NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

SPACE SHUTTLE MISSION STS-66

PRESS KIT NOVEMBER 1994

Atmospheric Laboratory for Applications and Science-3 (ATLAS-3)
Cryogenic Infrared Spectrometers and Telescopes for the Atmosphere - Shuttle Pallet Satellite (CRISTA-SPAS)

STS-66 INSIGNIA

STS066-S-001 -- Designed by the crewmembers, the STS-66 insignia depicts the space shuttle Atlantis launching into Earth orbit to study global environmental change. The payload for the Atmospheric Laboratory for Applications and Science (ATLAS-3) and complementary experiments are part of a continuing study of the atmosphere and the Sun's influence on it. The space shuttle is trailed by gold plumes representing the astronaut symbol and is superimposed over Earth, much of which is visible from the flight's high inclination orbit. Sensitive instruments aboard the ATLAS pallet in the shuttle payload bay and on the free-flying Cryogenic Infrared Spectrometers and Telescopes for the Atmospheric-Shuttle Pallet Satellite (CHRISTA-SPAS) will gaze down on Earth and toward the Sun, illustrated by the stylized sunrise and visible spectrum.

The NASA insignia design for space shuttle flights is reserved for use by the astronauts and for other official use as the NASA Administrator may authorize. Public availability has been approved only in the form of illustrations by the various news media. When and if there is any change in this policy, which we do not anticipate, it will be publicly announced.

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RELEASE: 94-175

ATMOSPHERIC LABORATORY MAKES THIRD FLIGHT

NASA will continue to study how the Earth's environment is changing and how human beings affect that change during the upcoming flight of Space Shuttle Atlantis. STS-66, the third flight of the Atmospheric Laboratory for Applications and Science (ATLAS), is part of NASA's Mission to Planet Earth, a coordinated research effort to comprehensively study the planet's environment. Also during the STS-66 mission, astronauts will deploy and retrieve a free-flying satellite designed to study the middle and lower thermospheres and will perform a series of experiments covering life sciences research and microgravity processing.

The STS-66 crew will be commanded by Donald R. (Don) McMonagle who will be making his third Shuttle flight. Curtis L. (Curt) Brown will serve as pilot and will be making his second flight. The four STS-66 mission specialists aboard Atlantis will include Ellen Ochoa, the STS-66 Payload Commander and Mission Specialist-1, who will be making her second flight, Joseph R. (Joe) Tanner, Mission Specialist-2, Jean-Francois Clervoy, Mission Specialist-3, and a European Space Agency astronaut, and Scott E. Parazynski, Mission Specialist-4. Tanner, Clervoy, and Parazynski will be making their first space flight.

Launch of Atlantis on the STS-66 mission is currently targeted for Nov. 3, 1994 at 11:56 a.m. EST from Kennedy Space Center's Launch Complex 39-B. After launch, the crew will work in two teams, each on 12 hour shifts, making observations and collecting data with the experiments and instruments being carried on the mission. The mission is scheduled to last 10 days, 19 hours, 46 minutes An on-time launch on Nov. 3 would produce a landing at Kennedy Space Center's Shuttle Landing Facility on Nov. 14 at 7:42 a.m. EST.

ATLAS-3 is the third in NASA's series of Atmospheric Laboratory for Applications and Science Spacelab missions. The remote sensing laboratory studies the Sun's energy output, the middle atmosphere's chemical makeup, and how these factors affect global ozone levels. ATLAS-3's highly calibrated instruments also will provide a check on similar instruments on free-flying satellites, allowing scientists to determine how much those instruments may have been degraded by the harsh environment of space.

Complementing the ATLAS science mission, the German-built Shuttle Pallet Satellite (SPAS) which will carry two instruments -- the Cryogenic Infrared Spectrometers and Telescopes for the Atmosphere (CRISTA) and the Middle Atmosphere High Resolution Spectrograph Investigation (MAHRSI).

On Flight Day Two, the SPAS and its instruments will be deployed from Atlantis using the Shuttle's mechanical arm. The pallet will fly free of the Shuttle as it observes a variety of gases in the middle atmosphere and measures amounts of nitric oxide and hydroxyl in the middle atmosphere and lower thermosphere. Also onboard the satellite will be the small Surface Effects Sample Monitor, a materials-science experiment aimed at measuring decay of surfaces exposed to the near-Earth space environment.

For the retrieval of CRISTA-SPAS on the 10th day of STS-66, Atlantis will use a new rendezvous approach to the satellite than has been standard for past satellite retrievals. The new approach is being evaluated for use in rendezvous with the Russian Mir Space Station in 1995 due to the propellant savings that it may achieve. The new approach may not only conserve propellant when approaching the Mir station but also could mean less braking thruster firings are required during the rendezvous in general, reducing risk of damaging Mir.

Also flying in the payload bay will be the Experiment of the Sun for Complementing the Atlas Payload and for Education-II (ESCAPE-II), a student-designed and developed payload engineered to gather data that will contribute to a better understanding of the Sun's radiative effects on the Earth's upper atmosphere.

The ESCAPE II experiment was designed, managed and built entirely by undergraduate and graduate students at the Colorado Space Grant Consortium at the University of Colorado, Boulder. ESCAPE II is expected to shed new light on how the Sun's extreme ultraviolet wavelengths affect the temperature and chemical composition of the upper atmosphere. The release of human-produced chlorofluorocarbons

(CFCs), is believed to be largely responsible for the recent seasonal decline in stratospheric ozone levels, most markedly over the Earth's poles. In order to understand the magnitude of human-caused changes in the atmosphere, scientists first need to measure the variability of natural solar radiation.

Two collaborative experiments developed by NASA and the National Institutes of Health (NIH) will be part of the STS-66 mission. The NIH-R-1 payload is a developmental biology experiment consisting of 11 experiments that will study the effects of space flight on developing rats. These experiments will provide important insights into the fields of gravitational and space biology and gravity's effects on living organisms. The NIH-C-2 payload is comprised of two biomedical experiments that will make use of a computerized tissue culture incubator known as the Space Tissue Loss (STL) Culture Module. STL was developed at the Walter Reed Army Medical Center in Washington, D.C., to study cells in microgravity. Both experiments will study the effects of space flight on cells from chicken embryos.

The STS-66 mission will carry two related Protein Crystal Growth (PCG) experiments -- the Crystal Observation System and the Vapor Diffusion Apparatus. These two experiments will continue research into the structure of proteins and other macromolecules such as viruses. Proteins are important, complex biochemicals that serve a variety of purposes in living organisms. Determining their molecular structure will lead to a greater understanding of functions in living organisms. Knowledge of the structure can also assist the pharmaceutical industry in the development of disease-fighting drugs.

The Space Acceleration Measurement System (SAMS) will be flying for the eleventh time during the STS-66 mission. The middeck payloads that SAMS is supporting are the PCG experiments. SAMS will collect and record data characterizing the microgravity environment in the Shuttle's middeck. SAMS will provide the scientists studying the PCG experiments with information on the microgravity environment these crystals experienced during the mission. The scientists will be able to account for the rocket thruster firings, crew activity and background vibrations that influence these delicate experiments.

The Heat Pipe Performance-2 (HPP-2) Experiment will investigate the thermal performance and fluid dynamics of heat pipes operating with asymmetric and multiple heating zones under microgravity conditions. A Thermal Performance Apparatus (TPA) mounted to middeck seat studs allows the Orbiter crew members to test individual heat pipes in the crew compartment during the flight. Thirty-five tests will be performed with ten different axially grooved aluminum/Freon heat pipes.

The design of effective spacecraft thermal control systems requires an understanding of heat pipe fluid dynamics in a microgravity environment. This behavior cannot be adequately evaluated on Earth because gravity tends to dominate the capillary forces developed in the apparatus. For these reasons, flight experiments are critical for collecting the data necessary for computer model validation.

The original Heat Pipe Performance Flight Experiment (HPP-1) was flown on STS-52 in October, 1992, to investigate and document the microgravity behavior and performance of several different types of heat pipes. Data from HPP-1 was used to modify and validate a NASA heat pipe computer model known as the Groove Analysis Program (GAP). The current version of GAP models heat pipes with single and uniform heating and cooling zones. The HPP-2 experiment will test heat pipes with asymmetric and multiple heating zones, providing data for correlation with new modifications to the GAP model. The basic difference between the two experiments is that HPP-1 tested "ideal case," or simple heat pipes, while HPP-2 will test more realistic heat pipe designs that mirror the complexity of actual spacecraft applications.

The end product of the HPP-1 and HPP-2 Flight Experiments will be a GAP model capable of accurately predicting the performance of any type of axially grooved heat pipe design prior to manufacture, so large costs incurred by building and testing prototype heat pipes can be avoided. The final version of GAP will allow thermal system engineers to be less conservative in their designs, leading to fewer heat pipes per spacecraft, thereby achieving significant weight and cost savings.

Shuttle Mission STS-66 will be the 13th flight of Atlantis and the 66th flight of the Space Shuttle system.

(END OF GENERAL RELEASE; BACKGROUND INFORMATION FOLLOWS.)

STS-66 QUICK LOOK

Launch Date/Site:	Nov. 3, 1994/KSC Pad 39B
Launch Time:	11:56 a.m. EST
Orbiter:	Atlantis (OV-104) - 13th Flight
Orbit/Inclination:	165 nautical miles/57 degrees
Mission Duration:	10 days, 19 hours, 46 minutes
Landing Time/Date:	7:42 a.m. EST November 14, 1994
Primary Landing Site:	Kennedy Space Center, Fla.
Abort Landing Sites:	Return to Launch Site - KSC, Fla. Transatlantic Abort landing - Zaragoza, Spain Moron, Spain Ben Guerir, Morocco Abort Once Around - White Sands Space Harbor, NM
Crew:	Don McMonagle, Commander (CDR) Curtis Brown, Pilot (PLT) Ellen Ochoa, Mission Specialist 1 (MS1) Joseph Tanner, Mission Specialist 2 (MS2) Jean-Francois Clervoy, Mission Specialist 3 (MS3) Scott Parazynski, Mission Specialist 4 (MS4)
	Red Team: McMonagle, Ochoa, Tanner Blue Team: Brown, Clervoy, Parazynski
Cargo Bay Payloads:	Atmospheric Laboratory for Applications and Sciences-3 (ATLAS-3) Cryogenic Infrared Spectrometers and Telescopes for Atmosphere/Shuttle Pallet Satellite (CRISTA/SPAS) Shuttle Solar Backscatter Ultraviolet (SSBUV/A) Experiment of the Sun Complementing the ATLAS Payload and Education-II (ESCAPE-II)
Middeck Payloads:	Protein Crystal Growth-Thermal Enclosure System (PCG-TES) Protein Crystal Growth-Single Locker Thermal Enclosure System (PCG-STES) Heat Pipe Performance Experiment-Reflight (HPP-RFL) Physiological and Anatomical Experiment/National Institute of Health-Rodents (PARE/NIH-R) Space Acceleration Measurement System (SAMS) Space Tissue Loss-A (STL-A)

Development Test Objectives/Detailed Supplementary Objectives:

DTO 254	Subsonic Aerodynamics Verification (part 2)
DTO 301D	Ascent Structural Capability Evaluation
DTO 307D	Entry Structural Capability Evaluation
DTO 312	External Tank Thermal Protection System Performance
DTO 414	Auxiliary Power Unit Shutdown Test (sequence A)
DTO 623	Cabin Air Monitoring
DTO 664	Cabin Temperature Survey
DTO 668	Advanced Lower Body Restraint Test
DTO 677	Evaluation of Microbial Capture Device in Microgravity
DTO 680	On Orbit Fit Check of the Recumbent Seating System on OV-104
DTO 683	Interlimb Resistance Device Evaluation
DTO 700-2	Laser Range and Range Rate Device
DTO 700-7	Orbiter Data for Real Time Navigation Evaluation
DTO 805	Crosswind Landing Performance
DTO 834	Notch Filter
DTO 835	Mir Approach Demonstration
DTO 836	Tools for Rendezvous and Docking

DSO 484B	Circadian Shifting in Astronauts by Bright Light
DSO 485	Inter Mars Tissue Equivalent Proportional Counter
DSO 487	Immunological Assessment of Crewmembers
DSO 493	Monitoring Latent Virus Reactivation and Shedding in Astronauts
DSO 603	Orthostatic Function During Entry, Landing and Egress
DSO 604	Visual-Vestibular Integration as a Function of Adaptation
DSO 605	Postflight Recovery of Postural Equilibrium Control
DSO 608	Effects of Space Flight on Aerobic and Anaerobic Metabolism During Exercise
DSO 612	Energy Utilization
DSO 614B	The Effect of Prolonged Space Flight on Head and Gaze Stability During Locomotion
DSO 621	In-Flight Use of Florines to Improve Orthostatic Intolerance Postflight
DSO 624	Pre and Postflight Measurement of Cardiorespiratory Responses to Submaximal Exercise
DSO 626	Cardiovascular and Cerebrovascular Responses to Standing Before and After Space Flight
DSO 901	Documentary Television
DSO 902	Documentary Motion Picture Photography
DSO 903	Documentary Still Photography

SPACE SHUTTLE ABORT MODES

Space Shuttle launch abort philosophy aims toward safe and intact recovery of the flight crew, Orbiter, and its payload. Abort modes include:

- Abort-To-Orbit (ATO) -- Partial loss of main engine thrust late enough to permit reaching a minimal 105-nautical mile orbit with orbital maneuvering system engines.

- Abort-Once-Around (AOA) -- Earlier main engine shutdown with the capability to allow one orbit around before landing at White Sands Space Harbor, N.M.

- Transatlantic Abort Landing (TAL) -- Loss of one or more main engines midway through powered flight would force a landing at either Zaragoza, Spain; Moron, Spain; or Ben Guerir, Morocco. * Return-To-Launch-Site (RTLS) -- Early shutdown of one or more engines, and without enough energy to reach Zaragoza, would result in a pitch around and thrust back toward KSC until within gliding distance of the Shuttle Landing Facility.

STS-66 contingency landing sites are the Kennedy Space Center, White Sands, Zaragoza, Moron, and Ben Guerir.

STS-66 SUMMARY TIMELINE

Red/Blue Flight Day 1
Ascent
OMS-2 burn (163 n.m. x 165 n.m.)

Red Flight Day 1
ATLAS activation
RMS checkout
SPAS activation
Group B powerdown

Blue Flight Day 2
ATLAS operations
SSBUV activation
SSBUV operations

Red Flight Day 2
Group B powerup
CRISTA/SPAS checkout
CRISTA/SPAS deploy

CRISTA/SPAS separation
RMS payload bay survey
ESCAPE activation
Group B powerdown

Blue Flight Day 3
ATLAS operations

SSBUV operations

Red Flight Day 3
ATLAS operations
SSBUV operations

CRISTA/SPAS stationkeeping

Blue Flight Day 4
HPP operations
ATLAS operations
SSBUV operations

Red Flight Day 4
HPP operations
ATLAS operations
SSBUV operations
CRISTA/SPAS stationkeeping

Blue Flight Day 5
ATLAS operations
SSBUV operations

Red Flight Day 5
ATLAS operations
SSBUV operations
HPP operations
ESCAPE deactivation
CRISTA/SPAS stationkeeping

Blue Flight Day 6
ATLAS operations
SSBUV operations
HPP operations

Red Flight Day 6
ATLAS operations
SSBUV operations

HPP operations

Blue Flight Day 7
ATLAS operations
SSBUV operations
HPP operations
CRISTA/SPAS stationkeeping

Red Flight Day 7
ATLAS operations
SSBUV operations
CRISTA/SPAS stationkeeping
ESCAPE activation

Blue Flight Day 8
ATLAS operations
SSBUV operations
HPP operations
ESCAPE deactivation

Red Flight Day 8
ATLAS operations
SSBUV operations
HPP deactivation, stow
Half day off duty

Blue Flight Day 9
ATLAS operations
SSBUV operations

Half day off duty
CRISTA/SPAS stationkeeping

Red Flight Day 9
ATLAS operations
SSBUV operations
CRISTA/SPAS stationkeeping

Blue Flight Day 10
ATLAS operations
SSBUV operations
Group B powerup
CRISTA/SPAS rendezvous

Red Flight Day 10
CRISTA/SPAS proximity operations
CRISTA/SPAS grapple
CRISTA/SPAS deactivation/stow
Group B powerdown

Blue Flight Day 11
ATLAS operations
SSBUV operations

ESCAPE activation
Flight Control Systems checkout

Red Flight Day 11
ATLAS operations

SSBUV operations
RMS stow

Red/Blue Flight Day 12
ESCAPE deactivate, stow
Group B powerup
Cabin stow
ATLAS deactivation
SSBUV deactivation
Deorbit
Entry
Landing

STS-66 VEHICLE AND PAYLOAD WEIGHTS

	Pounds
Orbiter (Atlantis) empty and 3 SSMEs	173,103
Atmospheric Laboratory for Applications and Sciences-3	8,287
Shuttle Solar Backscatter Ultraviolet	893
CRISTA/SPAS (deployable)	7,194
ESCAPE-II	747
Heat Pipe Performance experiment	141
Physical and Anatomical Rodent Experiment-National Institutes of Health - R	134
Protein Crystal Growth	250
Space Tissue Loss	57
Detailed Test/Supplementary Objectives	175
Shuttle System at SRB Ignition	4,508,369
Orbiter Weight at Landing	209,857

STS-66 ORBITAL EVENTS SUMMARY

Event	Start Time (dd/hh:mm:ss)	Velocity Change (ft/sec)	Orbit (n mi)
OMS-2	00/00:39:00	262 fps	163 x 165
SPAS deploy	00/19:52:00	N/A	162 x 165
Sep 2	00/20:09:00	1 fps	165 x 162
NC1	00/23:11:00	0.4 fps	165 x 162
NC	01/17:18:00	2.8 fps	164 x 165
NC3	01/21:50:00	3.3 fps	162 x 165
NC4	02/14:27:00	1.2 fps	162 x 165
NC5	03/01:01:00	TBD	162 x 165
NC6	03/07:04:00	0.2 fps	162 x 165
NC7	04/01:11:00	1.2 fps	163 x 165
NC-8	04/11:46:00	TBD	162 x 165
NC-9	04/17:48:00	2.4 fps	161 x 165
NC-10	05/08:55:00	TBD	161 x 165
NC-11	05/19:30:00	0.7 fps	162 x 165
NC-12	06/00:02:00	TBD	162 x 165
NC-13	06/15:08:00	0.2 fps	161 x 166
NC-14	07/13:49:00	0.2 fps	161 x 165
NC-15	08/01:55:00	TBD	161 x 165
NC-16	08/08:32:00	TBD	162 x 165
NC-17	08/13:11:00	16 fps	162 x 166
NH	08/13:56:00	1 fps	162 x 175
NC-18	08/14:41:00	23 fps	162 x 175
NCC-1	08/15:15:00	TBD	160 x 161
MF	08/16:12:00	10 fps	160 x 161
NCC-2	08/16:46:00	TBD	161 x 165
TI	08/17:43:00	9 fps	161 x 165
Grapple	08/20:09:00	N/A	161 x 165
Deorbit	10/18:46:00	265 fps	N/A
Landing	10/19:46:00	N/A	N/A

NOTES:

1. All maneuvers are recalculated in real time based on actual tracking and the orbiter's navigation. Many times and total velocities may change. Some burns may be deleted.

2. NC-1 through NC-16 are stationkeeping burns that serve to keep Atlantis at 20-40 nautical miles ahead of CRISTA-SPAS.

3. NC-17 will move Atlantis from a point about 20 nautical miles ahead of CRISTA-SPAS to a point about 20 nautical miles trailing CRISTA-SPAS.

4. The MAHRSI Football (MF) burn will occur when Atlantis is about 8 nautical miles behind the CRISTA-SPAS and take Atlantis as close as 3 nautical miles to CRISTA-SPAS during one orbit for observations of the shuttle by CRISTA-SPAS. The final phase of the rendezvous will occur when Atlantis is again about 8 nautical miles behind CRISTA-SPAS with the Terminal Phase Initiation (TI) burn, putting Atlantis directly on a course over one orbit for the retrieval.

STS-66 CREW RESPONSIBILITIES

Task/Payload	Primary	Backups/Others
ATLAS-3	Ochoa (red)	Parazynski (blue)
CRISTA-SPAS	Ochoa (red)	Clervoy (blue)
SSBUV	Ochoa (red)	Parazynski (blue)
ESCAPE	Parazynski (blue)	Ochoa (red)
Middeck Payloads:		
HPP	Clervoy (blue)	McMonagle, Ochoa (red)
NIH-R	Tanner (red)	Parazynski (blue)
PCG-TES	Tanner (red)	Parazynski (blue)
PCG-STES	Tanner (red)	Parazynski (blue)
SAMS	Brown (blue)	McMonagle (red)
STL	Brown (blue)	Ochoa (red)
Detailed Supplementary/Test Objectives:		
DTO 664 (cabin temp.)	Brown	Tanner
DTO 677 (microbial)	Parazynski	Ochoa
DTO 668 (lower restraint)	Ochoa	Clervoy, Tanner
DTO 680 (seats)	Clervoy	McMonagle
DTO 683 (resistance dev.)	Parazynski	Tanner
DSO 608 (exercise)	Brown	
DSO 624 (exercise)	McMonagle	Tanner
DSO 603B (orthostatic)	Clervoy	Parazynski
Other:		
Photography/TV	Parazynski	Tanner
In-Flight Maintenance	Brown	Tanner
Earth Observations	Brown	Tanner
RMS	Ochoa	Clervoy
Medical	Parazynski	Ochoa

ATMOSPHERIC LABORATORY FOR APPLICATIONS AND SCIENCE-3 (ATLAS-3)

ATLAS 3 is the third in NASA's series of Atmospheric Laboratory for Applications and Science Spacelab missions. The remote sensing laboratory studies the Sun's energy output, the middle atmosphere's chemical makeup, and how these factors affect global ozone levels. ATLAS 3's highly calibrated instruments will also provide a check on similar instruments on free-flying satellites, allowing scientists to determine how much those instruments may have been degraded by the harsh environment of space.

The ATLAS flights are part of NASA's Mission to Planet Earth, a long-term, coordinated research effort to study the Earth as a single, global environment. Mission to Planet Earth's main focus is studying how the global environment is changing and how human beings affect that change.

The overall ATLAS 3 science mission includes six experiments on the ATLAS pallet and a seventh on the wall of the Space Shuttle payload bay. Complementing the ATLAS payloads, the German freeflying science satellite CRISTA-SPAS is co-manifested as a prime payload. This satellite carries the German CRISTA telescope and the U.S. instrument MAHRSI. CRISTA-SPAS will be deployed and retrieved during the STS-66 mission and is controlled from Kennedy Space Center. It is the second mission in a series of at least four flights of the reusable science satellite ASTRO-SPAS covered by a Memorandum of Understanding between NASA and the German Space Agency DARA.

ATLAS 3's seven instruments, which flew on ATLAS 1 in March 1992 and ATLAS 2 in April 1993, will again focus on the processes that affect ozone levels. A thin layer of ozone, between 6 and 20 miles high in the atmosphere, shields life on Earth from most of the Sun's harmful ultraviolet radiation. However, in recent years ozone depletion has been observed in both the Southern and Northern hemispheres, the most notable example being the ozone "hole" that forms over Antarctica in September and which can persist into December.

Ozone is created and destroyed by complex reactions involving ultraviolet radiation from the Sun and gases in the middle atmosphere. While some of those gases occur naturally, concentrations of destructive chemicals are increasing due to human activity. To fully understand the many factors that drive atmospheric chemical reactions and to predict changes, scientists must have a comprehensive knowledge of the gases which make up the atmosphere. In addition, they must have precise data on the Sun's energy output as it fluctuates.

The first two flights gathered a large number of global atmospheric measurements at many different altitudes and measured changes in the Sun's total energy output. No other collection of space-based instruments gives the range of atmospheric measurements provided by those of the ATLAS payload.

Among other accomplishments, ATLAS 1 measured at various altitudes the concentrations of chemicals resulting from the breakdown of industrial compounds called chlorofluorocarbons (CFCs). These observations are the most direct confirmation that CFCs are the source of increased chlorine in the atmosphere. ATLAS 2 measured middle atmospheric ingredients over high northern latitudes during daylight hours, helping scientists understand the atmosphere's behavior following a winter of record-low ozone levels. Indications are that total ozone decreased by 10 percent at mid-latitudes in the Northern Hemisphere during the period between ATLAS 1 and ATLAS 2.

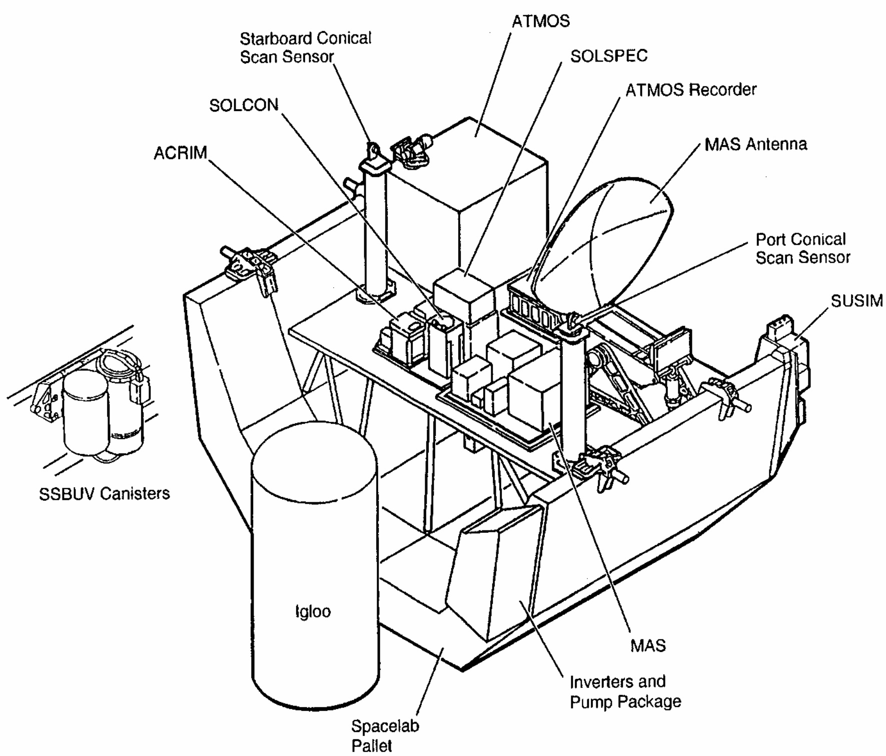
ATLAS 3 will make detailed measurements over the Northern Hemisphere in the late fall, allowing scientists to study important, but poorly understood, processes as the atmosphere shifts from relatively quiet summer conditions to more active winter conditions. Investigators also will study the chemical processes occurring in and near the Antarctic ozone hole, which usually peaks in early October. Observations of both areas should provide valuable data for comparison with the spring data of ATLAS 1 and 2.

The Space Shuttle is an ideal platform for NASA's remote-sensing atmospheric laboratory. The flight crew can maneuver the Orbiter so the instruments in the bay point precisely toward the atmosphere, the Sun or the Earth's surface. The Shuttle's generous payload capacity and power supply allow a diverse assembly of large instruments to make simultaneous observations. Another advantage of flying aboard the Shuttle is the ability to calibrate the Atlas instruments before and after flight, offering more insight to scientists. ATLAS instruments make more detailed measurements than similar ones now flying aboard satellites.

Satellite Underflights

An important goal of the ATLAS program is to provide measurements that relate to, and coincide with, those of instruments flying on satellites. ATLAS data is being used to refine existing ozone information and to measure satellite instrument degradation caused by exposure to ultraviolet radiation and particles including atomic oxygen. Since the Shuttle missions are short, any drift in instrument accuracy should be small and can be determined once the Shuttle instrument is back on Earth.

On previous flights, all the ATLAS experiments achieved correlative measurements with instruments on free-flyers such as the Upper Atmosphere Research Satellite (UARS), NOAA meteorological satellites, the Earth Radiation Budget Satellite (ERBS), and the European Retrievable Carrier (EURECA). Coincident measurements also were made with Total Ozone Mapping Spectrometers (TOMS) on the Nimbus-7 and Meteor-3 satellites.



ATLAS ATMOSPHERIC SCIENCE

ATLAS 3's atmospheric science goals continue from the previous missions: measuring global, middle-atmosphere temperatures and trace-gas concentrations and providing these measurements to the science community for comparisons with those of other spacecraft. In addition, because of factors such as time of year, orbital lighting conditions, current state of knowledge of the atmosphere, and new instruments, some goals are unique to the ATLAS 3 mission. When ATLAS 3 launches, atmospheric instruments will examine the response of the Southern Hemisphere to the Antarctic ozone hole and the change in Earth's northern middle atmosphere from summer to winter conditions. Also, the presence of two additional instruments on a free-flying satellite will enhance the ATLAS atmospheric data, providing more information on gas concentrations, including details of their physical distribution.

The ATLAS Instruments

Atmospheric Trace Molecule Spectroscopy (ATMOS).
Principal Investigator: Dr. Michael R. Gunson, NASA Jet Propulsion Laboratory, Pasadena, Calif.

The Atmospheric Trace Molecule Spectroscopy (ATMOS) experiment will measure the concentrations of more than 30 gases in the middle atmosphere. These measurements will be compared with those from previous ATLAS flights to identify and characterize changes in the atmosphere's chemical composition.

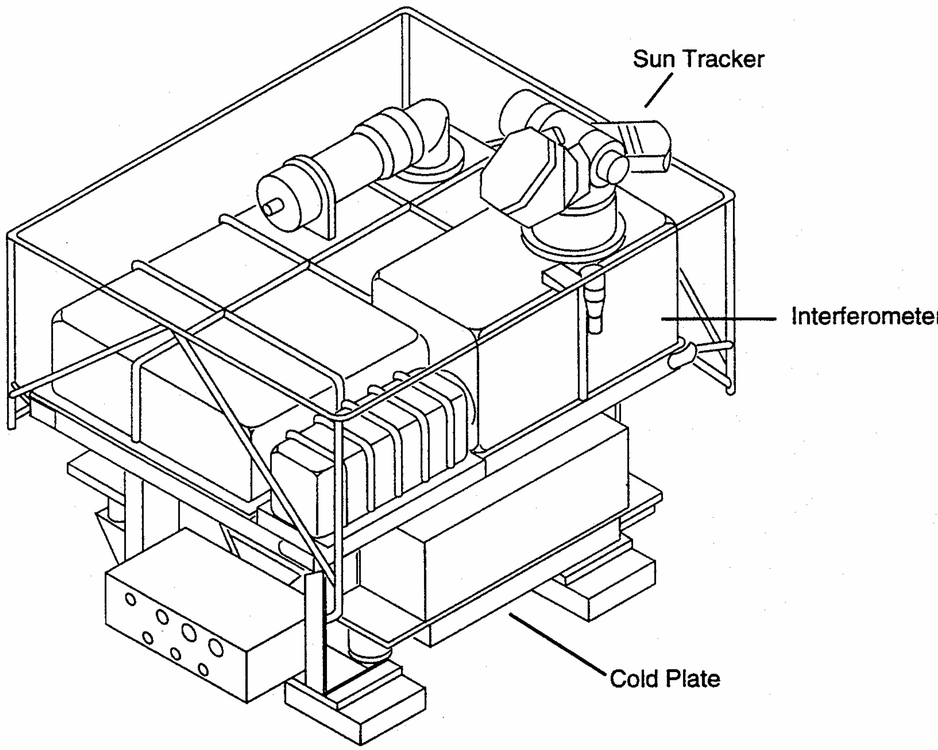
As the Shuttle's orbit carries the spacecraft in and out of Earth's shadow (orbital night), the ATMOS instrument views the Sun as it rises or sets through the atmosphere. The spectrometer measures changes in the infrared component of sunlight as the Sun's rays pass through this segment of atmosphere, called the Earth's limb. Because trace gases absorb at very specific infrared wavelengths, the science team can determine what gases are present, in what concentrations, and at what altitudes by identifying the wavelengths that are "missing" from their data.

During the ATLAS 3 mission, the ATMOS instrument will have a video camera to record pictures of the Sun during the sunrises and sunsets, confirming the instrument's pointing. The ATMOS recorder also will have an improved controller, designed to give ground scientists more information about the recorder's status and condition.

Changes in the atmosphere have been observed over the years, but the causes and effects of those changes are not fully understood. A more thorough knowledge of which gases are present, and of how their concentrations change over time, can help scientists determine if the alterations are man-made, natural or a combination of both.

During ATLAS 1, ATMOS obtained atmospheric measurements over latitudes between 30 degrees North and 55 degrees South. These measurements were compared to those collected over the same areas by ATMOS during the Spacelab 3 Shuttle flight in 1985 to determine changes in the amounts of industrial CFCs released and to study their conversion into inorganic chlorine. Results indicate an increase in inorganic chlorine from 2.77 to 3.44 parts per billion, with a rise in fluorine from 0.76 to 1.23 parts per billion. The fluorine increase confirms that the source of the increased chlorine levels is industrial CFCs.

The ATLAS 1 mission occurred only nine months after the eruption of the Mount Pinatubo volcano, the largest such event this century. ATMOS was able to measure changes in the components of the middle atmosphere resulting from the presence of a thick layer of tiny droplets of sulfuric acid formed from sulfur dioxide emitted by the eruption. Scientists are presently working to determine if the ozone loss in the Northern Hemisphere in 1992-1993 was a direct result of an imbalance in the middle atmosphere's chemistry caused by the Mt. Pinatubo emissions.



Atmospheric Trace Molecule Spectroscopy (ATMOS)

The night launch of ATLAS 2 allowed the ATMOS instrument to complement ATLAS 1 measurements by extending the area of observations to include Northern Europe, Siberia, Alaska and Canada at sunrise. It enabled scientists to study a large remnant of the polar vortex, a mass of cold air normally isolated from lower latitude air by strong winds that circulate around the North Pole in winter. Quite different conditions exist inside and outside this area.

During the early-spring flight of ATLAS-2, conditions outside the vortex appear to have returned to normal, although with slightly higher ozone levels. However, the amount of chlorine nitrate, a key chlorine-carrying gas, remained surprisingly high inside the vortex-an important indication of the earlier ozone depletion in this region. Scientists believe these conditions are part of the processes that lead to the loss of ozone in polar winter and spring. Further analysis of ATLAS-2 data should help clarify details of the important changes that occur during this complex period.

ATMOS is a single assembly mounted on the Spacelab pallet in the Space Shuttle's cargo bay. Within the assembly are the Sun tracker, detector, thermal control and electronics assemblies. The experiment will operate during the orbital sunrises and sunsets during the Earth viewing portions of the mission, observing sunrises at high southern latitudes and sunsets spanning the northern tropics through the mid-latitudes.

Millimeter-Wave Atmospheric Sounder (MAS).
Principal Investigator: Dr. Gerd K. Hartmann, Max Planck Institute for Aeronomy, Katlenburg-Lindau, Germany

The Millimeter-Wave Atmospheric Sounder (MAS) measures the distribution of water vapor, chlorine monoxide and ozone at altitudes between 12 and 60 miles (20 to 100 km).

Chlorine monoxide, formed mainly by the breakdown of CFCs in the middle atmosphere, plays an important part in ozone loss. This compound is produced when CFCs meet ultraviolet radiation in the upper atmosphere approximately 3 to 5 years after their release into the air at the Earth's surface. CFCs come from sources such as coolants in refrigerators and air conditioners, from foam containers and from halons, chemical compounds often used in fire extinguishers. The harmful effects of these products were not foreseen when the chemicals were first put into use.

MAS measures the strength of millimeter waves, or waves of frequencies between 30 and 300 gigaHertz, radiating at the specific frequencies of water vapor, chlorine monoxide and ozone. With a new chlorine monoxide receiver that is twice as sensitive as the one that flew on the ATLAS 1 and 2 missions, MAS will attempt to better measure chlorine monoxide and ozone over the upper latitudes of both hemispheres. Also, investigators plan to examine the evolution and/or breakup of the Antarctic vortex, the mixing of polar and mid-latitude air and other atmospheric changes occurring in the Southern Hemisphere.

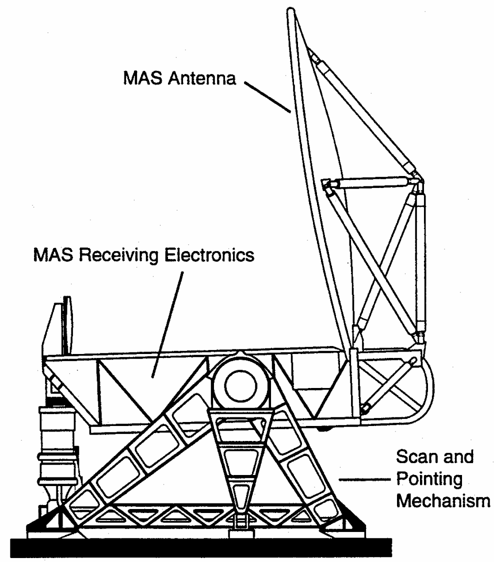
Global information about ozone and chlorine monoxide helps provide answers to the problem of human influences on the ozone layer, and MAS therefore serves as part of an early warning system to determine how widespread the destruction of ozone really is.

MAS results from ATLAS-1 agreed with theoretical expectations and calculations. For example, a large daylight-to-dark ozone variation was observed at heights above 43 miles (70 km), with much greater quantities on the night side of the Shuttle's orbit. Also, the varied quantities of water vapor measured in the middle atmosphere are consistent with expected results.

The ATLAS 2 night launch made it possible for MAS investigators to observe ozone in Earth's middle atmosphere at high latitudes in both the Southern and Northern hemispheres. Chlorine monoxide, a key gas in ozone destruction, was measured over the northern latitudes during the daylight. The daily changes in ozone concentration, including increased nighttime ozone at high altitudes, were observed over the southern latitudes. The MAS instrument also measured water vapor, an excellent indicator of atmospheric movement.

ATLAS 2 data confirm that upward atmospheric movement occurs over the equator and downward atmospheric movement over the poles during the spring equinox, the time of the mission.

MAS, mounted on the Spacelab pallet, uses a dish-shaped antenna to scan Earth's limb (the far horizon) to collect spectral information at distinct altitudes. By measuring the strength of the microwave radiations, scientists can deduce concentrations of ozone, chlorine monoxide, water vapor and temperature.



Millimeter-Wave Atmospheric Sounder (MAS)

Shuttle Solar Backscatter Ultraviolet Spectrometer (SSBUV).
Principal Investigator: Mr. Ernest Hilsenrath, NASA Goddard Space Flight Center, Greenbelt, Md.

SSBUV provides accurate, reliable readings of global ozone to verify the reliability of ozone information gathered by satellite instruments which are in orbit for extended periods of time. Scientists compare SSBUV data with observations from National Oceanic and Atmospheric Administration's NOAA-9 and NOAA-11 and NASA's Ultraviolet Atmospheric Satellite. The same atmospheric location is mapped by the UARS, SSBUV, Total Ozone Mapping Spectrometer (TOMS) aboard the Russian Meteor-3 Satellite and NOAA instruments within 60 minutes up to 17 times a day.

SSBUV has flown on the Space Shuttle six times since 1989, including the ATLAS 1 and 2 missions. The instrument detected and verified a decrease in ozone of approximately 10 to 15 percent in the northern and mid-latitudes of the Northern Hemisphere between ATLAS 1 and 2. This decrease was observed at the same time by satellites and through ground-based observations.

The instrument also made solar observations, which were compared with those made by the instrument on previous flights, and with solar observations made by UARS instruments and other ATLAS investigations. Recent comparisons with the UARS and ATLAS solar measurements indicate that the precision of the solar measurements made by SSBUV is at least five times better than measurements made before the ATLAS mission.

During ATLAS 2, controllers used SSBUV's ability to focus on specific wavelengths to look for nitric oxide. They further refined the procedure during STS-62 in March 1994, the instrument's last flight, to measure nitric oxide during five orbits. Measurements of sulfur dioxide in the lower stratosphere were also attempted.

The SSBUV spectrometer is located in a Get-Away-Special canister, attached to the side of the Shuttle's cargo bay. A motorized door assembly opens up to allow the SSBUV to view the Earth and Sun, and then closes to protect the instrument from contamination when it is not in use. Data, command and power systems are housed in an adjacent interconnected canister.

SSBUV measures solar radiation in 12 ultraviolet wavelengths that scatter back from the atmosphere. Variations in the 12 wavelengths of backscattered radiation indicate how the ozone is distributed by altitude. Ozone absorbs shorter wavelengths of ultraviolet radiation more strongly than it does longer ones. Shorter wavelengths of ultraviolet radiation are backscattered from higher altitudes, while longer wavelengths move deeper into the atmosphere and are scattered from lower levels.

Solar Science

Sunlight provides the energy for many atmospheric processes; yet, the Sun's radiant output fluctuates over an 11-year cycle, from a maximum to a minimum and back again. Within this 11-year cycle are the short-term variations of the 27-day solar rotation period. Earth's atmosphere is influenced by both cycles, especially by variations in ultraviolet radiation. By gathering nearly simultaneous data on the Sun and the atmosphere, scientists hope to identify and quantify the connections between variations in solar energy and changes in the atmosphere.

The absolute value of the solar irradiance is one of the critical factors that, in combination with Earth's absorption and reflection of that radiation, determines the energy balance that governs the circulation of the atmosphere. More accurate measurements of the value of the solar irradiance are needed and can be made only from above the densest layers of Earth's atmosphere.

The first ATLAS flight occurred just after the beginning of solar cycle 22, a time of near-maximum solar activity. ATLAS 2 experienced a Sun without sunspots during the last half of the mission. Investigators expect even less solar activity for ATLAS 3 as the cycle continues toward minimum activity, expected to occur in 1996-97. The STS-66 crew will turn the Shuttle's cargo bay toward the Sun four times during the mission, for solar viewing periods lasting from six to eight orbits.

The Active Cavity Radiometer Irradiance Monitor (ACRIM).

Principal Investigator: Dr. Richard C. Willson, NASA Jet Propulsion Laboratory, Pasadena, Calif.

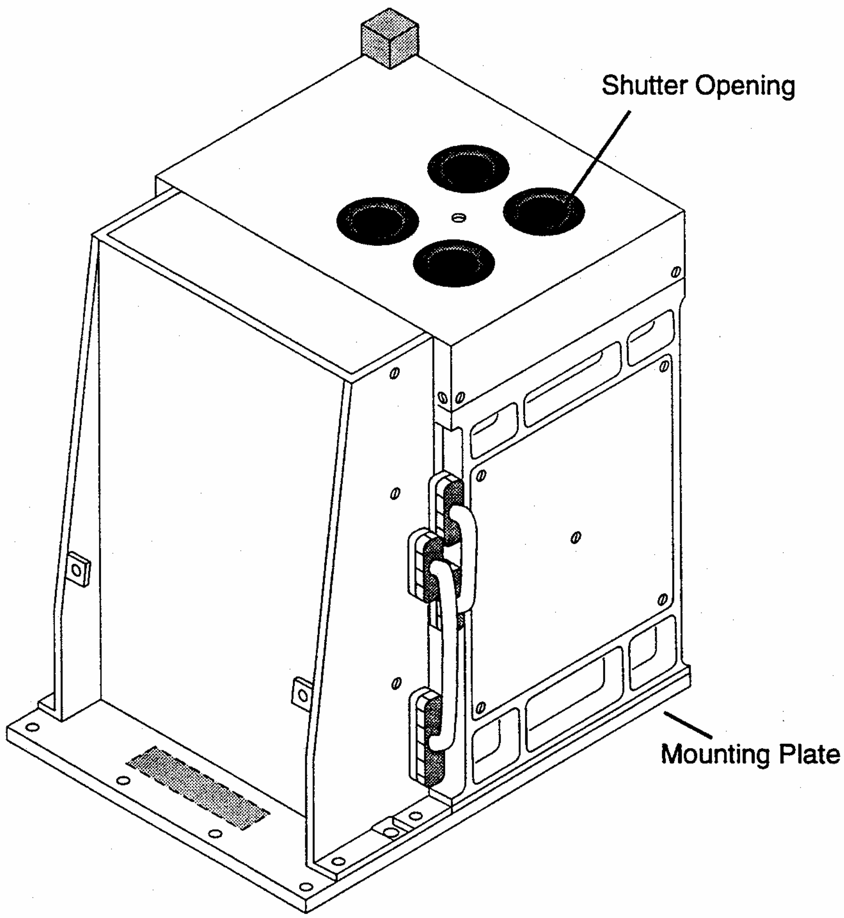
The primary objective of ACRIM is to determine the degree and direction of possible variations in the Sun's total output of energy, or irradiance ACRIM measures the total solar irradiance from ultraviolet through infrared wavelengths to better than 0.1 percent precision.

As part of a long-term program to study the physical behavior of the Sun and its effect on Earth's climate, NASA is putting together a highly precise collection of information on solar irradiance. For more than 20 years, the total solar irradiance has been monitored by instruments orbiting on spacecraft such as Nimbus-7, the Solar Maximum Mission and UARS. An ACRIM instrument flew on Spacelab 1 (1983), the Solar Maximum Mission (1980-1989), UARS (1991-) and on ATLAS 1 and ATLAS 2.

During ATLAS 2, the instrument collected 25 orbits of observations and made measurements that coincided with UARS' ACRIM. Investigators noticed outstanding instrument performance and highly precise measurements. Measurements were improved because the Sun was in a very quiet period during the mission, allowing for possibly the most stable calibrations ever achieved between the two instruments.

Through successive comparisons, the accuracy of the satellite measurements can be maintained. These instruments will help establish the total solar radiation scale for the International System of Units. By comparing measurements of the solar constant made during ATLAS 3, scientists can further refine the accuracy of this scale.

ACRIM , located on the ATLAS 3 platform, contains four cylindrical bays. Three of the bays house independent heat sensors, called pyrheliometers, which are self-calibrating and automatically controlled. The fourth bay holds a sensor that measures the relative angle between the instrument and the Sun.



Active Cavity Radiometer Irradiance Monitor (ACRIM)

Measurement of the Solar Constant (SOLCON).
Principal Investigator: Dr. Dominique Crommelynck, Belgian Royal Institute of Meteorology, Brussels, Belgium

SOLCON measures the absolute value of the total solar irradiance and detects and measures long-term variations that may exist in its absolute value. The accuracy of the instrument allows the science team to determine the value of the solar constant during a particular mission to within 0.1 percent accuracy and about 0.01 percent precision.

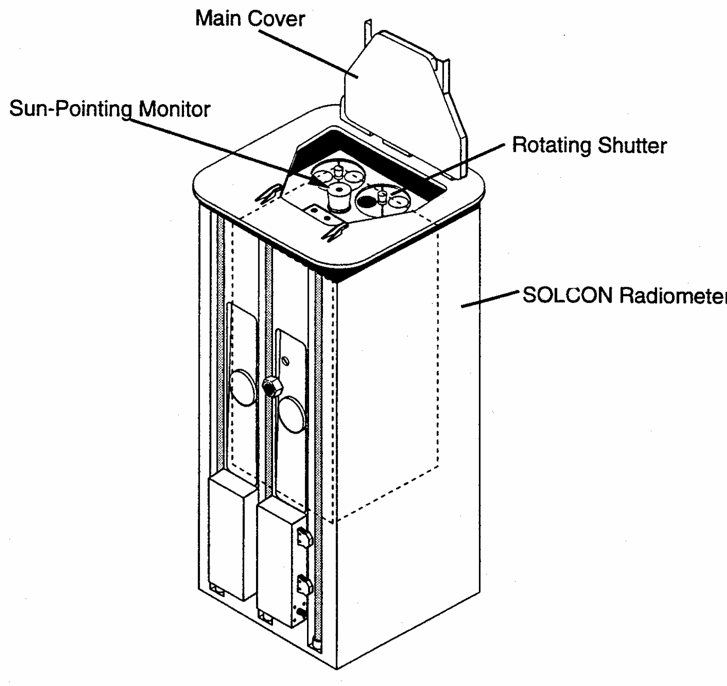
Scientists theorize that systematic changes of only 0.5 percent per century in total solar energy reaching the Earth could explain the entire range of past climate changes from tropical to ice age conditions. The ATLAS solar instruments are designed to measure the changes in irradiance to a long-term accuracy of 0.1 percent. Continuous, more accurate measurements of the solar constant will allow future generations to identify solar and climatic trends over the centuries.

By comparing measurements of the solar constant from SOLCON and ACRIM, as well as those from free-flying satellites, scientists can continue to refine the accuracy of the total solar radiation measurements.

SOLCON flew on Spacelab 1 (1983), ATLAS 1 and ATLAS 2. A copy, called SOVA 1, also flew on the European Space Agency's European Retrievable Carrier (EURECA), launched from the Shuttle in July 1992 and retrieved in June 1993. Preliminary results from ATLAS 1 indicate the number of solar spots on the rotating solar disc influences the fluctuation of the solar irradiance value.
The ATLAS 2 mission provided 26 orbits of operations and measurements that coincided with SOVA 1. These measurements were taken during a very quiet period of solar cycle 22. As with ACRIM, this situation provided the best possible scenario for observations and comparison of the instrument's radiometers. Analysis of the data indicates that the measurements made by SOLCON and SOVA 1 agree very closely on each of their two channels regarding the approximate value of the solar constant as 1367 watts per square meter.

SOLCON is a high-resolution, self-calibrating radiometer with a digital processing/converter unit. The only part of the experiment that is not automatic is the pointing operation, which requires that the investigators analyze values obtained from a Sun sensor and, if necessary, request minor changes in the orbiter's attitude that will correctly position the experiment to point directly at the Sun.

The majority of SOLCON commands will be issued from the Space Remote Operations Center in Brussels, Belgium, but the principal investigator will be in Huntsville to participate in science planning. About half of SOLCON's operations during ATLAS 2 were commanded remotely from Brussels. This was a significant test of technologies that will be used for future space operations.



Measurement of the Solar Constant (SOLCON)

Solar Spectrum Measurement from 180 to 3,200 Nanometers (SOLSPEC).
Principal Investigator: Dr. Gerard O. Thuillier, Aeronomy Service of the National Center for Scientific Research, Verrieres-le-Buisson, France

The objectives of SOLSPEC are to measure the absolute spectral solar irradiance with the highest accuracy possible and to measure the solar variability at different times during a solar cycle.

Although most solar energy is contained in the visible and infrared light that reaches the Earth's surface, the energy present in ultraviolet and shorter wavelengths can vary significantly during an 11-year solar cycle. This variation can change the amount of energy reaching the atmosphere, driving changes in the middle and upper atmospheres. Investigators want to identify regions in the atmosphere that are likely to respond to particular changes in solar infrared, visible, and ultraviolet ranges. More simultaneous solar and atmospheric data will improve our understanding of atmospheric processes and, eventually, our ability to predict atmospheric behavior.

SOLSPEC flew on Spacelab 1, and it was part of both ATLAS 1 and ATLAS 2. During ATLAS 1, SOLSPEC made observations of the light backscattered by the ozone layer. The preliminary analysis of SOLSPEC data indicates that the values for ultraviolet, visible and infrared light are close to the expected values, which will be helpful in validating scientists' models showing the interaction of sunlight with the atmosphere. These measurements were compared to those taken by SSBUV and SUSIM. The total irradiance measured was compared with that measured by the SOLCON and the ACRIM.

During ATLAS 2, SOLSPEC operated through 26 orbits and obtained measurements that coincide with those from similar instruments on EURECA and UARS. Analysis of the data is continuing, and correlation between ultraviolet and solar constant changes is being studied in great detail.

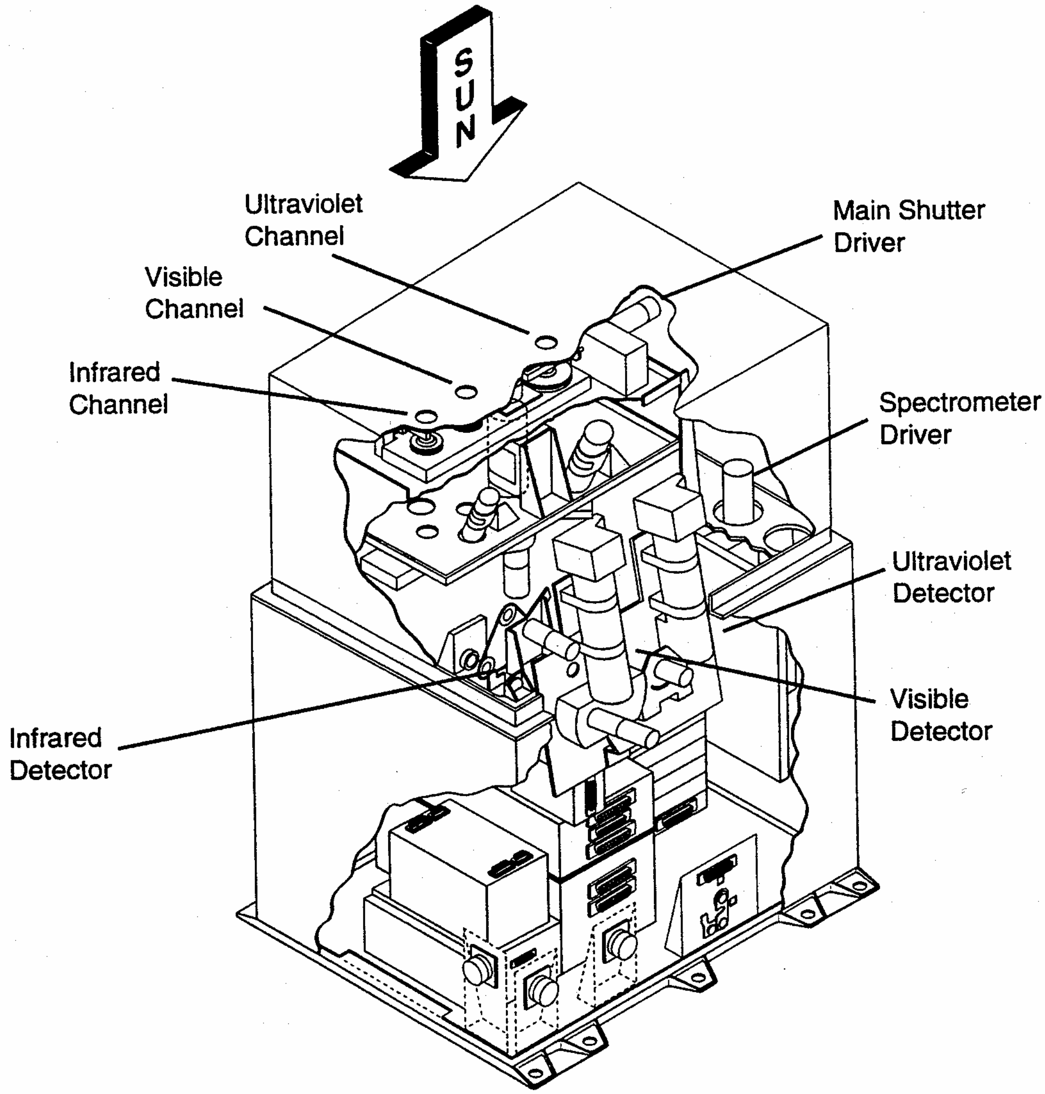
Investigators also had an important opportunity to study solar variability when the activity level of the Sun decreased from the beginning to the end of the ATLAS 2 mission. ATLAS 2 data agree with data gathered during ATLAS 1, and both sets of data have a greater degree of accuracy than those obtained during Spacelab 1. ATLAS 1 and ATLAS 2 results differ at certain wavelengths, and this dissimilarity demonstrates the difference in solar activity during the two missions.

SOLSPEC, located on the ATLAS 3 pallet, has an onboard calibration device and three double spectrometers that record solar radiation. Once in orbit, the SOLSPEC equipment is closely monitored by scientists at the Spacelab Mission Operations Control center in Huntsville, Ala., during the first calibration. Later calibrations and observations are controlled through the onboard equipment computer. Some commands will be sent from the remote center in Brussels.

Solar Ultraviolet Spectral Irradiance Monitor (SUSIM).
Principal Investigator: Dr. Guenter Brueckner, Naval Research Laboratory, Washington, D.C.

SUSIM has two purposes. First, it measures the fluctuation of the Sun's ultraviolet radiation. During an 11-year solar cycle, changes in ultraviolet radiation bring about changes in atmospheric conditions, such as the amount of ozone in the stratosphere. A better record of the Sun's ultraviolet output will help scientists distinguish between atmospheric changes caused by variations in ultraviolet radiation and those brought about by human activity.

Second, SUSIM determines how much the ultraviolet light being measured degrades the accuracy of the measuring instrument. Unless the extent of degradation is known, it is impossible to distinguish real changes in solar radiation from the loss of accuracy in the instrument.



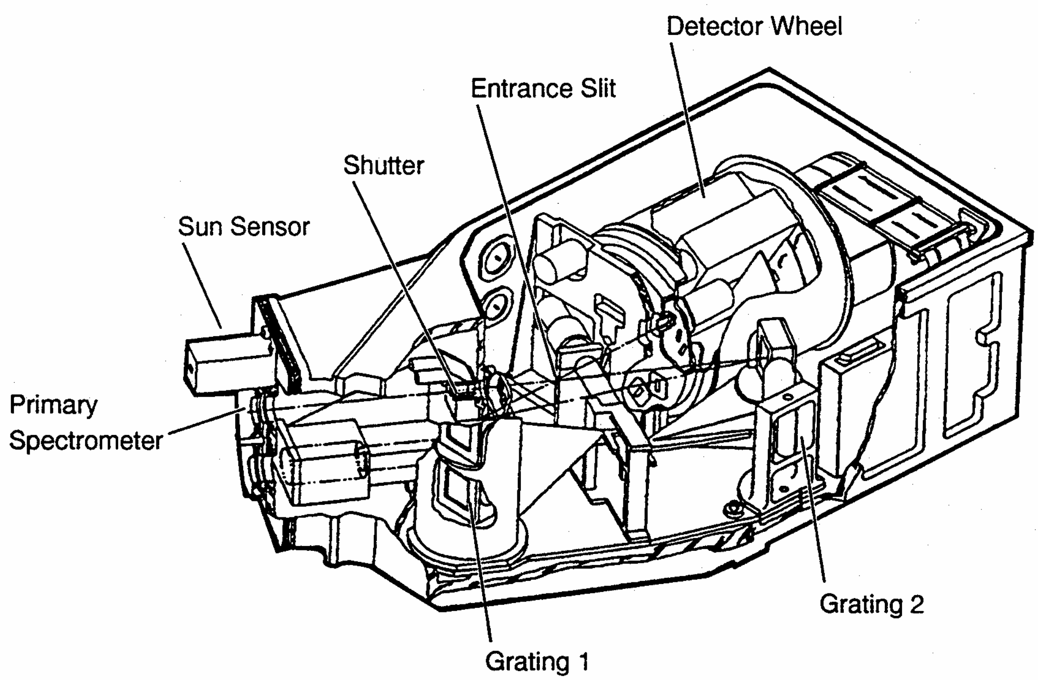
Solar Spectrum Measurement (SOLSPEC)

SUSIM operates during the Shuttle's solar-pointing periods to establish a new and more accurate database on solar ultraviolet irradiance (that portion of ultraviolet energy that reaches the top of Earth's atmosphere) over a wide range of wavelengths, from 110 to 410 nanometers. Measurements of radiation in these wavelengths are almost completely absorbed in the middle and upper atmosphere, preventing detailed observation from Earth.

Data from the instrument's observations are used for solar physics studies and for a study of the Sun's influence on Earth's atmosphere. In addition, SUSIM will continue to make measurements that coincide with those from a similar instrument on UARS to help calibrate the satellite instrument. During the first 800 days of the UARS mission, the UARS SUSIM instrument lost 90 percent of its sensitivity to short wavelengths for one of its channels. The ATLAS SUSIM data can greatly reduce the UARS error by providing an estimate of this sensitivity loss.

During ATLAS 1, SUSIM collected more than 100 solar ultraviolet radiation measurements. On ATLAS 2 , it collected data through 24 orbits of solar pointing. Comparisons of data obtained by SUSIM during Spacelab 2, ATLAS 1 and ATLAS 2 show there was a drop in the total amount of ultraviolet irradiance from the Sun between 1985 and 1993. Significantly, observations made during ATLAS 2 did not confirm many of the assumptions about the way ultraviolet spectral lines would follow Sunspot activity. Rather, ultraviolet changes appear to be larger than what would be predicted by the change in sunspot and total constant change.

Located on the ATLAS 3 platform, SUSIM is composed of two precision ultraviolet spectrometers with two sets of optics and an in-flight calibration deuterium lamp. A new internal computer, the Dedicated Experiment Processor (DEP) and a new version of flight software have been added to the SUSIM experiment for the ATLAS 3 mission. Also, several electronics modules have been modified to allow the processor to collect more accurate wavelength measurements over the entire spectrum. These changes should significantly improve the total accuracy of the data.



Ultraviolet Irradiance Monitor (SUSIM)

The ATLAS-3 Team

The ATLAS program is sponsored by NASA's Office of Mission to Planet Earth in Washington, D.C. The management and control of each ATLAS mission is the responsibility of NASA's Marshall Space Flight Center in Huntsville, Ala. The mission manager directs a civil service and contractor team effort to match science objectives with Shuttle-Spacelab resources so each flight is fine-tuned to gather the maximum amount of science information. This effort includes preparing a minute-by-minute schedule, called a timeline, that combines crew activities, experiment requirements, Spacelab resources and Shuttle maneuvers into an efficient operating plan.

Principal investigators of the individual experiments form an Investigator Working Group that meets regularly before the mission to advise the mission manager's team on science-related issues and payload operations. The working group is chaired by the mission scientist, a member of the mission manager's team.

During the mission, the management, principal investigators and science teams collect scientific data from ATLAS instruments around the clock from NASA's Spacelab Mission Operations Control facility at Marshall. The facility contains banks of computers, monitors and communication consoles which enable the ground team to monitor the payload, collect data, send direct commands to the experiments and communicate with the Shuttle crew. The SSBUV instrument will also receive commands from payload operations control centers at Goddard Space Flight Center.

The science team will meet twice daily during the mission as a Science Operations Planning Group, which includes the investigators for the CRISTA-SPAS instruments. The team evaluates science activities, solve problems and recommend ways to take full advantage of any unplanned opportunities.

Every ATLAS flight crew is divided into two teams, each of which works a 12-hour shift so science operations can continue around the clock. At least one member of each team has special training in both Spacelab and experiment operations and will oversee science activities on the shift. Most of the ATLAS instruments operate automatically, commanded by the Spacelab computers or by the science teams in Huntsville. However, crewmembers can use keyboards to enter observation sequences if necessary. Another crewmember on each team is part of the orbiter crew and is responsible for maneuvering the Shuttle when an instrument requires precise pointing or must be operated in a specific attitude.

CRYOGENIC INFRARED SPECTROMETERS AND TELESCOPES FOR THE ATMOSPHERE-SHUTTLE PALLET SATELLITE (CRISTA-SPAS)

Complementing the ATLAS science mission, the German-built Astronomy Shuttle Pallet Satellite (ASTRO-SPAS) will carry two instruments to investigate the Earth's atmosphere. The ATLAS 3/CRISTA-SPAS mission will constitute a joint science mission, with a single set of science objectives managed by a single science team.

The ASTRO-SPAS will carry the Cryogenic Infrared Spectrometers and Telescopes for the Atmosphere (CRISTA) and the Middle Atmosphere High Resolution Spectrograph Investigation (MAHRSI). CRISTA will observe a variety of gases in the middle atmosphere and MAHRSI will measure amounts of nitric oxide and hydroxyl in the middle atmosphere and lower thermosphere. Also onboard the satellite will be the small Surface Effects Sample Monitor (SESAM), a materials-science experiment aimed at measuring decay of surfaces exposed to the near-Earth space environment.

By operating apart from the Shuttle, CRISTA AND MAHRSI are independent of orbiter maneuvers. Since the satellite is deployed and retrieved on a single flight, data tapes can be retrieved and the instruments recalibrated in the same way as the ATLAS instruments.

The ASTRO-SPAS program is based on a Memorandum of Understanding between NASA and the German Space Agency (DARA) and makes provisions for several joint missions. The first of these missions - ORFEUS-SPAS - was launched on September 12, 1993, aboard STS-51. The satellite carried the German Orbiting and Retrievable Far and Extreme Ultraviolet Spectrograph (ORFEUS) telescope. CRISTA-SPAS is the second mission in this series. The CRISTA-SPAS Mission

CRISTA-SPAS will be carried to space in the cargo bay of the Shuttle Atlantis. Early in the mission, the crew will position the satellite using the Remote Manipulator System. After release, the CRISTA-SPAS will fly from 25 to 44 miles (40 to 70 km) behind the Space Shuttle. The satellite will operate independently, except for required communication periods with the Orbiter. During these periods, the instrument will relay information about its status through Atlantis to the CRISTA-SPAS station at KSC. The first opportunity to communicate with Atlantis will occur immediately after the release of CRISTA-SPAS. Additional communication opportunities will occur every 10 to 12 hours.

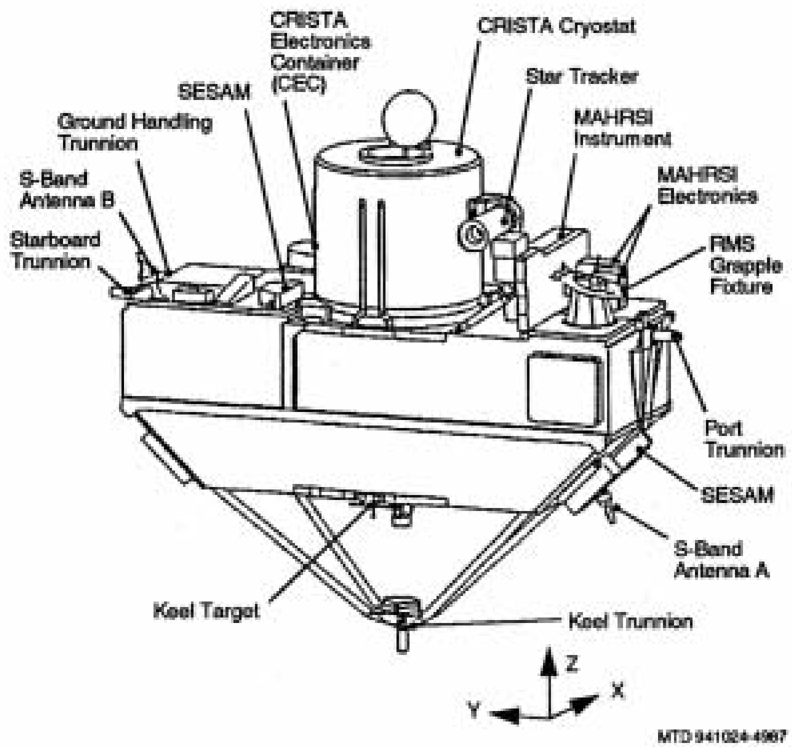
The payload will be controlled from the German SPAS Payload Operations Center (SPOC) at KSC. The orbiter will link CRISTA-SPAS and the ground station. After approximately one week, the satellite will be retrieved and returned to Earth, where the data will be processed and the instruments will be refurbished.

The ASTRO-SPAS carrier is designed for up to 14 days of autonomous operation in the vicinity of the Space Shuttle orbiter. It is approximately 15 feet (4.6 meters) in height, 7 feet (2 meters) in length and weighs approximately 7,500 pounds (3,400 kilograms). Precise attitude control is achieved by a 3-axis stabilized cold gas system in combination with a star tracker and two specially developed Global Positioning Satellite (GPS) receivers. Power is generated by a battery package which can supply 20 to 50 kilowatt hours to the science instruments depending on mission requirements. The spacecraft also carries a central onboard computer for satellite operation and attitude control which also execute commands and an S-band transponder for communications with the ground which is relayed through the Space Shuttle orbiter.

CRISTA-SPAS Pre-launch Processing

The versatility of the ASTRO-SPAS as a science platform permits it to support experiments ranging from ultraviolet astronomy to infrared sensing of the Earth's atmosphere. Refurbishment between missions can be achieved in less than a year.

The ASTRO-SPAS payload arrived at NASA Spacecraft Hangar AM on Cape Canaveral Air Station on June 20 to begin the integration of instruments and checkout. It was moved to the Vertical Processing Facility on Sept. 20 for tests to verify compatibility with the Space Shuttle Atlantis. Finally, the payload is scheduled to be taken to the launch pad on Oct. 6 for installation into the payload bay of Atlantis on Oct. 11.



CRISTA-SPAS Payload Configuration

<u>CRISTA-SPAS Instruments</u>

Cryogenic Infrared Spectrometers and Telescopes for the Atmosphere (CRISTA).
Principal Investigator: Dr. Dirk Offermann, University of Wuppertal, Wuppertal, Germany

The CRISTA instrument will gather the first global information about medium and small scale disturbances in trace gases of the middle atmosphere. These measurements will be taken in three directions simultaneously and will provide information about disturbances caused by winds, wave interactions, turbulence and other processes.

Evidence suggests there are small three-dimensional wave-shaped patterns in the middle atmosphere, such as the wave-line variations seen during balloon flights. Many other small atmospheric structures have been predicted theoretically; however, they cannot be measured by current satellite instruments. These structures may be of important influence on many processes in the atmosphere, and precise horizontal and vertical measurements with good resolution are needed to validate and possibly improve models of the atmosphere and Earth's energy balance.

Instruments previously used to measure the compositions of the middle atmosphere work in either one direction or two. For example, instruments on balloons and rockets take vertical measurements, and most instruments on satellites provide measurements on a two-directional basis. Previously, it has not been possible for scientists to take global measurements in all three dimensions with good spectral resolution at once.

CRISTA is an infrared instrument composed of three telescopes, with four spectrometers. Three of the spectrometers measure near infrared wavelengths (4 to 13 micrometers), and the fourth is sensitive to the far-infrared wavelengths (14 to 71 micrometers). Each telescope has a short-wavelength spectrometer attached, and the center telescope also holds the spectrometer that measures longer wavelengths.

Because of the high speed of CRISTA-SPAS (about five miles, or eight kilometers, per second) optics and detectors must be very fast to achieve good resolution for the measurements. The spectrometers take one spectrum per second and measure up to 15 gases in 26 channels during this time. The telescopes obtain complete altitude observations of these gases within about one minute as the lines-of-sight are scanned through the atmosphere. The required high measurement speed and the required high sensitivity is achieved by cryogenically cooling the CRISTA optics and detectors.

The CRISTA instrument is contained in a vacuum container cooled with liquid helium. The container is covered by a motorized door assembly. An electronics module that controls and monitors the functions and measurements of the instrument is contained in a Get-Away Special canister also located on the ASTRO-SPAS satellite. The satellite has its own pointing system and, by operating apart from the Shuttle, is not affected by orbiter maneuvers. CRISTA data is stored on the on-board data recorder.

The Middle Atmosphere High Resolution Spectrograph Investigation (MAHRSI).
Principal Investigator: Dr. Robert Conway, Naval Research Laboratory, Washington, D.C.

MAHRSI will measure amounts of hydroxyl and nitric oxide in the middle atmosphere and lower thermosphere, from 24 to 72 miles (40 to about 120 km) high. The experiment also will provide precise knowledge of the density and temperature in the upper atmosphere.

This information will be used to test many theories that have been based on assumed values and will provide the first global vertical measurements of hydroxyl in the stratosphere.

The area of the middle atmosphere between 25 and 75 miles altitude (40 and 120 km) is too high for balloon experiments, but is too quickly crossed by sounding rockets for scientists to obtain adequate data. Investigators have had to make assumptions regarding the atmospheric composition found in this region, and they have had to estimate the effects of vertical and horizontal mixing on its chemistry. Using horizon scanning, MAHRSI will measure the ultraviolet sunlight scattered by hydroxyl and nitric oxide in this region of the atmosphere to give scientists new information about these important gases.

Hydroxyl is an important part of the hydrogen family that contributes directly to destroying the ozone in the middle atmosphere. Hydroxyl combines with molecules of the "odd" nitrogen family to form nitric acid and other ingredients that participate in ozone chemistry. At heights above 37.5 miles (60 km) the distribution of nitric oxide is changed by winds and currents from the lower thermosphere.

MAHRSI also will provide a unique measurement of the temperature of the atmosphere in the region around 62.5 miles (100 km) high, the coldest region of the atmosphere. In a cooperative observation with CRISTA, this temperature and the nitric oxide quantity information will be combined to give important understanding of the thermal balance, which plays a significant role in ozone chemistry.

MAHRSI data will help scientists more accurately test the present understanding of ozone levels in the middle atmosphere and resolve conflicts between satellite ozone observations and the ozone amounts predicted by computer models.

MAHRSI takes high-resolution ultraviolet measurements of daytime radiation in Earth's atmosphere, in the wavelength range between 190 and 320 nanometers. MAHRSI measures light from hydroxyl and nitric oxide after these molecules absorb ultraviolet energy from the Sun. Hydroxyl measurements will be taken between 22 to 56 miles (35 to 90 km), and nitric oxide measurements from 28 to 90 miles (45 to 145 km).

By knowing the shape of the nitric oxide band, researchers can also determine the temperatures of the atmosphere at heights from 56 to 75 miles (90 to 120 km). MAHRSI will take either complete nitric oxide measurements or complete hydroxyl measurements each orbit.

MAHRSI consists of a Czerny-Turner spectrograph with a 30-inch (75-cm) focal length behind a 20-inch (50-cm) focal length telescope mounted on the ASTRO-SPAS satellite. MAHRSI transmits information to the recorder on-board.

CRISTA-SPAS Management

DARA is responsible for CRISTA-SPAS mission management, while overall science management for the joint science mission is the responsibility of NASA's Marshall Space Flight Center. Dr. Roland Wattenbach of Deutsche Agentur Fuer Raumfarhtangelegenheiten (DARA), Bonn, Germany, is the ASTRO-SPAS program manager. Dr. Konrad Moritz of Deutsche Aerospace (DASA) is the CRISTA-SPAS mission manager.

Detailed Test Objective 835: Mir Approach Demonstration

For the retrieval of CRISTA-SPAS on the 10th day of STS-66, Atlantis will use a new rendezvous approach to the satellite than has been standard for past satellite retrievals. Rather than approaching for the final approximately 1.5 miles to CRISTA-SPAS from a point directly ahead of the satellite, Atlantis will approach from beneath the satellite. An approach from directly in front of the satellite is called a iV-Bar,i approach, or approaching directly along the velocity vector of the satellite. The V-Bar approach is the standard technique that has been used on all past shuttle rendezvous. Atlantis will use a different approach, flying the final mile to CRISTA-SPAS along the iR-Bar,i an imaginary line drawn from the satellite to the center of the Earth.

The R-Bar approach is being evaluated for use in rendezvous with the Russian Mir Space Station in 1995 due to the propellant savings that it may achieve. Approaching the Mir, the shuttle will have to fire its braking jets in a mode called ilow Z,i where jets facing toward Mir do not fire and risk damaging the station. Instead, braking of the shuttle’s approach is performed by firing jets offset from facing directly at the station. The ilow Zi approach requires more propellant when used during a V-Bar rendezvous approach than during an R-Bar approach. To fully evaluate the planned Mir rendezvous, Atlantis will use ilow Zi braking as it performs the R-Bar CRISTA-SPAS rendezvous. The new approach may not only conserve propellant when approaching the Mir station but also could mean less braking thruster firings are required during the rendezvous in general, reducing any risk of damaging Mir.

EXPERIMENT OF THE SUN FOR COMPLEMENTING THE ATLAS PAYLOAD AND FOR EDUCATION-II (ESCAPE-II)

ESCAPE II (Experiment of the Sun for Complementing the Atlas Payload and for Education), a student-designed and -developed payload, will gather data that will contribute to a better understanding of the Sun's radiative effects on the Earth's upper atmosphere.

The ESCAPE II experiment was designed, managed and built entirely by undergraduate and graduate students at the Colorado Space Grant Consortium at the University of Colorado, Boulder. The consortium is a group of 13 state colleges and universities, linked by NASA in 1989 as part of a national effort to help maintain America's preeminence in space.

Instruments on ESCAPE II include a spectrometer and a digital imaging telescope, which will gather data in extreme ultraviolet wavelengths in which little research has been done over the last 20 years.

ESCAPE II will obtain digital images of the solar disk in Lyman alpha, a wavelength (121.6 n.m.) in the extreme ultraviolet. The students of ESCAPE II project are hoping the images will provide a correlation between solar activity and solar radiation reaching the Earth's atmosphere.

The ESCAPE II experiment is expected to shed new light on how the Sun's extreme ultraviolet wavelengths affect the temperature and chemical composition of the upper atmosphere. Understanding such variation is critical changes in solar radiation are known to influence a wide variety of chemical processes, including the natural production and destruction of stratospheric ozone. The release of human-produced chlorofluorocarbons (CFCs), is believed to be largely responsible for the recent seasonal decline in stratospheric ozone levels, most markedly over the Earth's poles. But to understand the magnitude of human-caused changes in the atmosphere, scientists first need to measure the variability of natural solar radiation.

The objectives of the ESCAPE II team earned the payload status as a secondary payload to NASA's ATLAS 3 mission. NASA's Get Away Special (GAS) program provided the students with an experiment canister that will be bolted into the payload bay of the Space Shuttle Atlantis. It is roughly 3 feet tall and 23 inches in diameter. ESCAPE II's instruments are contained in the canister, which has been fitted with a motorized door to accommodate view of the solar disk.

ESCAPE II is a follow-on payload to ESCAPE I (Extreme ultraviolet Solar Complex Autonomous Payload Experiment), which flew in April 1993 onboard the Space Shuttle Discovery as part of the STS-56/ATLAS 2 mission.

NATIONAL INSTITUTES OF HEALTH-R-1

The NIH-R-1 payload is a collaborative developmental biology experiment developed by NASA and the National Institutes of Health (NIH). The 11 experiments that comprise NIH-R-1 will study the effects of space flight on developing rats. These experiments will provide important insights into the fields of gravitational and space biology and gravity's effects on living organisms.

Flying in the Space Shuttle's middeck, the payload consists of two Animal Enclosure Modules (AEMs), each containing five pregnant rats. There are nine U. S. principal investigators, along with a principal investigator from France and one from Russia.

Effects of Space Flight on Muscles and Nerves
Kathryn Clark, Ph.D.
University of Michigan
Ann Arbor, Mich.

The goal of this study is to understand the effects of gravity on the formation, development and growth of rodent thigh muscles and nerves from a small, general mass of cells to fully developed systems. This study will further our understanding of how muscles develop and may also lead to advances in treatment of muscles following injury or disease.

An Experiment to Study the Role of Gravity in the Development of the Optic Nerve
James L. Lambert, Ph.D.
Jet Propulsion Laboratory
Pasadena, Calif.

The purpose of this experiment is to identify changes in development of the optic nerve in rats exposed to the weightlessness of space prior to birth. The results of this research may help us begin to understand the way in which gravity influences the development of our visual system.

In young animals, the final route or destination of electrical impulses from eye to brain is not well defined. The brain receives "fuzzy images" of the world because images captured by the eye may be sent to a range of points in the brain's visual center. The microgravity environment of space may indirectly play a role in modifying the retina to brain signal pattern.

Effects of Weightlessness on Vestibular Development
Bernd Fritzsch, Ph.D.
Creighton University
Omaha, Neb.

This experiment addresses the questions of whether gravity is essential for the normal development of balance and whether weightlessness causes the growth of abnormal connections in brain areas that control balance.

Animals that are in space for even brief periods are unable to maintain their balance when they return to Earth. Although adults regain the ability to orient to gravity within a few days, some animals raised in space never acquire the ability to orient in gravity.

One cause of this abnormal response to gravity may be the development of the connection between the gravity receptor of the ear and the brain. This experiment will study rats that develop in space beginning at an age before these connections are formed until near the time of birth.

Effect of Spaceflight on Development of Immune Responses

Gerald Sonnenfeld, Ph.D.
Carolinas Medical Center
Charlotte, N.C.

Space flight has been shown to change immune responses, which are those responses of the body that protect people and other animals from infection. These changes in immune responses could be due to the very low gravity found in space, as well as to other factors such as stress. Changes in immune responses could have an impact on the body's ability to resist infection. The current flight study will look at the effects of space flight on immune responses of developing rats.

The results of this study should indicate whether or not exposure of a developing rat to space flight will have an effect on its ability to have a normal immune response. This should provide information about the human immune system as well. In addition, the increased understanding of the development of immune responses could aid in the development of treatments for medical problems on Earth. For example, we may be able to find new ways to fight diseases in children on Earth.

Choroid Plexus, Brain and Heart NP Development in Space

Jacqueline Gabrion, Ph.D.
Universite de Montpellier
Montpellier, France

This experiment, sponsored by CNES (the French Space Agency), will study the effects of reduced gravity conditions on fluid regulation systems in the hearts, brains and bodies of rats developing in space. This experiment will study how the distribution of fluid regulating hormones change when the rat develops in microgravity.

Studies performed on the heart and brain during ground development have shown that these systems are different in developing and adult rats. This mission offers the first opportunity to obtain basic information on the effects of microgravity on the generation, storage and release of these hormones in the heart and brain of developing rats.

Fluid-Electrolyte Metabolism

Luba Serova, Ph.D.
Institute of Biomedical Problems
Moscow, Russia

This experiment will examine whether microgravity causes serious physiological changes in the mother rat, which in turn may induce changes in fluid electrolytes. Fluid electrolytes are substances that, in liquid form, easily transmit electric current; they are often mineral or nutrient rich. This experiment will examine whether microgravity causes serious physiological changes in the mother rat, which in turn may induce changes in fluid electrolytes, directly affecting signal transmission between nerves in developing offspring.

Previous Russian space flight studies have shown that pregnant rats exposed to microgravity for five days were able to maintain the fluid-electrolyte balance of developing rats within their normal limits. However, this led to serious changes in the mother rat, including significantly delayed body weight gain and reduced calcium in the liver and kidneys.

The objective of this flight experiment is to measure water, sodium, potassium, calcium, magnesium, copper, zinc and iron in developing rats that will have spent almost half of their gestation period in microgravity.

Other objectives are to measure the size of segments of various areas of the skeleton, to identify developmental abnormalities in young rats and to examine the size and tissue structure of different organs of young rats that have developed in space.

Microgravity and Placental Development
Randall H. Renegar, Ph.D.
East Carolina University School of Medicine
Greenville, N.C.

This experiment will use pregnant rats to determine the effect of microgravity on development of the rat placenta.

Ten pregnant rats will be aboard the space shuttle during its 11-day mission. Upon return to Earth, the rat uteruses and placentas will be examined. Hormones produced by these tissues will be analyzed to determine whether the cells involved have retained their structure and are operating correctly. These studies could identify factors that regulate pregnancy and provide important insights of the role that gravity plays in pregnancy on Earth .

Spaceflight Effects on Mammalian Development
Jeffrey Alberts, Ph.D.
Indiana University
Bloomington, Ind.

The vestibular system, which develops before birth, is the part of the body and brain that senses and translates information about gravity, thus providing the basis for balance, movement and coordination.

There is reason to expect that the vestibular system needs gravitational information to establish its early function. But there is no way to remove gravity on Earth, so the microgravity conditions of space provide the best insight into the role of gravity in early mammalian development. Studying the behavior of rats that have not been exposed to the normal force of gravity may provide information about the earliest development of the vestibular system.

Effect of Gravity on the Attachment of Tendon to Bone
Roger B. Johnson, D.D.S., Ph.D.
University of Mississippi, School of Dentistry
Jackson, Miss.

The strength of the attachment of tendons to bone is important to the movement of the legs. There is little information about the effects of space flight on the attachment of tendons to bone. This experiment is designed to determine if these attachments become weakened during space flight. If so, tendons could be torn from the bone, producing a serious injury and pain, thus preventing normal movement of the legs.

This experiment will study the attachment of tendons to the shin bone and heel of rats following their return from space flight. The attachments of the quadriceps and hamstring muscles to the shin bone and the calf muscle to the heel (the Achilles tendon) will be given special attention. This study will provide new and important information concerning the probability of damage to the attachment of tendon to bone during space flight and will aid in research designed to prevent such injuries to astronauts during future space flights.

Effect of Microgravity on Epidermal Development in the Rat
Steven B. Hoath, M.D.
Children's Hospital Medical Center
Cincinnati, Ohio

The effects of space flight and microgravity on the multiple functions of the skin have not yet been explored. This research will examine the composition, organization and integrity of the skin rats develop under the conditions of space flight. Analysis will include: the amount of calcium in the skin; a microscopic look at the cellular organization of its outermost layer; and measurement of selected properties. The data obtained from these studies will result in a better understanding of the effects of non terrestrial environments in altering the development and maturation of skin.

Development of Sensory Receptors in Skeletal Muscle
Mark DeSantis, Ph.D.
University of Idaho
Moscow, Idaho

This study of rats that undergo part of their prenatal development in space will examine microscopically the formation of sensory receptors (known as muscle spindles) and tendon organs in hind limb skeletal muscles. It will determine the presence, number and size of the muscle spindles. This research also will examine the effects of microgravity on the hind limb walking patterns of the rats.

NATIONAL INSTITUTES OF HEALTH-C-2

The NIH-C-2 payload is comprised of two collaborative biomedical experiments sponsored by NASA and the National Institutes of Health (NIH). These two experiments will make use of a computerized tissue culture incubator known as the Space Tissue Loss (STL) Culture Module. STL was developed at the Walter Reed Army Medical Center in Washington, D.C., to study cells in microgravity. Both experiments will study the effects of space flight on cells from chicken embryos.

Investigations of the Effects of Microgravity on in vitro Cartilage Calcification

Adele L. Boskey, Ph.D.
Hospital for Special Surgery
New York, N.Y.

Analyses of the crystals found in the bones of young chickens hatched from eggs flown in space have shown the presence of smaller crystals (cartilage or hydroxyapatite crystals) and the absence of any change in mineral crystal properties compared with Earth-based controls.

In this experiment, a scientific model of naturally occurring cartilage (a cartilage matrix) will be used to simulate animal cartilage. The experiment focuses on mineral deposition or calcification of cartilage. This experiment will be used to compare the mineral formed in the microgravity of space with that formed on Earth. Cultures at two different stages of development will be fixed for analysis at five points during the flight, allowing evaluation of changes in proliferation, maturation and mineralization of the cultures. Two additional cultures will be fixed after re-entry.

Results will provide direct insight into how calcification in cartilage and bone may be controlled in space. This knowledge is important prior to extended human stays on the Space Station and may also provide a better understanding of the events involved in normal bone development on Earth. Such understanding may eventually lead to the development of improved treatments for osteoporosis and other bone disorders.

Effect of Space Travel on Skeletal Myofibers

Herman H. Vandenburgh
The Miriam Hospital and Brown University
Providence, R.I.

This experiment will use tissue-cultured muscle cells to study the effects of space flight on muscle atrophy, protein turnover rates and growth factor secretion. The results of the experiment will indicate whether tissue cultured skeletal muscle fibers exposed to microgravity atrophy in the same way as fibers in humans and other animals do on Earth. The lack of tension on muscles in space, due to the lack of gravitational force, offers the opportunity to study the cellular mechanisms that cause microgravity-induced atrophy.

This type of research may help identify and develop countermeasures to sustain muscle strength on long-duration space voyages. The experiment also will provide a rapid screening system for testing drugs to prevent muscle atrophy on Earth.

PROTEIN CRYSTAL GROWTH EXPERIMENTS

Dr. Larry DeLucas
University of Alabama in Birmingham
Birmingham, Ala.

The STS-66 mission will carry two related systems - the Crystal Observation System, housed in a Thermal Enclosure System (COS/TES), and the Vapor Diffusion Apparatus, housed in a Single-locker Thermal Enclosure System (VDA/STES) - to continue research into the structure of proteins and other macromolecules such as viruses. In addition to using the microgravity of space to grow high-quality protein crystals for structural analysis, the experiments help develop technologies and methods to improve the protein crystallization process on Earth as well as in space.

Proteins are important, complex biochemicals that serve a variety of purposes in living organisms. Determining their molecular structure will lead to a greater understanding of functions in living organisms. Knowledge of the structure can also assist the pharmaceutical industry in the development of disease-fighting drugs.

Many proteins can be grown as crystals and their molecular structure determined through analysis of the crystals by X-ray crystallography. Unfortunately, crystals grown in the gravity environment of Earth often have internal defects that make such analysis difficult or impossible. As demonstrated on Space Shuttle missions since 1985, some protein crystals grown in space -- away from gravity's distortions -- are larger and have fewer defects.

Some of the proteins to be grown on STS-66 are: serum albumin, malic enzyme, aldehyde reductase and thrombin inhibitor complex.

Experiments in both crystal growth systems will evaporate large droplets of protein solution to begin the crystallization process. The protein solution and precipitating agent are carried into space in opposite sides of a double-barreled syringe. At the beginning of the mission, an astronaut pushes the syringe pistons to form a drop at the tip of each syringe. Water evaporates from the droplet in the growth chamber, and it is transferred as vapor to an absorbent wicking material in a receiving container. Proteins in the droplets crystallize as their concentrations rise. Crystals can be viewed through a window in the growth chamber. At the end of the mission, the crew retracts the droplets with crystals into the syringes for safe return to Earth.

Small video cameras within the Crystal Observation System will allow investigators to observe growing protein crystals several times a day, without excessive crew handling that could disrupt growth and without removing the system from its temperature-controlled environment. These observations could help scientists refine their control of the growing conditions, which could produce larger crystals with a more uniform internal order.

The Vapor Diffusion Apparatus (VDA) includes three trays, each containing 20 protein crystal growth chambers. The crew will turn a handwheel on each tray at the beginning of the mission to start growth, and each tray will be scanned with a video camera. The tray will be rescanned and photographed at the end of the mission.

The experiments are sponsored by NASA's Office of Life and Microgravity Sciences and Applications.

SPACE ACCELERATION MEASUREMENT SYSTEM (SAMS)

The Space Acceleration Measurement System (SAMS) will be flying for the eleventh time aboard the Space Shuttle. The middeck payloads that SAMS is supporting are the Protein Crystal Growth (PCG) experiments. SAMS will collect and record data characterizing the microgravity environment in the Shuttle's middeck.

Proteins play an important role in everyday life, from providing nourishment to fighting disease. Analyses of crystal forms of proteins can reveal much about how they work. Earth-grown crystals that are large enough to study often have numerous flaws caused by gravity. The study of crystals grown in space could lead to the development of foods with higher protein content and the design of more effective drugs.

SAMS will provide the scientists studying these crystals with the information of the microgravity environment that these crystals experienced during the mission. The scientists will be able to account for the rocket thruster firings, crew activity and background vibrations that influence these delicate experiments. The instrument is managed by NASA's Lewis Research Center, Cleveland, Ohio for the agency's Office of Life and Microgravity Sciences and Applications, Washington, D.C.

HEAT PIPE PERFORMANCE AND WORKING FLUID BEHAVIOR IN MICROGRAVITY (HPP)

The Heat Pipe Performance-2 (HPP-2) Experiment will investigate the thermal performance and fluid dynamics of heat pipes operating with asymmetric and multiple heating zones under microgravity conditions. A Thermal Performance Apparatus (TPA) mounted to middeck seat studs allows the Orbiter crew members to test individual heat pipes in the crew compartment during the flight. Thirty-five tests will be performed with ten different axially grooved aluminum/Freon heat pipes.

The design of effective spacecraft thermal control systems requires an understanding of heat pipe fluid dynamics in a microgravity environment. This behavior cannot be adequately evaluated on Earth because gravity tends to dominate the capillary forces developed in the wick. In the microgravity environment, however, surface tension forces within the apparatus. For these reasons, flight experiments are critical for collecting the data necessary for computer model validation.

The original Heat Pipe Performance Flight Experiment (HPP-1) was flown on STS-52 in October, 1992, to investigate and document the microgravity behavior and performance of several different types of heat pipes. Data from HPP-1 was used to modify and validate a NASA heat pipe computer model known as the Groove Analysis Program (GAP). The current version of GAP models heat pipes with single and uniform heating and cooling zones. The HPP-2 experiment will test heat pipes with asymmetric and multiple heating zones, providing data for correlation with new modifications to the GAP model. The basic difference between the two experiments is that HPP-1 tested 'ideal case', or simple heat pipes, while HPP-2 will test more realistic heat pipe designs that mirror the complexity of actual spacecraft applications.

The end product of the HPP-1 and HPP-2 Flight Experiments will be a GAP model capable of accurately predicting the performance of any type of axially grooved heat pipe design prior to manufacture, so large costs in incurred by building and testing prototype heat pipes can be avoided. The final version of GAP will allow thermal system engineers to be less conservative in their designs, leading to fewer heat pipes per spacecraft, thereby achieving significant weight and cost savings.

STS-66 CREWMEMBERS

STS066-S-002 -- The STS-66 crew portrait includes the following: Donald R. McMonagle (front right) is mission commander, and Curtis L. Brown (front center) is pilot. Other crewmembers include Ellen S. Ochoa, payload commander; Scott E. Parazynski (rear left), and Joseph R. Tanner (rear center), mission specialists, along with ESA astronaut Jean-Francois Clervoy (front left), mission specialist. Clervoy, Parazynski and Tanner, members of the 1992 astronaut class, are making their initial flights in space.

BIOGRAPHICAL DATA

DONALD (DON) R. MCMONAGLE, 42, Lt. Col., USAF, will be the Commander (CDR) of STS-68. Selected as an astronaut in 1987, McMonagle was born in Flint, Mi., and will be making his third space flight.

McMonagle graduated from Hamady High School, Flint, Mi., in 1970; received a bachelors in astronautical engineering from the Air Force Academy in 1974; and received a masters in mechanical engineering from California State University-Fresno in 1985.

McMonagle completed pilot training with the Air Force at Columbus Air Force Base, Miss., in 1975. He graduated from the Air Force Test Pilot School as the outstanding graduate of his class in 1981 and served as a test pilot at Edwards Air Force Base from 1982-1985. He attended the Air Force Command and Staff College at Maxwell Air Force Base, Ala., from 1985-86. With NASA, his first shuttle flight was as a mission specialist on STS-39 in April 1991, an unclassified mission devoted to studies for the Strategic Defense Initiative Office. He next flew as pilot of STS-54 in January 1993, a mission that deployed a NASA Tracking and Data Relay Satellite and performed astronomical studies using the Diffuse X-Ray Spectrometer.

McMonagle has logged more than 343 hours in space and more than 4,200 hours flying time in a variety of jet aircraft.

CURTIS (CURT) L. BROWN, 38, Lt. Col., USAF, will serve as Pilot (PLT). Selected as an astronaut in 1987, Brown was born in Elizabethtown, N.C., and will be making his second space flight.

Brown graduated from East Bladen High School, Elizabethtown, in 1974 and received a bachelors in electrical engineering from the Air Force Academy in 1978.

Brown completed pilot training with the Air Force in 1979 and was assigned to fly the A-10 aircraft at Myrtle Beach Air Force Base, S.C., in 1980. He was reassigned as an A-10 instructor pilot at Davis-Monthan Air Force Base, Ariz., in 1982. He attended the Air Force Fighter Weapons School in 1983 and graduated from the Air Force Test Pilot School in 1986 and later served the A-10 and F-16 aircraft.

Brown's first shuttle flight was as pilot of STS-47 in September 1992, the first Japanese-U.S. cooperative Spacelab mission. Brown has logged more than 190 hours in space and 3,700 hours flying time in jet aircraft.

DR. ELLEN OCHOA, Ph.D., 36, will be Payload Commander and Mission Specialist 1 (MS1) on STS-66. Selected as an astronaut in January 1990, Ochoa considers La Mesa, Ca., her hometown and will be making her second space flight.

Ochoa graduated from Grossmont High School in La Mesa in 1975; received a bachelors in physics from San Diego State University in 1980; and received a masters and doctorate in electrical engineering from Stanford University in 1981 and 1985, respectively.

Ochoa joined Sandia National Laboratories in 1985 in a research staff position and worked on developing optical methods for distortion-invariant object recognition and optical filters for noise removal, becoming a co-inventor on two patents in these areas. Her doctoral dissertation on using photorefractive crystals, a real-time holographic medium, in a coherent four-wave mixing optical system to perform nonlinear filtering of images also resulted in a patent. In 1988, Ochoa joined NASA's Ames Research Center, Moffett Field, Ca., to lead a research group in optical processing and later as chief of the Intelligent Systems Technology Branch, performing research and development of high performance computational systems for aerospace missions.

Ochoa's first flight was as a mission specialist on STS-56 in April 1993, the second flight of the Atmospheric Laboratory for Applications and Sciences (ATLAS-2). Ochoa has logged more than 216 hours in space.

BIOGRAPHICAL DATA

JOSEPH (JOE) R. TANNER, 44, will be Mission Specialist 2 (MS2). Selected as an astronaut in 1992, Tanner was born in Danville, Ill., and will be making his first space flight.

Tanner graduated from Danville High School in 1968 and received a bachelor's in mechanical engineering from the University of Illinois in 1973.

Tanner joined the Navy after high school and completed pilot training in 1975, later serving as an A-7E pilot with Light Attack Squadron 94 aboard the USS Coral Sea. He completed his regular Navy service as an advanced jet instructor pilot with Training Squadron 4 in Pensacola, Fla., although he remained active in the Naval Reserves.

Tanner joined NASA's Johnson Space Center in 1984 as an aerospace engineer and research pilot, serving as an instructor pilot in the Shuttle Training Aircraft used to train landing techniques for the space shuttle. He later became deputy chief of the Aircraft Operations Division. Tanner has logged more than 6,800 hours flying time in military and NASA jet aircraft.

JEAN-FRANCOIS CLERVOY, 35, a European Space Agency (ESA) astronaut, will be Mission Specialist 3 (MS3). Selected as an astronaut by ESA in 1992, Clervoy considers Toulouse, France, his hometown and will be making his first space flight.

Clervoy received his baccalaureate from College Militaire de Saint Cyr l'Ecole in 1976; graduated from Ecole Polytechnique, Paris, in 1981; graduated from Ecole Superieure de l'Aeronautique et de l'Espace, Toulouse, in 1983; and graduated as a Flight Test Engineer from Ecole du Personnel Navigant d'Essais et de Reception, Istres, in 1987.

Clervoy worked with the Delegation Generale pour L'Armamente of the French Space Agency (CNES) from 1983 to 1985 on automatic systems and attitude control systems of various projects, including the SPOT Earth Observations Satellite, the STAR inter-satellite optical link and the VEGA comet probe. In 1985, he was selected as a French Space Agency astronaut and worked as chief test director of the Parabolic Flight Program and also in the Hermes Crew Office, Toulouse, where he supported efforts in extravehicular activity, rendezvous and robotic arms. In 1991, Clervoy completed six weeks of intensive training in Star City, Russia, on the Soyuz, Mir and EVA systems. In the JSC Astronaut Office, he has supported development work on remote manipulator system and robotics issues.

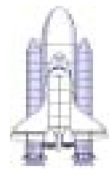
SCOTT E. PARAZYNSKI, M.D., 33, will be Mission Specialist 4 (MS4). Selected as an astronaut in 1992, Parazynski considers Palo Alto, Ca., and Evergreen, Co., his hometowns and will be making his first space flight.

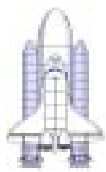
Parazynski attended high school first at the Tehran American School, Iran, and then graduated from the American Community School, Athens, Greece, in 1979; received a bachelors in biology from Stanford University in 1983; and received a doctorate in medicine from Stanford Medical School in 1989.

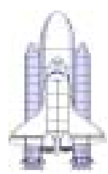
Parazynski was awarded a NASA Graduate Student Fellowship while in medical school and conducted research on fluid shifts that occur during human space flight. Additionally, he was involved in the design of several exercise devices being developed for long-duration space flight. Parazynski completed his medical internship at the Brigham and Women's Hospital of Harvard Medical School in 1990 and completed a 22-month residency in emergency medicine in Denver, Co., prior to his selection as an astronaut.

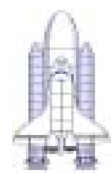
SHUTTLE FLIGHTS AS OF NOVEMBER 1994

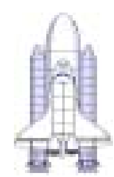
65 TOTAL FLIGHTS OF THE SHUTTLE SYSTEM -- 40 SINCE RETURN TO FLIGHT











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		STS-60 02/03/94 - -2/11/94		
STS-65 07/08/94 0 07/23/94		STS-51 09/12/93 - 09/22/93		
STS-62 03/04/94 - 03/18/94		STS-56 04/08/83 - 04/17/93		
STS-58 10/18/93 - 11/01/93		STS-53 12/02/92 - 12/09/92		
STS-55 04/26/93 - 05/06/93		STS-42 01/22/92 - 01/30/92		
STS-52 10/22/92 - 11/01/92		STS-48 09/12/91 - 09/18/91		
STS-50 06/25/92 - 07/09/92		STS-39 04/28/91 - 05/06/91	STS-46 07/31/92 - 08/08/92	
STS-40 06/05/91 - 06/14/91		STS-41 10/06/90 - 10/10/90	STS-45 03/24/92 - 04/02/92	
STS-35 12/02/90 - 12/10/90	STS-51L 01/28/86	STS-31 04/24/90 - 04/29/90	STS-44 11/24/91 - 12/01/91	
STS-32 01/09/90 - 01/20/90	STS-61A 10/30/85 - 11/06/85	STS-33 11/22/89 - 11/27/89	STS-43 08/02/91 - 08/11/91	
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STS-5 11/11/82 - 11/16/82	STS-41C 04/06/84 - 04/13/84	STS-51G 06/17/85 - 06/24/85	STS-34 10/18/89 - 10/23/89	STS-61 12/02/93 - 12/13/93
STS-4 06/27/82 - 07/04/82	STS-41B 02/03/84 - 02/11/84	STS-51D 04/12/85 - 04/19/85	STS-30 05/04/89 - 05/08/89	STS-57 06/21/93 - 07/01/93
STS-3 03/22/82 - 03/30/82	STS-8 08/30/83 - 09/05/83	STS-51C 01/24/85 - 01/27/85	STS-27 12/02/88 - 12/06/88	STS-54 01/13/93 - 01/19/93
STS-2 11/12/81 - 11/14/81	STS-7 06/18/83 - 06/24/83	STS-51A 11/08/84 - 11/16/84	STS-61B 11/26/85 - 12/03/85	STS-47 09/12/92 - 09/20/92
STS-1 04/12/81 - 04/14/81	STS-6 04/04/83 - 04/09/83	STS-41D 08/30/84 - 09/05/84	STS-51J 10/03/85 - 10/07/85	STS-49 05/07/92 - 05/16/92
OV-102 Columbia (17 flights)	**OV-099 Challenger (10 flights)**	**OV-103 Discovery 19 flights)**	**OV-104 Atlantis (12 flights)**	**OV-105 Endeavour (7 flights)**