Italy is building the satellite; both are providing scientific investigations. On its first flight, the satellite will be deployed on a conducting tether above the Space Shuttle to a distance of 20 km. The deployer consists of a Spacelab pallet, a reel for deployment and final retrieval of the satellite, an electrical power and distribution subsystem, a communications and data management subsystem, and a tether control capability. A separate support structure will carry science instrumentation. The satellite is spherical with a diameter of 1.6 meters. The upper hemisphere will house the scientific payload, while the lower hemisphere will contain the support equipment. The satellite is equipped with cold gas (nitrogen) thrusters used for deployment, retrieval, and altitude control.

Launch Date:	March 1992
Payload:	Deployer, Satellite and Pallet-mounted Experiments
Orbit:	300 km altitude, 28.5 degree inclination, circular
Duration:	36 hours
Length:	5.76 m
Weight:	5,840 kg
Diameter:	1.6 m (Satellite)
Launch Vehicle:	Space Shuttle
Foreign Participation:	Italy

Instruments

- A Theoretical and Experimental Investigation of TSS Dynamics (TEID) - S. Bergamaschi (University of Padova)
- Detection of the Earth's Surface of ULF/VLF Emissions by TSS (OESEE) - G. Tacconi (University of Genoa)
- Investigation of Dynamic Noise in TSS (IMON) - G. Gulhorn (Smithsonian Astrophysical Observatory)
- Investigation of Electromagnetic Emissions from Electrodynamic Tether (EMST) - R. Estes (Smithsonian Astrophysical Observatory)
- Italian Core Equipment for Tether Current/Voltage Control (DOORE) - C. Bonifazi (ASI)
- Magnetic Field Experiment for the TSS Missions (TMAG) - F. Mariani (2nd University of Rome)
- Research on Electrodynamic Tether Effects (RETE) - M. Dobrowolny (CNR)
- Research on Orbital Plasma Electrodynamics (ROPE) - N. Stone (MSFC)
- Shuttle Electrodynamic Tether System (SETS) - P. Banks (Stanford University)
- Shuttle Potential and Return Electron Experiment (SPREE) - M. Oberhardt (Air Force Geophysical Lab)
- Tethered Optical Phenomena (TOP) - S. Mende (Lockheed Palo Alto Research Lab)

Tethered Satellite System (TSS) (continued)

Mission Events

Preliminary instrument design: Completed

Mission concept, feasibility studies: Completed

Mission definition studies: Completed

Mission implementation: Ongoing

Payload delivery to Kennedy Space Center: November 1990

Management

NASA Headquarters

T. Stewart, Deployer Program Manager

R. Howard, Experiments Program Manager

D. Evans, Program Scientist

Marshall Space Flight Center

J. Price, Project Manager

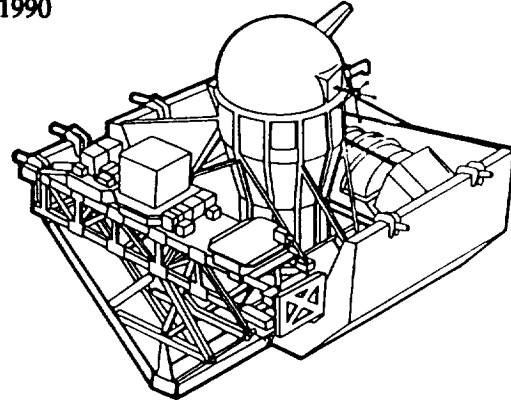
N. Stone, Project Scientist

Italian Space Agency (ASI)

G. Manarini, Program Manager

F. Mariani, Program Scientist

M. Dobrowolny, Project Scientist



Status

Deployer and satellite have been delivered to Kennedy Space Center. Integration with Shuttle System proceeding.

United States Microgravity Laboratory (USML) Series

Objective

The United States Microgravity Laboratory (USML) Series will establish a space laboratory program with long-term continuity to focus on U.S. microgravity materials processing technology, science, and research requiring the low gravity environment of Earth orbit. USML will offer the U.S. scientific and commercial communities access to Spacelab and its capabilities, fostering development of a science and technology base for Space Station applications.

Description

The USML series will focus on materials sciences and applications experiments, as well as technology development. USML missions will fly at 2 1/2 year intervals in order that scientists may build upon results from previous investigations. The payload crew will be actively involved in many investigations as trained scientists performing experiments in orbit and providing immediate scientific assessment of experiment progress to investigators on the ground. NASA provides the flight opportunities, defines and integrates the payload, and maintains responsibility for mission management.

The USML program will use an Extended Duration Orbiter (EDO) capability which, through use of additional cryogenic tankage in the cargo bay, can extend flight duration up to 16 days. The EDO kit offers an increase in total flight energy (kilowatt hours) over that provided in a fifth energy kit-outfitted Space Shuttle. The USML program will also conduct experiments in which flight hardware is mounted on the cargo bay and exposed to the space environment (rather than inside the pressurized volume offered by the Spacelab long module). This payload configuration is designated the United States Microgravity Payload (USMP).

Launch Date:	USML-1: June 1992 USML-2: 1994 USML-3: 1997
Investigations:	13 investigations, 17 demonstration experiments
Orbit:	297 km altitude, 28.5 degree inclin.
Duration:	13 Days
Length:	10 m
Weight:	15,385 kg (maximum)
Diameter:	4.6 m
Launch Vehicle:	Spacelab/Space Shuttle

Investigations/Instruments

Crystal Growth Furnace (CGF) - D. Larsen (Grumman Aerospace)

Drop Physics Module (DPM) - R. Apfel (Yale University)

R/IM VDA : Protein Crystal Growth (PCG-II) - C. Bugg (University of Alabama, Birmingham)

Solid Surface Combustion Experiment (SSCE) - R. Altenkirch (Mississippi State University)

Surface Tension Driven Convection Experiment (STDCE) - S. Ostrach (Case Western Reserve University)

USML-1 Glovebox Experiments Module (GEM) (17 experiments) - various

Spacecraft Acceleration Movement System (SAMS) - R. De Lombard (NASA/LeRC)

Extended Duration Orbiter Medical Program (EDOMP) - C. Savin (NASA/JSC)

Zeolite Crystal Growth (ZCG) - A. Sacco (Worcester Polytechnic Institute)

Commercial Generic Bioprocessing Apparatus (CGBA) - L. Stodieck (Bioserve Technologies)

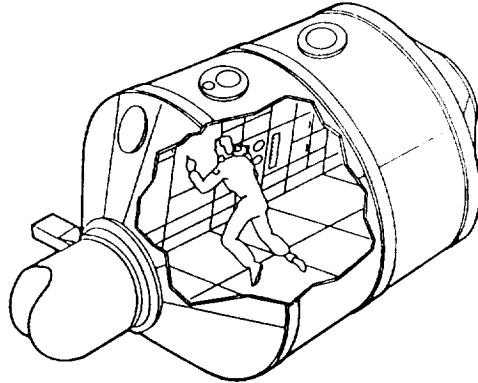
Astroculture (ASC) - T. Tibbets (Wisconsin Center for Space Automation and Robotics)

United States Microgravity Laboratory (USML) Series (Continued)

Mission Events

USML-1:

Authorization to proceed: June 1988
Mission Preliminary Design Review: October 1989
Mission Critical Design Review: July 1990
Cargo Integration Review: April 1991
Payload Readiness Review: March 1992
Flight Readiness Review: May 1992



Management

NASA Headquarters
J. McGuire, Program Manager
M. Lee, Program Scientist
Marshall Space Flight Center
C. Sprinkel, Mission Manager
D. Frazier, Mission Scientist

Status

USML-1 integrated payload Critical Design Review has been completed. Science investigations have been confirmed.

United States Microgravity Payload (USMP)

Objective

The United States Microgravity Payload (USMP) will perform materials processing and other experiments in the weightless (microgravity) space environment with in-flight monitoring of phenomena, sample production, and post-flight analysis of samples. Such activities are expected to advance significantly basic knowledge of materials science and fundamental science.

Description

USMP series of mixed cargo flights will employ flight-proven experiment support systems. The USMP carrier is derived from the Mission Peculiar Equipment Support Structure (MPRESS), was flown on the second Office of Space and Terrestrial Applications payload (OSTA-2). The power, data, and thermal control services developed for the Materials Science Laboratory-2 that flew on STS 61-C (January 1986) are also incorporated into the USMP carrier. The facilities on the carrier are exposed to the space environment, rather than being inside Spacelab's pressurized long module. Crew participation in the experiments is limited to activities that can be controlled remotely. A launch rate of one USMP flight per year has been requested to facilitate follow-ups on experimental results.

Launch Date:	USMP-1: September 1992 USMP-2: August 1993 USMP-3: 3rd Quarter FY 1994 USMP-4: 4th Quarter FY 1995 USMP-5: 3rd Quarter FY 1996
Payload:	Various microgravity science experiments mounted on the Materials Science Laboratory (MSL) Carrier and MPRESS
Orbit:	No special requirement
Design Life:	Variable
Length:	Approx. 3 m
Weight:	4,516 kg (10,035 lbs.)
Diameter:	4.6 m
Launch Vehicle:	Space Shuttle
Foreign Participation:	France

Investigations and Instruments

USMP-1

Lambda Point Experiment (LPE) - J. Lipa (Stanford University)

Material pour l'Etude des Phenomenes Interessant la Solidification sur Terre et en Orbite

(MEPHISTO) - J. Favier (Centre d'Etudes Nucleaires de Grenoble)

Space Acceleration Measurement System (SAMS) - R. DeLambard (LeRC)

Mission Events

Preliminary instrument design: Completed

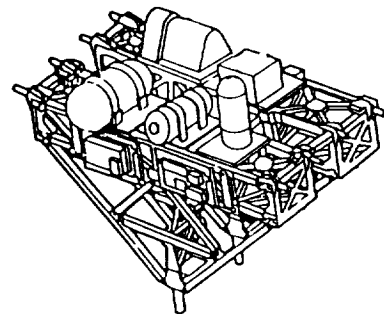
Mission concept, feasibility studies: Completed

Mission definition studies: Completed

Mission implementation: Ongoing

Instrument delivery to Kennedy Space Center: November 1991

Launch of USMP-1: June 1992



United States Microgravity Payload (USMP) (Continued)

Management

NASA Headquarters

D. Jarrett, Program Manager

M. Lee, Program Scientist

Marshall Space Flight Center

R. Valentine, Mission Manager

S. Lehoczky, Mission Scientist

Status

USMP-1

The USMP-1 payload includes: the *Lambda Point Experiment*, which will investigate the unique properties of liquid Helium as its temperature is changed through the superfluid region; the *Space Acceleration Measurements Systems (SAMS)*, which will measure and record disturbances in the microgravity environment of the USMP carrier; and *MEPHISTO*, a sophisticated materials science experiment provided by the French space agency (CNES).

The integrated payload Preliminary Design Review (PDR) was held in April 1990. The Payload Integration was signed in July 1990. The integrated payload Critical Design Review is scheduled for January 1991.

USMP-2

The USMP-2 payload includes: the *Advanced Automated Directional Solidification Furnace (AADSF)*, a device for growing electronic materials; the *Critical Fluid Light Scattering Experiment (CFLSE/Zeno)*, which will investigate the properties of Xenon during phase transitions; the *Isothermal Dendritic Growth Experiment (IDGE)*, will probe the fundamental behavior of materials as they solidify; the French *MEPHISTO* experiment; and the *SAMS* acceleration measurement package.

The integrated payload Preliminary Design Review is scheduled for February 1991. The integrated payload Critical Design Review is scheduled for August 1991.

USMP-3

The USMP-3 payload includes the *Shuttle Test of Relativity Experiment (STORE)*, which will test critical components of the proposed Gravity Probe-B mission, as well as reflights of the AADSF, SAMS and MEPHISTO experiments.

USMP-4

The USMP-4 payload includes reflights of the AADSF, IDGE, SAMS, and MEPHISTO experiments.

USMP-5

The USMP-5 payload includes the *Critical Fluid Viscosity Measurement Experiment (CFVME)*, which will investigate the changing viscosity of a test fluid as it undergoes its phase change, as well as reflights of the IDGE, SAMS, and MEPHISTO experiments.

Upper Atmosphere Research Satellite (UARS)

Objective

The Upper Atmosphere Research Satellite (UARS) will provide the global database necessary for understanding the coupled chemistry and dynamics of the stratosphere and mesosphere, the role of solar radiation in driving the chemistry and dynamics, and the susceptibility of the upper atmosphere to long-term changes in the concentration and distribution of key atmospheric constituents, particularly ozone. It is a crucial element of NASA's long term program in upper atmospheric research, a program initiated in response to concerns about stratospheric ozone depletion.

Description

UARS will provide the first integrated global measurements of the chemistry, dynamics, and energetics of the stratosphere, mesosphere, and lower thermosphere. The mission consists of a free-flying experiment with nine instruments dedicated to upper atmosphere research and one flight of opportunity instrument.

Launch Date:	December 1991
Payload:	10 instruments
Orbit:	600 km altitude, 57 degree inclination, circular
Design Life:	36 months
Length:	9.75 m
Weight:	6,818 kg
Diameter:	4.58 m
Launch Vehicle:	Space Shuttle
Foreign Participation:	Canada, France, United Kingdom

Investigations/Instruments

- Cryogenic Limb Array Etalon Spectrometer (CLAES) - A. Roche (Lockheed Palo Alto Research Laboratory)
- Improved Stratospheric and Mesospheric Sounder (ISAMS) - F. Taylor (Oxford University, England)
- Microwave Limb Sounder (MLS) - J. Waters (Jet Propulsion Laboratory)
- Halogen Occultation Experiment (HALOE) - J. Russell (LeRC)
- High Resolution Doppler Imager (HRDI) - P. Hays (University of Michigan)
- Wind Imaging Interferometer (WINDII) - G. Shepherd (York University, Canada)
- Solar Ultraviolet Spectral Irradiance Monitor (SUSIM) - G. Brueckner (Naval Research Laboratory)
- Solar/Stellar Irradiance Comparison Experiment (SOLSTICE) - G. Rottman (University of Colorado)
- Particle Environment Monitor (PEM) - J. Winningham (Southwest Research Institute)

Mission Events

- Announcement of Opportunity (AO): September 1978
- UARS Mission new start: FY 1985
- Initial instrument deliveries: January 1990

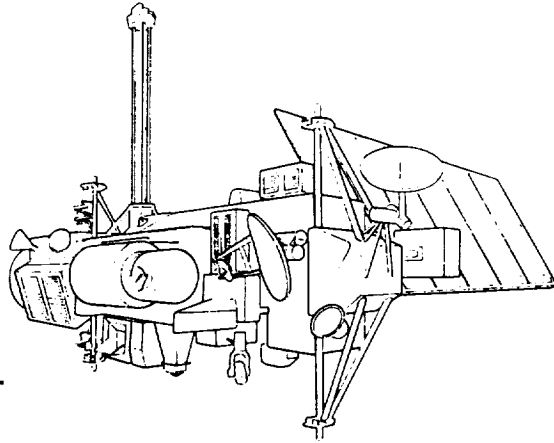
Upper Atmosphere Research Satellite (UARS) (Continued)

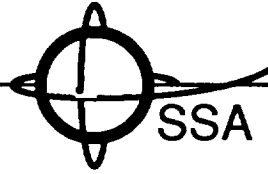
Management

NASA Headquarters
M. Luther, Program Manager
R. McNeal, Program Scientist
Goddard Space Flight Center
L. Gonzales, Project Manager
C. Reber, Project Scientist
Major Contractor
General Electric

Status

Final observatory integration and test underway.





On-Going Flight Projects

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Combined Release and Radiation Effects Satellite (CRRES)

Objective

The Combined Release and Radiation Effects Satellite (CRRES) will: 1) study effects of natural radiation and microelectronic devices; 2) characterize the geospace electrical, magnetic and radiation environment; 3) evaluate performance of gallium arsenide solar cells; 4) study interaction of plasmas with the magnetosphere; 5) study the coupling of the upper atmosphere with the ionosphere; and, 6) study the structure and chemistry of the ionosphere.

Description

CRRES is a joint project of NASA and the U.S. Air Force. The CRRES satellite contains five payloads which include experiments on high efficiency solar cells, ionospheric structure and chemistry, and radiation effects on microelectronic devices. The satellite also contains a NASA chemical payload which consists of 24 chemical canisters. These canisters will be ejected from the main spacecraft and release chemicals at specific times during the mission.

Launch Date:	July 25, 1990
Payload:	24 chemical canisters
Orbit:	348 km by 33,582 km, 18.1 degree inclination, elliptical
Design Life:	Greater than 1 year
Length:	2.2 m
Weight:	1,724 kg
Diameter:	2.6 m
Launch Vehicle:	Atlas/Centaur
Foreign Participation:	Germany

Instruments

High Efficiency Solar Panel Experiment (AFAPL-801) - T. Trumble (Wright Aeronautical Lab)
Space Radiation Experiment (AFGL-701) - E. Mullen (Air Force Geophysical Laboratory)
Diamagnetic Cavity, Plasma Coupling (GTO (G-1,2,3)) - R. Hoffman (GSFC)
Diamagnetic Cavity, Plasma Coupling (GTO (G-4)) - S. Mende (Jet Propulsion Laboratory)
Stimulated Electron Precipitation to Produce Auroras (GTO (G-5)) - G. Haerendel (Max Planck Institute); P. Bernhardt (Naval Research Lab)
Stimulated Ion-Cyclotron Waves and Ion Precipitation (GTO (G-6)) - S. Mende (Lockheed Palo Alto Research Laboratory)
Ion Tracing and Acceleration (GTO (G-7)) - W. Peterson (Lockheed Palo Alto Research Laboratory)
Gravitational Instability, Field Equipotentiality (GTO (G-8)) - G. Haerendel (Max Planck Institute)
Velocity Distribution Relaxation and Field Equipotentiality (GTO (G-9)) - M. Pogrutz (Los Alamos National Laboratory); E. Westcott (University of Alaska)
Stimulating a Magnetospheric Substorm (GTO (G-10)) - D. Simons (Los Alamos National Laboratory)
Mirror Force, Field Equipotentiality, Ambipolar Acceleration (GTO (G-11,12)) - E. Westcott (University of Alaska)
Critical Velocity Ionization (GTO (G-13,14)) - E. Westcott (University of Alaska)
Low Altitude Satellite Studies of Ionospheric Irregularities (NRL-701) - P. Rodrigues (Naval Research Lab)
Heavy Ions Experiment (ONR-307) - R. Vondrak (Lockheed Palo Alto Research Lab)
Isotopes in Solar Flares (ONR-604) - J. Simpson (University of Chicago)

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Combined Release and Radiation Effects Satellite (CRRES) (Continued)

Instruments (Continued)

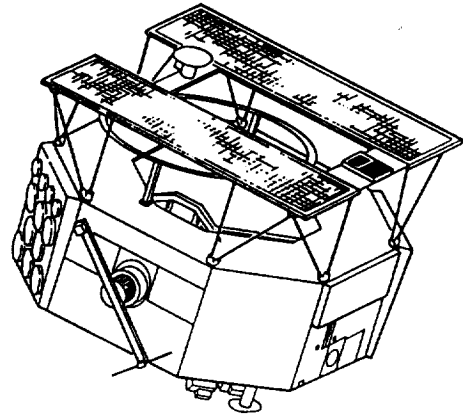
F-Region Irregularity Evolution (SR, AA-1) - F. Djuth (Aerospace Corporation); H. Carlson (Air Force Geophysical Laboratory)
HF Ionospheric Modification of a Barium Plasma (SR, AA-2) -F. Djuth (Aerospace Corporation); L. Duncan (Clemson University)
HF-Induced Ionospheric Striations and Different Ion Expansion (SR, AA-3A)-L. Duncan (Clemson University)
HF-Induced Ionospheric Striations and Different Ion Expansion (SR, AA-3B) - E. Szuszczewicz (Science Applications International Corporation)
Ionospheric Focused Heating (SR, AA-4) - P. Bernhardt (Naval Research Lab)
Equatorial Instability Seeding (SR, AA-5,6) - M. Mendillo (Boston University)
E-Region Image Formation (SR, AA-7) - H. Carlson (Air Force Geophysical Lab)

Mission Events

Chemical releases are planned for January/February 1991 over Northern Canada and July/August 1991 over the Caribbean
End of mission: Fall 1993

Management

NASA Headquarters
R. Howard, Program Manager
D. Evans, Program Scientist
Marshall Space Flight Center
T. Little, Project Manager
D. Reasoner, Project Scientist
Major Contractors
Ball Corporation, Aerospace Systems Division



Status

The CRRES spacecraft was originally configured for launch on the Space Shuttle. The spacecraft has been reconfigured for launch on an Atlas/Centaur. Spacecraft was delivered to the Kennedy Space Center in March 1990. CRRES was successfully launched on July 25, 1990. First two canister releases were successfully conducted on September 1990. Spacecraft is performing nominal, Department of Defense experiments have been turned on and checked out. 53 instruments are operating as expected.

Cosmic Background Explorer (COBE)

Objective

The Cosmic Background Explorer (COBE) will: 1) investigate the beginnings of organization of matter into galaxies, voids and clusters of galaxies following the Big Bang; 2) examine departures from perfect uniformity that must have occurred shortly after the Big Bang, appearing as spectral irregularities and anisotropy in the microwave and far infrared cosmic background radiation; and, 3) search for the accumulated light from the very first stars and galaxies.

Description

The Cosmic Background Explorer (COBE) is a free-flying Explorer mission that will survey the sky for diffuse emissions in the wavelength range from 1 micrometer (μm) to 1 centimeter. At long wavelengths, the Far Infrared Absolute Spectrophotometer (FIRAS) measures the spectrum of the cosmic microwave background while the Differential Microwave Radiometer (DMR) measures the anisotropy. At shorter wavelengths, the search for the first stars and galaxies is conducted by the Diffuse Infrared Background Experiment (DIRBE). FIRAS and DIRBE are cooled to near absolute zero inside the observatory's dewar of liquid helium. The receivers of the DMR are mounted between the dewar and COBE's deployable radio frequency/thermal shield. COBE was developed "in-house" at the Goddard Space Flight Center (GSFC) with subsystems procured from private industry.

Launch Date:	November 18, 1989
Payload:	3 instruments
Orbit:	900 km altitude, 99 degree inclination
Design Life:	1 year (dewar coolant lifetime)
Length:	2.2/5.4 m (stowed/deployed)
Weight:	2,206 kg
Diameter:	2.2/8.4 m (stowed/deployed)
Launch Vehicle:	Delta 5920
Foreign Participation:	None

Instruments

Far Infrared Absolute Spectrophotometer (FIRAS) - J. Mather (GSFC)
Differential Microwave Radiometer (DMR) - G. Smoot (GSFC)
Diffuse Infrared Background Experiment (DIRBE) - M. Hauser (GSFC)

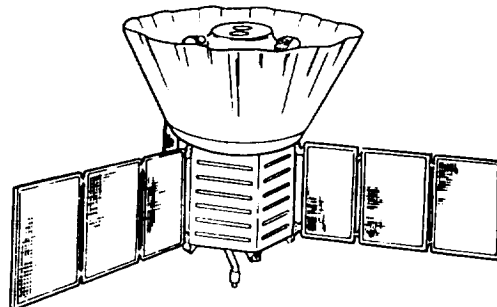
Mission Events

Launch: November 18, 1989
Completion of all-sky survey: June 18, 1990
Helium Depletion: September 21, 1990

Management

NASA Headquarters
G. Riegler, Program Manager
L. Caroff, Program Scientist
Goddard Space Flight Center
R. Sanford, Project Manager
J. Mather, Project Scientist
Major Contractor

COBE is an in-house project with GSFC serving in the role of the systems contractor.



Cosmic Background Explorer (COBE) (Continued)

Status

COBE was launched successfully on November 18, 1989. COBE completed its first all-sky survey on June 18, 1990. On September 21, 1990, COBE's supply of cryogenic helium coolant was depleted. Four of the ten channels of DIRBE, and the DMR will continue to operate for a second year. An extension of the COBE mission for a third year is under review.

Galileo

Objective

Galileo will investigate the chemical composition and physical state of Jupiter's atmosphere and satellites and will investigate the structure and physical dynamics of Jupiter's magnetosphere.

Description

An instrumented probe will enter the Jovian atmosphere and take *in situ* measurements for at least 60 minutes, down to a pressure level of 10 bars, and relay its data to the Orbiter for real-time transmission to Earth. The Orbiter will then be injected into a highly elliptical orbit around Jupiter. The four major Jovian satellites – Io, Europa, Ganymede, and Callisto – will be studied in detail.

Launch Date:	October 18, 1989
Payload:	11 instruments on orbiter and 6 instruments on probe
Orbit:	Dual-spin orbiter for stabilization
Design Life:	> 6 years to Jupiter, at least 22 months of study (mission duration) by orbiter, 1 hour of probe data
Length:	9 m
Weight:	2,668 kg
Diameter:	4.8 m (antenna)
Launch Vehicle:	Space Shuttle/Inertial Upper Stage
Foreign Participation:	Germany

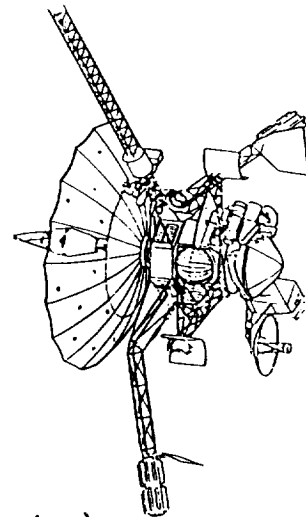
Investigations/Instruments

Probe

Atmospheric Structure - A. Seiff (ARC)
Neutral Mass Spectrometer - H. Niemann (GSFC)
Helium Abundance - U. von Zahn (University of Bonn, Germany)
Net Flux Radiometer - L. Stromovsky (University of Wisconsin)
Lightning/Energetic Particles - L. Lanzerotti (Bell Laboratories)
Nephelometer - B. Ragert (Ames)

Orbiter

Solid-State Imaging Camera - M. Belton (NOAO)
Near-Infrared Mapping Spectrometer - R. Carlson (Jet Propulsion Laboratory)
Ultraviolet Spectrometer - C. Hord (University of Colorado)
Photopolarimeter Radiometer - J. Hanssen (Goddard Institute of Space Science)
Magnetometer - M. Kivelson (University of California, Los Angeles)
Energetic Particles - D. Williams (Johns Hopkins Applied Physics Laboratory)
Plasma - L. Frank (University of Iowa)
Plasma Wave - D. Gurnett (University of Iowa)
Dust - E. Grun (Max Planck Institute, Germany)
High-Energy Ion Counter - E. Stone (California Institute of Technology)
Extreme Ultraviolet Spectrometer - L. Broadfoot (University of Arizona)
Radio Science: Celestial Mechanics - F. Anderson (Jet Propulsion Laboratory)
Radio Science: Propagation - H. Howard (Stanford University)



Galileo (Continued)

Mission Events

Venus Flyby: February 1990
Earth Flyby 1: December 1990
Gaspra Encounter: October 1991
Earth Flyby 2: December 1992
Ida Encounter: August 1993
Jupiter Arrival: December 1995
End of Mission: October 1997

Management

NASA Headquarters

E. Beyer, Program Manager
W. Quaide, Program Scientist

Jet Propulsion Laboratory

W. O'Neil, Project Manager
T. Johnson, Project Scientist

Ames Research Center

B. Chin

Major Contractors

DFVLR (Germany)
Hughes Aircraft
Messerschmitt-Boelkow-Blohm (MBB) (Germany)

Status

The Galileo spacecraft, a combined orbiter and atmospheric probe, was successfully launched from the Kennedy Space Center on October 18, 1989 by the Space Shuttle Atlantis. After deployment from the Shuttle cargo bay, an Inertial Upper Stage placed the spacecraft on a near perfect trajectory toward the planet Venus and the beginning of its 6-year journey to Jupiter.

After injection into the Venus trajectory and a preliminary assessment of the orbiter engineering subsystems, the probe (including its six science instruments), was successfully tested. The probe's power was then turned off; it will remain in this state during the cruise phase of the mission, except for annual retesting. The orbiter instruments were thoroughly tested 2 months later.

On February 10, 1990, the spacecraft passed within 10,000 miles of Venus where it received the first of three gravity assists. Galileo will conduct two close-up observations of asteroids and two earth/moon flybys enroute to Jupiter. In December 1995, Galileo will begin a 22-month investigation of the Jovian system with injection of the instrumented probe into the planet's atmosphere.

Hubble Space Telescope (HST)

Objective

The Hubble Space Telescope (HST) will: 1) investigate the constitution, physical characteristics, and dynamics of celestial bodies; 2) determine the nature of processes occurring in stellar and galactic objects; 3) study the history and evolution of the universe; and, 4) confirm universality of physical laws.

Description

HST, the first of the Great Observatories, will provide coverage of the visible and ultraviolet portions of the electromagnetic spectrum. It is a free-flying observatory with a 15-year operational lifetime achieved through on-orbit servicing. HST has a 2.4-meter optical telescope with a cluster of Principle Investigator-developed scientific instruments (Wide Field/Planetary Camera, Faint Object Camera, Faint Object Spectrograph, Goddard High Resolution Spectrograph and High Speed Photometer) at its focal plane. The European Space Agency (ESA) provided one of the science instruments (the Faint Object Camera), the solar arrays and operational support to the program. HST science instruments are replaceable to maintain state-of-the-art performance. A subsequent payload may include cryogenically cooled detectors in the near infrared portion of the electromagnetic spectrum.

Launch Date:	April 24, 1990
Payload:	5 instruments
Orbit:	620 km altitude, 28.5 degree inclination, circular
Design Life:	15 years (with servicing)
Length:	13.1 m
Weight:	11,000 kg
Diameter:	4.3 m
Launch Vehicle:	Space Shuttle
Foreign Participation:	European Space Agency

Instruments

Faint Object Camera (FOC) - D. Macchetto (European Space Agency)

Faint Object Spectrograph (FOS) - D. Harms (ARC)

Goddard High Resolution Spectrometer (GHRS) - J. Brandt (University of Colorado)

High Speed Photometer (HSP) - R. Bless (University of Wisconsin)

Wide Field/Planetary Camera (WF/PC) - J. Westphal (California Institute of Technology)

Mission Events

Launch and deployment: April 24, 1990

Servicing mission and potential reboost: July 1993

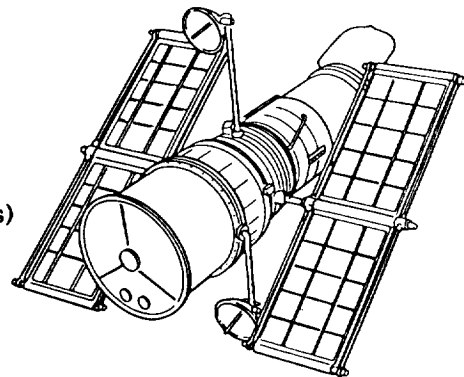
Management

NASA Headquarters

D. Broome, Program Manager

D. McCarthy, Deputy Program Manager (Operations)

E. Weiler, Program Scientist



Hubble Space Telescope (HST) (Continued)

Management (Continued)

Marshall Space Flight Center

F. Wojtalik, Project Manager

Goddard Space Flight Center

J. Rothenberg, Project Director

A. Merwarth, Project Manager (Operations)

F. Ceppolina, Project Manager (Flight Systems & Servicing)

A. Boggess, Project Scientist

Major Contractors

Lockheed Missiles and Space Company

Hughes Danbury Optical Systems (Formerly Perkin-Elmer)

Space Telescope Science Institute

Status

HST was successfully launched on the Space Shuttle Discovery on April 24, 1990. During HST's on-orbit verification period, a problem in the optical system was identified. This problem results in spherical aberration, the inability of HST's mirrors to concentrate light at a single focus.

HST's scientific capabilities are limited by the spherical aberration only for faint objects or objects in very crowded fields. For brighter objects, the effects of the spherical aberration are minimal; HST fully meets its spatial resolution specification for these objects. The scientific effects of the aberration will be significantly reduced or eliminated as part of a planned servicing mission scheduled for 1993.

Magellan

Objective

Magellan will: 1) improve knowledge of the surface tectonics and geologic history of Venus by analyzing the surface morphology and the processes that control it; 2) improve knowledge of the geophysics of Venus, principally its density distribution and dynamics; 3) improve knowledge of the small-scale physics of the planet; 4) obtain global imagery to better than 1 km resolution; and, 5) obtain topography to 50 meter resolution.

Description

The Magellan spacecraft was launched on May 4, 1989, by the Space Shuttle and Inertial Upper Stage on an interplanetary trajectory to Venus. The selected trajectory has a heliocentric transfer angle slightly greater than 540 degrees and requires 15 months of flight time. Upon arrival at Venus on August 10, 1990, the spacecraft used its solid rocket motor to enter an elliptical near-polar orbit around Venus. During a Prime Mission mapping period of 8 months, the Synthetic Aperture Radar (SAR) will obtain radar images of 70 to 90 percent of the planet, with a resolution about ten times better than that achieved by the Soviets' earlier Venera 15 and 16 missions. Precise radio tracking of the spacecraft will provide gravity information. The resulting geological maps will permit the first global geological analysis of the planet.

Launch Date:	May 4, 1989
Payload:	1 instrument (Radar Sensor)
Orbit:	Elliptical with 250 km periapsis, 3.15 hr-period, 86 degree inclination
Design Life:	3 years
Length:	6.4 m with Solid Rocket Motor
Weight:	Injected Mass 3,450 kg; on-orbit dry mass 1,035 kg
Diameter:	3.7 m
Launch Vehicle:	Space Shuttle/2-stage Inertial Upper Stage
Foreign Participation:	Australia, France, United Kingdom

Instrument

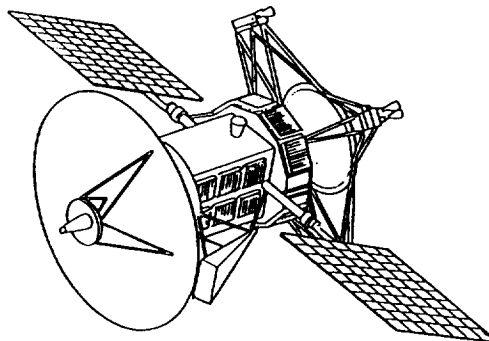
Synthetic Aperture Radar (SAR) - G. Pettengill (Massachusetts Institute of Technology)

Mission Events

Venus orbit insertion: August 10, 1990
Start mapping: September 1, 1990
End nominal mapping mission: May 1991

Management

NASA Headquarters
E. Beyer, Program Manager
J. Boyce, Program Scientist
Jet Propulsion Laboratory
A. Spear, Project Manager
R. Saunders, Project Scientist
Major Contractors
Martin Marietta
Hughes Aircraft Co.



Magellan (Continued)

Status

Magellan was launched on May 4, 1989, by the Space Shuttle and an Inertial Upper Stage (IUS) on an interplanetary trajectory to Venus. Assembly and test of the spacecraft prior to launch demonstrated all the functional elements of the system, but substantial development has continued after launch in preparation for mapping operations. An initial test of the radar instrument during the cruise phase of Magellan's mission was completed in December 1989, and a full simulation of mapping operations was conducted in May 1990. Venus Orbit Insertion (VOI) occurred on August 10, 1990. Standard mapping began on September 15, 1990. The first full mapping cycle is scheduled to continue for 243 days. Since VOI, the spacecraft has experienced problems which result in the spacecraft entering a safe mode and the loss of mapping orbits. Even so, Magellan is expecting to reach the first cycle goal of mapping 70 percent of Venus.

Roentgen Satellite (ROSAT)

Objective

The Roentgen Satellite (ROSAT) will: 1) study coronal x-ray emission from stars of all spectral types; 2) detect and map x-ray emission from galactic supernova remnants; 3) evaluate the overall spatial and source count distributions for various x-ray sources; 4) perform detailed study of various populations of active galaxy sources (Seyferts, Quasars, etc); 5) perform morphological study of the x-ray emitting clusters of galaxies; and, 6) perform detailed mapping of the local interstellar medium (by the extreme ultraviolet (XUV) survey).

Description

ROSAT is an Earth-orbiting x-ray observatory orbiting at a 57 degree inclination and 580 km altitude. It has a fourfold nested grazing incidence mirror system with 83 centimeter aperture and 240 centimeter focal length, and covers the wavelength range from 0.1 to 2.0 thousand electron volts (keV). The ROSAT expected lifetime is approximately 2.5 years. This mission is a cooperative NASA/United Kingdom/Germany x-ray astronomy mission viewed by NASA as a stepping stone toward the Advanced X-ray Astrophysics Facility (AXAF). Germany is building the spacecraft and main telescope, the United Kingdom is providing a wide field camera, and NASA is providing the High Resolution Imager (HRI) and launch services.

Launch Date:	June 1, 1990
Payload:	4 Instruments
Orbit:	580 km altitude, 57 degree inclination
Design Life:	2.5 years
Length:	4.5 m (at launch)
Weight:	2,424 kg
Diameter:	3m
Launch Vehicle:	Delta II
Foreign Participation:	Germany, United Kingdom

Instruments

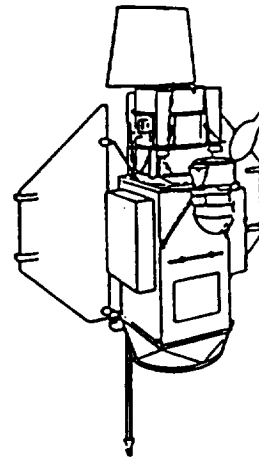
High Resolution Imager (HRI) - M. Zombeck (Smithsonian Astrophysical Observatory)
Position-Sensitive Proportional Counters (PSPC's) - J. Truemper (Max Plank Institute)
Wide-Field Camera (WFC) - K. Pounds (University of Leicester)

Mission Events

Launch: June 1, 1990
In-orbit Checkout Complete: July 30, 1990
Survey Phase Complete: January 1991

Management

NASA Headquarters
G. Riegler, Program Manager (Operations)
A. Bunner, Program Scientist
Goddard Space Flight Center
G. Ousley, Project Manager
S. Holt, Project Scientist
Major Contractors
Dornier systems



Status

ROSAT was successfully launched on June 1, 1990. The observatory has completed its in-orbit checkout and is currently into the 6-month survey phase.

Ulysses

Objective

Ulysses will perform investigations as a function of solar latitude of the following: 1) the physics of the outer corona of the Sun; 2) the origin and acceleration of the solar wind; 3) the internal dynamics of the solar wind, shock waves, and other discontinuities; 4) the propagation, composition and acceleration of energetic particles; 5) the energy spectra, composition, isotopes and anisotropes of the heliosphere; and 6) source locations of interstellar gamma rays.

Description

Ulysses, formerly known as the International Solar Polar Mission (ISPM), has been launched into a trajectory to intercept Jupiter and use its gravity well to leave the ecliptic plane and achieve high latitudes (above 70 degrees) relative to the Sun. Ulysses will assume a heliocentric orbit of 5 Astronomical Units (AU) by 1.3 AU. The European Space Agency (ESA) provided the spacecraft, five of nine instruments, and was responsible for instrument integration. The United States provided the launch vehicle, Radioisotope Thermoelectric Generator (RTG) power source, four science instruments, and mission operations facilities.

Launch Date:	October 6, 1990
Payload:	9 instruments
Investigations:	40
Orbit:	Heliocentric, 5 x 1.3 AU
Design Life:	5 years (mission duration)
Length:	2.2 m
Weight:	365.9 kg
Diameter:	4.1 m (including booms)
Launch Vehicle:	Space Shuttle/Inertial Upper Stage/Payload Assistant Module
Foreign Participation:	European Space Agency

Investigations/Instruments

Magnetic Field Measurements (HED) - A. Balogh (Imperial College of Science and Technology, England)

Solar Wind Plasma (BAM) - S. Bame (Los Alamos National Laboratory)

Solar-Wind Ion Composition (GLG) - G. Gloeckler (University of Maryland)

Cosmic Ray and Solar Charged Particle (SIM) - J. Simpson (University of Chicago)

Low Energy Charged Particle (LAN) - J. Lanzerotti (Bell Laboratories)

Radio and Plasma Wave Experiment (STO) - R. Stone (GSFC)

Medium Energy Isotopic Particle Detection (KEP) - E. Keppler (Max Planck Institute)

Solar X-rays and Cosmic Gamma-Ray Burst Experiment (HUS) - K. Hurley (CNES, France)

Cosmic Dust Experiment (GRU) - E. Grun (Max Planck Institute)

Radio Science (RSI) - H. Volland (University of Bonn, Germany)

Gravitational Wave (GWE) - B. Bertotti (University of Pavia, Italy)

Mission Events

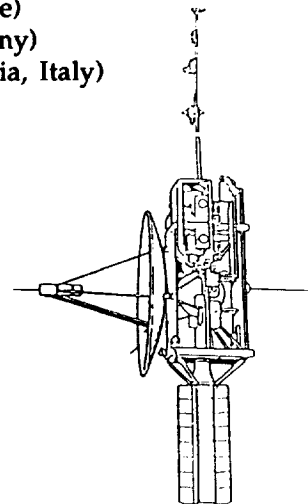
Launch: October 6, 1990

Jupiter encounter: February 1992

First polar pass of the Sun: May - September 1994

Second polar pass of the Sun: May - September 1995

End of Mission: December 1995



Ulysses (Continued)

Management

NASA Headquarters

R. Murray, Program Manager

V. Jones, Program Scientist

Jet Propulsion Laboratory

W. Meeks, Project Manager

E. Smith, Project Scientist

European Space Agency (ESA)

D. Eaton, Project Manager

P.-K. Wenzel, Project Scientist

Major Contractors

Dornier (Germany)

Status

The Ulysses spacecraft was launched on October 6, 1990 by the Space Shuttle Discovery and is on its way to Jupiter.

Ulysses was launched on a Shuttle/Inertial Upper Stage/Payload Assist Module (PAM-S) combination on October 6, 1990. After launch, the Inertial Upper Stage and PAM-S directed Ulysses on a trajectory toward Jupiter. Upon reaching Jupiter, Ulysses will be projected out of the elliptic plane and directed toward the Sun's southern pole. Ulysses will conduct its investigation of the higher latitudes of the Sun's southern pole for 5 months beginning in May 1994. Investigations of the Sun's other regions will follow. The conclusion of Ulysses' mission will occur in September 1995 at the Sun's northern pole.



Major Events

MAJOR EVENTS SPACE SCIENCE AND APPLICATIONS

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1990		Galileo Venus Flyby ▲ Voyager Lookback ▲		HST ■ PEGSAT ●		COBE Completes First Sky Survey ▲ ROSAT ●	CRRES ●	Magellan Arrival At Venus ▲		Ulysses/SSBUV-2 ■		Astro/BBXRT ■ Galileo at Earth ▲
1991				GRO ■	SLS-1 ■ NOAA-D ●					Galileo Gaspra Flyby ▲	UARS ■	NOAAH ● EUVE ● IML-1 ■
1992		Ulysses Jupiter Flyby ▲ GOES-1 ●	TSS-1 ■	ATLAS-1/SSBUV-4 ■		TOPEX/POSEIDON ● SAMPEX ● USML-1 ■	Geotail ●	ACTSDXS ■	LAGEOS II/USMP-1 ■ SL-J ■ Mars Observer ●	GOES-J ●		Wind ●
1993	ASTRO-SPAS ORFEUS ■	SL-D2 ■		ATLAS-2/SSBUV-A-1 ■		SLS-2 ■ Polar ●		USMP-2 Mars Observer ■ Arrival At Mars ▲ Galileo Ida Flyby ▲		UTE 1 ■		HST Revisit ■
1994	ATLAS-3/ASTRO-SPAS CRISTA/SSBUV-A-2 ■			IML-2 ■	USMP-3/STORE ■	RADARSAT ●	NOAA-K ●	Ulysses Over Sun's South Pole ▲	FAST ●	SRL-2 ■		XTE ■
1995	ATLAS-4/WISP/SSBUV-A-3 ■	USML-2 ■		SL-D3 ■		SWAS ● Ulysses Over Sun's North Pole ▲	SOHO ● GOES-K ●	USMP-4/STORE ■	SSF/MB-01 ■			Galileo Arrival At Jupiter ▲
1996	SRL-3 ■ Small Explorer-4 ●	CRAF ●	SSF/MB-03 ■		USMP-5 ■ LilleSat ● NOAA-L ●		SSF/MB-05 ■					

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■ SPACE SHUTTLE LAUNCHES ● EXPENDABLE LAUNCH VEHICLE LAUNCHES ▲ OTHER MAJOR EVENTS

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Acronym List

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1990 Office of Space Science and Applications Acronym List

Acronym	Description
AADSF	Advanced Automated Directional Solidification Furnace
AC	Alternating Current
ACE	Advance Composition Explorer
ACTS	Advanced Communications Technology Satellite
ADEOS	Advanced Earth Observation System (Japan)
AGN	Active Galactic Nuclei
ALT	RADAR (or LASER) Altimeter
AMIE	Airglow Measurements of Infrared Measurements Emissions
AO	Announcement of Opportunity
AOS	Acou-to-optical Spectrometer
Approx	Approximately
ARC	Ames Research Center
ARISTOTELES	Applications and Research Involving Space Technologies Observing Earth's Field from Low Orbiting Satellite
ASI	Italian Space Agency (Agenzia Spaziale Italiano)
ASM	All-Sky Monitor
ATLAS	Atmospheric Laboratory for Applications and Science
ATMOS	Atmospheric Trace Molecules Observed by Spectroscopy
AU	Astronomical Unit [Average Distance Between Earth and the Sun]
AXAF	Advanced X-ray Astrophysics Facility
BATSE	Burst And Transient Source Experiment
BBXRT	Broad Band X-ray Telescope
BMFT	Federal Ministry for Research and Technology (Germany)
CESR	Center d'Etude Spatiale des Rayonnements
CDR	Critical Design Review
CFLSE	Critical Fluid Light Scattering Experiment
CFVME	Critical Fluid Viscosity Measurement Experiment
CIP	Coordinates Instrument Package
CIR	Cargo Integration Review
CITE	Cargo Integration Test Equipment
CNES	French Space Agency (Centre National d'Etudes Spatiales)
CRPE	Center de Recherche en Physique d'Enviornnant Terrestres et Planetaires
COBE	Cosmic Background Explorer
COMPTEL	Imaging Compton Telescope
COSTR	Collaborative Solar-Terrestrial Research Program
CRAF	Comet Rendezvous Asteroid Flyby
CRISTA	Cryogenic Infrared Spectrometer Telescope for Atmosphere/Exploration Variability
CNET	Centre National d'Etude des Telecommunications
CRRES	Combined Release and Radiation Effects Satellite
CSA	Canadian Space Agency
CY	Calendar Year
CZCS	Coastal Zone Color Scanner
DARA	German Space Agency
DC	Direct Current
DIRBE	Diffuse Infrared Background Experiment
DLR	Aerospace Research Establishment (Germany)
DMR	Differential Microwave Radiometer

Acronym	Description
DSN	Deep Space Network
DXS	Diffuse X-ray Spectrometer
EDO	Extended Duration Orbiter
EGRET	Energetic Gamma Ray Experiment
ELV	Expendable Launch Vehicle
EOS	Earth Observing System
EOSAT	Earth Observation Satellite Corporation
EOSDIS	EOS Data and Information Systems
EOSSMS	EOS Space Measurement System
ESA	European Space Agency
ESTEC	European Space Research and Technology Center
EUV	Extreme Ultraviolet
EUVE	Extreme Ultraviolet Explorer
EVT	Experimental Verification Tests
FAST	Fast Auroral Snapshot Explorer
FIRAS	Far Infrared Absolute Spectrophotometer
FUSE	Far Ultraviolet Spectroscopic Explorer
FY	Fiscal Year
g	Gravity
GE	General Electric
GGS	Global Geospace Science Program
GHz	Gegahertz
GOES	Geostationary Operational Environmental Satellites
GP-B	Gravity Probe-B
GPTU	General Purpose Transfer Unit
GPWS	General Purpose Work Station
GRO	Gamma-Ray Observatory
GSFC	Goddard Space Flight Center
H-II	Japanese Launch Vehicle for Earth Probe
HEAO	High Energy Astronomy Observatory, Einstein Observatory
HRI	High Resolution Imager
HRMA	High Resolution Mirror Assembly
HST	Hubble Space Telescope
IAM	Interface Adapter Module
IDGE	Isothermal Dendritic Growth Experiment
IKI	Space Research Institute (U.S.S.R.)
IMAPS	Interstellar Medium Absorption Profile Spectrograph
IML	International Microgravity Laboratory
incl.	Inclination
IPS	Instrument Pointing System
IR	Infrared
IRAC	Infrared Array Camera
IRAS	Infrared Astronomical Satellite
IRIS	Italian Research Interim Stage
IRS	Infrared Spectrometer
ISAS	Institute of Space and Astronautical Sciences (Japan)
ISPM	International Solar Polar Mission
IUS	Inertial Upper Stage
JGOFS	Joint Global Ocean Flux Study
JPL	Jet Propulsion Laboratory
JSC	Johnson Space Center
K	Kelvin
keV	Thousand Electron Volts
kg	Kilogram
km	Kilometer

Acronym	Description
KSC	Kennedy Space Center
L ₁	Sun-Earth Lagrangian Point
LA	Letter Agreement
LAGEOS II	Laser Geodynamics Satellite II
LaRC	Langley Research Center
LAS	LAGEOS Apogee Stage
lbs	Pounds
LeRC	Lewis Research Center
LIDAR	Light Detection and Ranging
LIFESAT	Reusable Reentry Satellite
LITE	LIDAR In-Space Technology Experiment
LO	Lunar Observer
m	Meter
M3S-II	Japanese Launch Vehicle for SOX/Astro-D Mission
MAG	Magnetometer
MAPS	Measurement of Air Pollution from Satellites
MBB	Messerschmitt-Boelkow-Blohm (Germany)
MeV	Million Electron Volts
MFE	Magnetic Field Experiments
MHz	Megahertz
MIPS	Multi-band Imaging Photometer
MIT	Massachusetts Institute of Technology
mm	Millimeter
MOU	Memorandum of Understanding
MPESP	Mission Peculiar Environment Support Structure
MSAT	Mobile Satellite
MSFC	Marshall Space Flight Center
MSL	Materials Science Laboratory
N/A	Not Applicable
NAR	Non-Advocate Review
NASA	National Aeronautics and Space Administration
NASDA	National Space Development Agency of Japan
nm	Nautical Miles
NOAA	National Oceanographic and Atmospheric Administration
NRL	Naval Research Laboratory
NSCAT	NASA Scatterometer
OAET	Office of Aeronautics, Exploration and Technology
ORFEUS	Orbiting and Retrievable Far and Extreme Ultraviolet Spectrometer
OSL	Orbiting Solar Laboratory
OSSA	Office of Space Science and Applications
OSSE	Oriented Scintillation Spectrometer Experiment
OSTA	Office of Space and Terrestrial Applications
OV	Orbital Verification
PAM-S	Payload Assist Module
PCA	Proportional Counter Array
PDR	Preliminary Design Review
PI	Principal Investigator
PID	Payload Integration Plan
PIP	Payload Integration Plan
PMS	Physiological Monitoring Systems
POCC	Payload Operations Control Center
POES	Polar Orbiting Environmental Satellites
RADARSAT	Radar Satellite
RAHF	Research Animal Holding Facility
RFP	Request for Proposal

Acronym	Description
RIM	Refrigerator/Incubator Module
RMS	Remote Manipulator System
rms	Root Mean Square
ROSAT	Roentegen Satellite
RTG	Radioisotope Thermoelectric Generator
SAO	Smithsonian Astrophysics Observatory
SAMPEX	Solar, Anamalous, Magnetospheric Particle Explorer
SAMS	Space Acceleration Measurements Systems
SAR	Synthetic Aperture (Imaging) Radar
SAS	Small Astronomy Satellite
SeaWiFS	Sea-Viewing Wide Field Sensor
SHEAL	Shuttle High Energy Astrophysics Laboratory
SIR-C	Shuttle Imaging Radar
SIRTF	Space Infrared Telescope Facility
SL - J	Spacelab J
SLS	Spacelab Life Sciences
SMEX	Small Class Explorers
SMMI	Small Mass Measurement Instrument
SOFIA	Stratospheric Observatory for Infrared Astronomy
SOHO	Solar and Heliospheric Observatory Mission
SPAS	Shuttle Pallet Satellite
SPOC	Shuttle Payload of Opportunity Carrier
SRL	Space Radar Laboratory
SSBUV	Shuttle Solar Backscatter Ultraviolet
SSR	Science Status Review
STORE	Shuttle Test of Relativity Experiment
STScI	Space Telescope Science Institute
SV	Science Verification
SWAS	Submillimeter Wave Astronomy Satellite
TAPS	Two-Axis Pointing System
TBD	To Be Determined
TDRSS	Tracking and Data Relay Satellite System
TEM	Technical Exchange Meeting
TES	Thermal Emission Spectrometer
TOGA	Tropical Ocean Global Atmospheric
TOMS	Total Ozone Mapping Spectrometer
TOPEX	Ocean Topography Experiment
TOPO	Global Topographic Mapping Mission
TOS	Transfer Orbit Stage
TRMM	Tropical Rainfall Measuring Mission
TSS	Tethered Satellite System
UARS	Upper Atmosphere Research Satellite
USML	United States Microgravity Laboratory
USMP	United States Microgravity Payload
UV	Ultraviolet
VIMS	Visual and Infrared Mapping Spectrometer
VLBI	Very Long Baseline Interferometry
VOI	Venus Orbit Insertion
VOSTOK	U.S.S.R. Launch Vehicle for COSMOS Program
WOCE	World Ocean Circulation Experiment
X-SAR	X-band Synthetic Aperture Radar
XGRS	X-ray/Gamma-ray Spectrometer
XTE	X-ray Timing Explorer
XUV	Extreme Ultraviolet
µm	Micrometer

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