NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

SPACE SHUTTLE MISSION
STS-67

PRESS KIT
MARCH 1995

ASTRO-2

STS-67 INSIGNIA

STS067-S-001 -- Observation and remote exploration of the universe in the ultraviolet wavelengths of light are the focus of the STS-67/ASTRO-2 mission, as depicted in the mission insignia designed by the crewmembers. The insignia shows the ASTRO-2 telescopes in the space shuttle Endeavour's payload bay, orbiting high above Earth's atmosphere. The three sets of rays, diverging from the telescope on the insignia atop the Instrument Pointing System (IPS) , correspond to the three ASTRO-2 telescopes the Hopkins Ultraviolet Telescope (HUT), the Ultraviolet Imaging Telescope (UIT), and the Wisconsin Ultraviolet Photo-Polarimeter Experiment (WUPPE). The telescopes are co-aligned to simultaneously view the same astronomical object, as shown by the convergence of rays on the NASA symbol. This symbol also represents the excellence of the union of the NASA teams and universality's in the exploration of the universe through astronomy. The celestial targets of ASTRO-2 include the observation of planets, stars and galaxies shown in the design. The two small atoms represent the search in the ultraviolet spectrum for the signature of primordial helium in intergalactic space left over from the Big Bang. The observations performed on ASTRO-2 will contribute to man's knowledge and understanding of the vast universe, from the planets in our system to the farthest reaches of space.

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: 95-18

ASTRO TELESCOPES MAKE SECOND FLIGHT ON STS-67 MISSION

This March, Space Shuttle Endeavor will conduct NASA's longest Shuttle flight to date carrying unique ultraviolet telescopes that will give astronomers a view of the universe impossible to obtain from the ground.

The mission, designated STS-67, also will see Endeavour's crew perform a wide range of microgravity processing experiments, continue efforts in understanding the structure of proteins and study active control of flexible structures in space.

Launch of Endeavour is scheduled for March 2, 1995 at approximately 1:37 a.m. EST from NASA's Kennedy Space Center's Launch Complex 39-A. Endeavour's flight will be 15 days, 13 hours, 32 minutes. A 1:37 a.m. launch on March 2, would result in a landing at Kennedy Space Center's Shuttle Landing Facility on March 17, at 3:09 p.m. EST.

The STS-67 crew will be commanded by Stephen S. Oswald who will be making his third Shuttle flight. William G. Gregory, who will be making his first space flight, will serve as pilot. The three mission specialists aboard Endeavour will include John M. Grunsfeld, Mission Specialist-1 (MS-1) who will be making his first flight, Wendy B. Lawrence, Mission Specialist-2 (MS-2) who will be making her first flight and Tamara E. Jernigan, Payload Commander and Mission Specialist 3 (MS-3) who will be making her third flight. Rounding out the crew will be two payload specialists who flew on ASTRO-1 during the STS-35 mission in December 1990. Samuel Durrance will serve as Payload Specialist-1 (PS-1) and Ronald Parise will serve as Payload Specialist-2. Both Parise and Durrance will be making their second space flight.

The Astro Observatory, making its second flight aboard a Space Shuttle, is a package of three instruments mounted on the Spacelab Instrument Pointing System (IPS). The Hopkins Ultraviolet Telescope will conduct spectroscopy in the far ultraviolet portion of the electromagnetic spectrum, allowing scientists to learn what elements are present in targeted celestial objects, as well as identify physical processes taking place.

The second instrument, the Ultraviolet Imaging Telescope, will take wide-field photographs of objects in ultraviolet light, recording the images on film for processing back on Earth. The third instrument, the Wisconsin Ultraviolet Photo- Polarimeter Experiment, will measure the intensity of ultraviolet light and its degree of polarization. The instrument will give astronomers clues to the geometry of a star or the composition and structure of the interstellar medium it illuminates.

Simultaneous observations by these three telescopes will complement one another as they provide different perspectives on the same celestial objects. These observations also will complement those of ultraviolet instruments on other NASA spacecraft, such as the Hubble Space Telescope, the International Ultraviolet Explorer, and the Extreme Ultraviolet Explorer -- all currently in operation. By combining research findings from these various instruments, scientists hope to piece together the evolution and history of the universe and learn more about the composition and origin of stars and galaxies.

The flight also will see the continuation of NASA's Get Away Special (GAS) experiments program. The project gives individuals an opportunity to perform experiments in space on a Shuttle mission. Two GAS cans will be carried in the cargo bay in support of a payload from the Australian Space Office. The payload, coincidentally named Endeavour, is an Australian space telescope that will take images in the ultraviolet spectrum of violent events in nearby exploding galaxies. The third in a series of six Commercial MDA ITA Experiments (CMIX) payloads will also fly aboard Endeavour. CMIX-03 includes biomedical, pharmaceutical, biotechnology, cell biology, crystal growth and fluids science investigations. These experiments will explore ways in which microgravity can benefit drug development and delivery for treatment of cancer, infectious diseases and metabolic deficiencies. These experiments also will include protein and inorganic crystal growth, experiments on secretion of medically important products from plant cells, calcium metabolism, invertebrate development and immune cell functions.

Endeavour will carry two systems in Shuttle middeck lockers to continue space-based research into the structure of proteins and other macromolecules. The study of proteins, complex biochemicals that serve a variety of purposes in living organisms, is an important aspect of this mission. Determining the molecular structure of proteins will lead to a greater understanding of how the organisms function. Knowledge of the structures also can help the pharmaceutical industry develop disease-fighting drugs. The two systems are the Vapor Diffusion Apparatus in which trays will be housed within a temperature-controlled Thermal Enclosure System and the Protein Crystallization Apparatus for Microgravity that will be housed in a Single-locker Thermal Enclosure System.

The Middeck Active Control Experiment is an experiment designed to study the active control of flexible structures in space. In this experiment, a small, multi-body platform will be assembled and free-floated inside the Space Shuttle. Tests will be conducted on the platform to measure how disturbances caused by a payload impact the performance of another nearby payload which is attached to the same supporting structure.

The STS-67 crew will take on the role of teachers as they educate students in the United States and other countries about their mission objectives. Using the Shuttle Amateur Radio Experiment-II, Shuttle Commander Stephen S. Oswald (call sign KB5YSR), pilot William G. Gregory, (license pending), mission specialists Tamara E. Jernigan (license pending) and Wendy B. Lawrence (KC5KII) and Payload Specialists Ron Parise (WA4SIR) and Sam Durrance (N3TQA) will talk with students in 26 schools in the U.S., South Africa, India and Australia using “ham radio”, about what it is like to live and work in space.

The STS-67 mission will be the 8th flight of Space Shuttle Endeavour and the 68th flight of the Space Shuttle system.

(END OF GENERAL RELEASE; BACKGROUND INFORMATION FOLLOWS.)

MEDIA SERVICES INFORMATION

NASA Television Transmission

NASA Television is available through Spacenet-2 satellite system, transponder 5, channel 9, at 69 degrees West longitude, frequency 3880.0 MHz, audio 6.8 Megahertz.

The schedule for television transmissions from the Orbiter and for mission briefings will be available during the mission at Kennedy Space Center, FL; Marshall Space Flight Center, Huntsville, AL; Dryden Flight Research Center, Edwards, CA; Johnson Space Center, Houston; NASA Headquarters, Washington, DC; and the NASA newscenter operation at Mission Control-Moscow. The television schedule will be updated to reflect changes dictated by mission operations.

Television schedules also may be obtained by calling COMSTOR 713/483-5817. COMSTOR is a computer data base service requiring the use of a telephone modem. A voice update of the television schedule is updated daily at noon Eastern time.

Status Reports

Status reports on countdown and mission progress, on- orbit activities and landing operations will be produced by the appropriate NASA newscenter.

Briefings

A mission press briefing schedule will be issued prior to launch. During the mission, status briefings by a Flight Director or Mission Operations representative and when appropriate, representatives from the payload team, will occur at least once per day. The updated NASA television schedule will indicate when mission briefings are planned.

Access by Internet

NASA press releases can be obtained automatically by sending an Internet electronic mail message to **domo@hq.nasa.gov**. In the body of the message (not the subject line) users should type the words "subscribe press-release" (no quotes). The system will reply with a confirmation via E- mail of each subscription. A second automatic message will include additional information on the service.

Informational materials also will be available from a data repository known as an anonymous FTP (File Transfer Protocol) server at ftp.pao.hq.nasa.gov under the directory /pub/pao. Users should log on with the user name "anonymous" (no quotes), then enter their E-mail address as the password. Within the /pub/pao directory there will be a "readme.txt" file explaining the directory structure.

The NASA public affairs homepage also is available via the Internet. The page contains images, sound and text (press releases, press kits, fact sheets) to explain NASA activities. It also has links to many other NASA pages. The URL is: **http://www.nasa.gov/hqpao/hqpao_home.html**

Access by fax

An additional service known as fax-on-demand will enable users to access NASA informational materials from their fax machines. Users calling (202) 358-3976 may follow a series of prompts and will automatically be faxed the most recent Headquarters news releases they request.

Access by Compuserve

Users with Compuserve accounts can access NASA press releases by typing "GO NASA" (no quotes) and making a selection from the categories offered.

STS-67 QUICK LOOK

Launch Date/Site:	March 2, 1995/KSC Pad 39A
Launch Time:	1:37 a.m. EST
Launch Window:	2 hours, 30 minutes
Orbiter:	Endeavour (OV-105) - 8th flight
Orbit/Inclination:	190 nautical miles/28.45 degrees
Mission Duration:	15 days, 13 hours, 32 minutes
Landing Time/Date	March 17, 1995
Landing Time:	3:09 p.m. EST
Primary Landing Site:	Kennedy Space Center, FL
Abort Landing Sites:	Return to Launch Site - KSC Transoceanic Abort Landing - Ben Guerir, Morocco Moron, Spain Abort Once Around - Edwards Air Force Base, CA
Crew:	Steve Oswald, Commander (CDR), Red Team Bill Gregory, Pilot (PLT), Red Team John Grunsfeld, Mission Specialist 1 (MS 1), Red Team Wendy Lawrence, Mission Specialist 2 (MS 2), Blue Team:
Team:	Tammy Jernigan, Payload Commander, Mission Specialist -3 (MS 3), Blue Sam Durrance, Payload Specialist 1 (PS 1), Blue Team Ron Parise, Payload Specialist 2 (PS 2), Red Team
Extravehicular Crewmembers:	Jernigan (EV 1), Grunsfeld (EV 2)
Cargo Bay Payloads:	ASTRO-2 Getaway Special Canisters
Middeck Payloads:	MACE PCG-STES CMIX PCG-TES
In-Cabin Payloads:	SAREX-II

Developmental Test Objectives/Detailed Supplementary Objectives:

DTO 251: Entry Aerodynamic Control Surfaces Test
DTO 254: Subsonic Aerodynamics Verification
DTO 301D Ascent Structural Capability Evaluation
DTO 307D Entry Structural Capability
DTO 312: External Tank Thermal Protection System Performance
DTO 319D Orbiter/Payload Acceleration and Acoustics Data
DTO 414: APU Shutdown Test
DTO 667: Portable In-Flight Landing Operations Trainer (PILOT)
DTO 674: Thermoelectric Liquid Cooling System Evaluation
DTO 700-8 Global Positioning System Developmental Flight Test
DTO 700-9 Orbiter Evaluation of TDRS Acquisition in Bypass Mode
DTO 805: Crosswind Landing Performance

DSO 326: Window Impact Observations
DSO 328: In-Flight Urine Collection Absorber Evaluation
DSO 484: Assessment of Circadian Shifting in Astronauts by Bright Light
DSO 487: Immunological Assessment of Crewmembers
DSO 488: Measurement of Formaldehyde Using Passive Dosimetry
DSO 603: Orthostatic Function During Entry, Landing and Egress
DSO 604: Visual-Vestibular Integration as a Function of Adaptation
DSO 605: Postural Equilibrium Control During Landing/Egress
DSO 608: Effects of Space Flight on Aerobic and Anaerobic Metabolism
DSO 614: The Effect of Prolonged Space Flight on Head and Gaze Stability during Locomotion
DSO 624: Pre and Postflight Measurement of Cardiorespiratory Responses to Submaximal Exercise
DSO 626: Cardiovascular and Cerebrovascular Responses to Standing Before and After Space Fligh
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 for STS-67 include:

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

- Abort-Once-Around (AOA) -- Earlier main engine shutdown with the capability to allow one orbit of the Earth before landing at Edwards Air Force Base, CA.

- Transatlantic Abort Landing (TAL) -- The loss of one or more main engines midway through powered flight would force a landing at either Moron, Spain, or Ben Guerir, Morocco.

- Return-To-Launch-Site (RTLS) -- Early shutdown of one or more engines, before the Shuttle has enough energy to reach Moron or Ben Guerir, would result in a pitch around and thrust back toward KSC until the Orbiter is within gliding distance of the Shuttle Landing Facility.

MISSION SUMMARY TIMELINE

Flight Day 1
Launch/Ascent
OMS-2 Burn
Astro/Spacelab Activation
Instrument Pointing System Activation
Astro Observations

Flight Day 2
Astro Observations

Flight Day 3
Astro Observations
MACE Operations

Flight Day 4
Astro Observations
MACE Operations

Flight Day 5
Astro Observations

Flight Day 6
Astro Observations
Off-Duty Time for MS 3 and PS 1

Flight Day 7
Astro Observations
MACE Operations
Off-Duty Time for MS 1 and PS 2

Flight Day 8
Astro Observations

Flight Day 9
Astro Observations
MACE Operations

Flight Day 10
Astro Observations
MACE Operations

Flight Day 11
Astro Observations
Off-Duty Time for MS 3 and PS 1

Flight Day 12
Astro Observations
MACE Operations
Off-Duty Time for MS 1 and PS 2

Flight Day 13
Astro Observations
Crew News Conference

Flight Day 14
Astro Observations
Flight Control System Checkout
Instrument Pointing System Stow Check and Redeployment

Flight Day 15
Astro/Spacelab Deactivation
Instrument Pointing System Stow
Cabin Stow

Flight Day 16
Deorbit Prep
Deorbit Burn
Entry
KSC Landing

PAYLOAD AND VEHICLE WEIGHTS

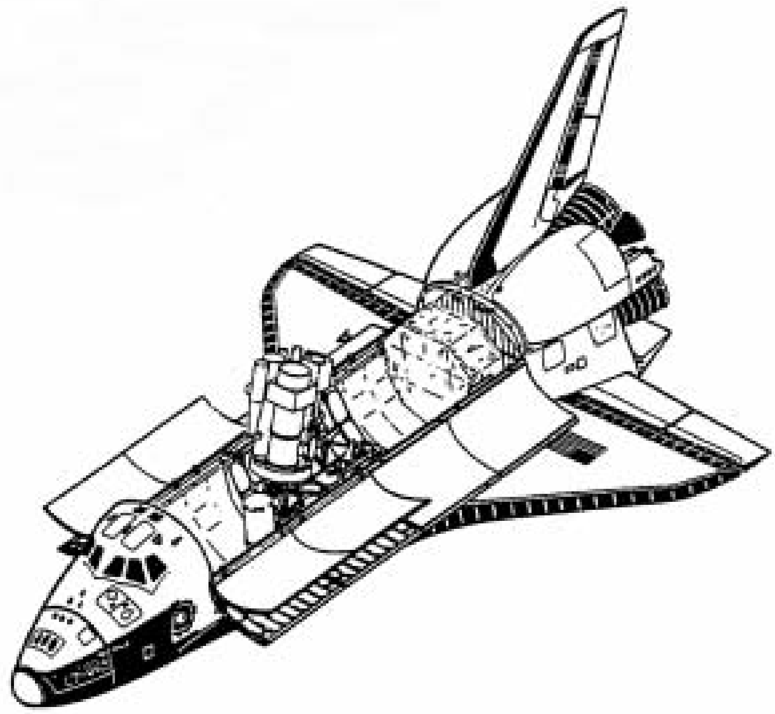
	Pounds
Orbiter (Endeavour) empty and 3 SSMEs	173,910
ASTRO-2 (Instruments and Support Equipment)	17,384
Getaway Special Canisters	1,000
CMIX	69
MACE (Middeck Active Control Experiment)	258
Protein Crystal Growth Experiment	205
Shuttle Amateur Radio Experiment	28
Detailed Test/Supplementary Objectives	171
Shuttle System at SRB Ignition	4,520,531
Orbiter Weight at Landing	217,683

STS-67 ORBITAL EVENTS SUMMARY

(Based on a March 2, 1995 Launch)

Event	MET	Time of Day (EST)
Launch	0/00:00	1:37 a.m., Mar. 2
OMS-2	0/00:51	2:28 a.m., Mar. 2
IPS Activation	0/03:15	4:52 a.m., Mar. 2
Crew News Conference	12/11:10	12:47 p.m., Mar. 14
FCS Checkout	13/11:45	1:22 p.m., Mar. 15
Deorbit Burn	15/12:25	2:02 p.m., Mar. 17
KSC Landing	15/13:32	3:09 p.m., Mar. 17

ASTRO-2 OBSERVATORY IN STS-67 PAYLOAD BAY



CREW RESPONSIBILITIES

Payloads and Activities	Prime	Backup
ASTRO	Jernigan	Grunsfeld Durrance, Parise
Getaway Specials	Grunsfeld	Lawrence
MACE	Oswald	Gregory
PCG	Lawrence	Gregory
CMIX	Gregory	Lawrence
SAREX	Parise	Oswald

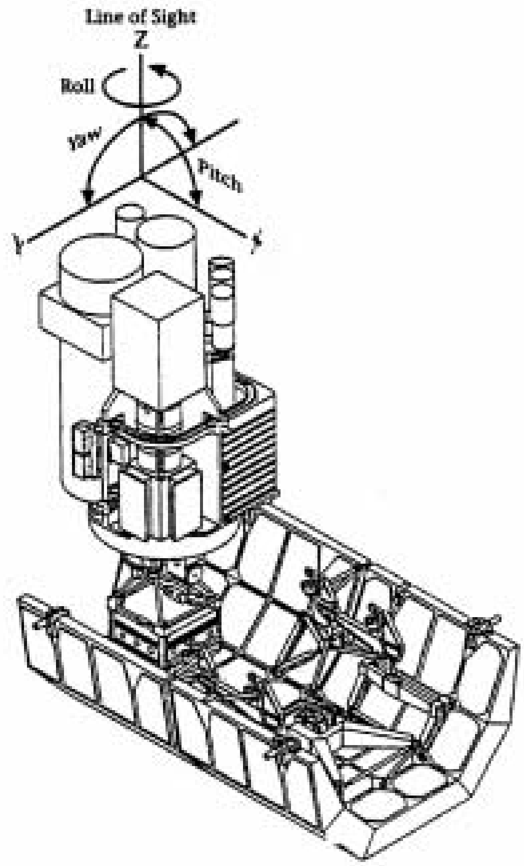
DTOs/DSOs

DTO 251:	Entry Aerodynamics Test	Oswald	Gregory
DTO 312:	Tank TPS Performance	Grunsfeld	Lawrence
DTO 667:	PILOT	Oswald	Gregory
DSO 484:	Circadian Shifting	Jernigan, Lawrence, Durrance	
DSO 487:	Immunological Assessment	All	
DSO 603C:	Entry Monitoring	Jernigan, Grunsfeld, Durrance, Parise	
DSO 604:	Head/Eye Movement	Grunsfeld, Parise, Oswald	
DSO 608:	Aerobic/Anaerobic	Oswald, Gregory, Lawrence	
DSO 605:	Postural Equilibrium	Oswald, Gregory	
DSO 614:	Head and Gaze Stability	Gregory, Grunsfeld	
DSO 624:	Submaximal Exercise	Durrance, Parise	
DSO 626:	Extended Stand Test	Jernigan, Grunsfeld, Durrance, Parise	

Other Activities:

Photography/TV	Grunsfeld	Lawrence, Gregory
In-Flight Maintenance	Gregory	Lawrence, Oswald
Earth Observations	Grunsfeld	Lawrence
Medical	Oswald	Jernigan

ASTRO-2 OBSERVATORY INSTRUMENT CONFIGURATION



ASTRO-2

A cluster of unique telescopes will turn the Space Shuttle Endeavour into an Earth-orbiting ultraviolet observatory. This set of mechanized "eyes" will give astronomers a view of the heavens impossible to obtain from the ground.

The mission, which will study some of the most energetic events in the cosmos, builds on the experience and scientific data obtained on the first Astro flight in 1990. This second mission will fill gaps in knowledge about ultraviolet astronomy, expand and refine existing data, and help astronomers better understand our dynamic universe.

NASA's Marshall Space Flight Center in Huntsville, AL, supervised development of the Astro observatory and manages Astro missions for the Astrophysics Division of NASA's Office of Space Science, Washington, DC.

Why Ultraviolet Astronomy?

Since the earliest days of astronomy, people have used the light from stars to test their understanding of the universe. However, the visible light that can be studied from Earth is only a small portion of the radiation produced by celestial objects. Other forms of radiation -- like lower energy infrared light and higher energy ultraviolet light and X-rays -- are absorbed by the atmosphere and never reach the ground.

Seeing celestial objects in visible light alone is like looking at a painting in only one color. To fully appreciate the meaning of the painting, viewers must see it in all of its colors.

Getting above the atmosphere with space instruments like the Astro ultraviolet telescopes lets astronomers add some of these "colors" to their view of stars and galaxies.

The universe of ultraviolet astronomy is strikingly different from our familiar night sky. Most stars fade from view, too cool to emit much ultraviolet radiation. But very young massive stars, some very old stars, glowing nebulae, active galaxies, quasars and white dwarfs stand out when observed with instruments sensitive to ultraviolet radiation.

Before the advent of orbiting ultraviolet telescopes, scientists had to be satisfied with rocket-borne ultraviolet telescopes. In fact, all three Astro telescopes are based on prototypes flown separately on sounding rockets. A typical rocket flight might gather 300 seconds of data on a single object. During Astro-2, scientists expect their three telescopes to gather hundreds of hours of data on a multitude of celestial objects.

THE ASTRO TELESCOPES

The Astro Observatory is a package of three instruments, mounted on the Spacelab Instrument Pointing System.

The **Hopkins Ultraviolet Telescope** (HUT), developed at The Johns Hopkins University, Baltimore, MD, conducts spectroscopy in the far ultraviolet portion of the electromagnetic spectrum. Spectroscopy allows scientists to learn what elements are present in an object, as well as identify physical processes taking place there.

The **Ultraviolet Imaging Telescope** (UIT), developed by NASA's Goddard Space Flight Center, Greenbelt, MD, takes wide- field photographs of objects in ultraviolet light, recording the images on film for processing back on Earth.

The **Wisconsin Ultraviolet Photo-Polarimeter Experiment** (WUPPE), developed at the University of Wisconsin at Madison, measures the intensity of ultraviolet light and its degree of polarization. When light waves are polarized, or vibrate in a preferred direction rather than randomly, they give astronomers clues to the geometry of a star or the composition and structure of the interstellar medium it illuminates.

Simultaneous observations by the three telescopes complement one another, as they provide different perspectives on the same celestial objects.

Astro-2 observations also complement those of ultraviolet instruments on other NASA spacecraft, such as the Hubble Space Telescope, the International Ultraviolet Explorer, and the Extreme Ultraviolet Explorer -- all currently in operation. By combining research findings from various instruments, scientists hope to piece together the evolution and history of the universe and learn more about the composition and origin of stars and galaxies.

Astro-1

The first flight of the Astro observatory took place in December 1990 and lasted nine days. In addition to the ultraviolet telescopes, the observatory included an X-Ray instrument called the Broad-Band X-Ray Telescope mounted on a separate pointing system.

During this mission the Astro team learned a number of valuable lessons about operating a Shuttle-based astronomical observatory in orbit -- lessons that will be put to good use during the Astro-2 mission.

The Astro-1 instruments captured the first views of many celestial objects in extremely short ultraviolet wavelengths, took the first detailed ultraviolet photographs of many astronomical objects, and made the first extensive studies of ultraviolet polarization.

The end of 1994 saw more than 110 scientific articles published on Astro-1 results by these four instrument teams.

One of the first-covered Hopkins Ultraviolet Telescope observations was designed to test a theory which had been proposed about the nature of so-called "dark matter," -- a substantial portion of the universe's mass that astronomers have been unable to account for. The observation effectively disproved the theory, leaving the "missing mass" in the universe as mysterious as ever.

Successive papers reveal an impressively wide range of scientific insights obtained by Astro-1. Observations covered everything from solar system objects, nearby interstellar medium, distant quasars, star clusters, galaxies, individual nebulae and stars. Each observation helps to fill in gaps in our understanding of the physics of these objects.

ASTRO-1 RESULTS AND ASTRO-2 GOALS

Many Astro-2 observations will build on discoveries from Astro-1, while others will seek to answer additional questions about the ultraviolet universe.

Stellar evolution. Stars like Earth's Sun are the most common type, emitting most of their radiation in visible light. But young stars being formed, and some old stars in later stages of their evolution, shine brighter in ultraviolet wavelengths.

On Astro-1, UIT images identified rings of massive star formation in several galaxies, and roughly half of the instrument's science program on Astro-2 is devoted to studies of star-forming galaxies. A unique UIT contribution is the identification of thousands of individual hot stars in other galaxies for later study by NASA's Hubble Space Telescope.

UIT also photographed globular clusters, where there are often so many stars grouped together that it is impossible to distinguish individual stars. The ultraviolet images picked out hot stars in late stages of evolution, where hydrogen has been depleted from the cores and energy is provided by burning helium. By comparing photographs taken in different wavelengths, scientists were able to measure the temperature as well as brightness of the individual stars.

Observing more globular clusters is a high priority for the imaging telescope on Astro-2. Astronomers will compare the observations to theoretical predications, to help fill in gaps in their knowledge about these late evolutionary stages.

All three Astro-2 telescopes will study white dwarf stars. These are old stars in a transition phase -- former giants which have shed their cool outer layers, leaving dormant cores containing a sun's worth of mass within a sphere the size of Earth. The hottest white dwarf stars, perhaps as hot as 200,000 degrees Fahrenheit (110,000 degrees Celsius), are very unstable and pulsate every five to ten minutes.

Spinning stars. One of the surprises from Astro-1 were observations of stars that are spinning very fast, called Be stars. A Be star is thought to be surrounded by a disk of gas lost from the star. WUPPE found that the amount of polarized light coming from these stars was less than is seen in visible light and less than expected in the ultraviolet, indicating that some of the ultraviolet polarized light was being removed by the gas in the disk around the star. The wavelengths in the ultraviolet where polarized light was missing told astronomers that there are apparently atoms of gaseous iron in the disks close to Be stars. The WUPPE team will try to learn more about the gaseous disks by viewing more Be stars during Astro-2.

Cataclysmic variables. Astro-1 ultraviolet telescopes observed cataclysmic variables -- dual star systems which occasionally increase dramatically in brightness as a dense old star called a white dwarf pulls material from its companion normal star. One particularly interesting observation was of a variable near the peak of its brightness, which Astro-1 was able to view after a support network of amateur astronomers using ground-based telescopes reported seeing an outburst in progress. Results from the Astro-1 observations did not match theoretical predictions, causing a re-evaluation of current theories about this type of star system.

Scientists will use follow-up observations during Astro-2 to learn more about what triggers the sudden outbursts of energy in cataclysmic variables, which can increase their brightness 100 times or more.

Supernova remnants. Supernova remnants are the ghosts of dead stars, expanding gaseous nebulae created by stellar explosions. Observing the young remnants of a supernova's explosion provides the only direct test of a process called nucleosynthesis, whereby lighter elements are manufactured into heavier elements in the centers of stars. Observations of old supernova remnants actually probe conditions in interstellar space as the shock wave encounters clouds of interstellar material.

During Astro-1, all three ultraviolet telescopes observed the Cygnus Loop, the remnant of an explosion some 40,000 years ago. Observations detected a much higher temperature and therefore much greater velocity of its shock wave than had been predicted. The telescopes also studied the Crab Nebula, a relatively young supernova remnant.

Astro-2 observations will include the Cygnus Loop and several other supernovas as well.

Galaxy morphology. Galaxies come in a variety of shapes and sizes, such as gigantic spirals like the Earth's Milky Way, egg-shaped ellipticals and irregular shapes with no preferred form. Studying the shapes of galaxies in the ultraviolet is a key to the study of galaxy evolution in the early universe.

Before Astro-1, there were only a handful of ultraviolet pictures of nearby galaxies available. UIT images from that mission revealed that the shapes of galaxies seen in ultraviolet wavelengths are strikingly different for their familiar forms in visible light. One UIT goal for Astro-2 is the construction of an ultraviolet atlas of spiral galaxies.

Active galaxies. Observations of active galaxies by the Astro telescopes may help astronomers explain why the cores of galaxies give off large amounts of high-energy ultraviolet, X-Ray and gamma-ray radiation.

Most astronomers believe that the radiation is produced by a massive black hole in the center of the galaxy, surrounded by a torus, or doughnut-shaped cloud of material. The WUPPE instrument on Astro-1 confirmed the existence of a thick torus, while another instrument showed unexpectedly high temperatures near it. These results support the idea that ultraviolet radiation is being absorbed by a disk of matter spiraling into a massive black hole.

Astro-2 observations will help confirm or refute this picture of what is happening in the centers of active galaxies.

Elliptical galaxies. Astro-1 observations by both HUT and UIT shed light on a 20-year-old mystery about the source of faint, ultraviolet emissions in elliptical galaxies. Such galaxies are thought to consist almost entirely of old red stars, which do not emit large amounts of ultraviolet light. However, early astronomical satellites showed that these elliptical galaxies increase in brightness at short ultraviolet wavelengths.

The Astro-1 studies ruled out some proposed explanations for the ultraviolet emissions, and they found strong evidence for a previously unknown stage of stellar evolution that apparently is occurring in these galaxies. During Astro-2, both UIT and HUT will observe more elliptical galaxies to confirm and extend these ideas.

Interstellar dust. On Astro-1, WUPPE used half a dozen bright stars like flashlights to illuminate the interstellar medium, literally shedding new light on the chemical composition and physical nature of the “dust” between stars in our Milky Way galaxy. Surfaces of these dust grains are thought to provide a safe haven for the formation of molecules, clouds of which are the “womb” for the formation of each generation of new stars.

Astro-1 observations revealed that some parts of the galaxy seem to have dust grains that may look like tiny hockey pucks, while other parts seem to have a mixture of several sizes, shapes and kinds of dust grains. Previously, astronomers had thought properties of this interstellar dust were the same wherever the dust was found. A major Astro-2 goal for WUPPE will be to determine whether these different types of dust grains form because conditions in some parts of the galaxy are different than they are in other areas.

* Primordial intergalactic gas. The primary Astro-2 goal for the Hopkins telescope is to detect the existence of primordial intergalactic gas, an investigation it did not get to perform on Astro-1.

This helium gas in the vast space between galaxies is thought to be left over from the “Big Bang,” the primordial fireball which marked the beginning of the universe. Existence of the gas is a logical consequence of the “Big Bang” theory.

HUT will look for evidence of intergalactic helium by observing the light of an extremely distant object called a quasar, located behind the gas, much as a hazy mist can be viewed when it is illuminated by the beam of a distant flashlight. Helium in the intervening gas would absorb light of a specific frequency from the quasar, altering the chemical signature the quasar could normally be expected to produce.

A recent Hubble Space Telescope observation found evidence of intergalactic helium in the spectrum of one quasar. However, HUT’s spectral region permits looking at more nearby quasars. Positive results from

Astro-2 observations would not only verify the Hubble findings, but they could allow the density and ionization state of the gas to be measured as well.

Solar system objects. HUT made several observations of the planet Jupiter and its moon Io during Astro-1, studying the dynamic nature of their relationship. Io, the most volcanically active body in the solar system, spews out volcanic material into space, where it is ionized and swept up by Jupiter's strong magnetic field. Ultraviolet observations permit a better understanding of the temperatures and densities of the resulting plasma. Scientists were able to use HUT's more detailed spectra to reinterpret data gathered by the Voyager spacecraft in the late 1970s.

More studies of Jupiter will be performed during Astro-2. The observations will help determine the importance to Jupiter's atmosphere of extreme ultraviolet radiation from the Sun. The telescopes also will look for changes in the planet's upper atmosphere resulting from recent impacts by fragments of Comet Shoemaker-Levy 9.

ASTRO-2 INSTRUMENTS

Hopkins Ultraviolet Telescope (HUT)

Principal Investigator: Dr. Arthur F. Davidsen
The Johns Hopkins University Baltimore, MD

The Hopkins Ultraviolet Telescope conducts spectroscopy in the far ultraviolet portion of the electromagnetic spectrum. During Astro-2, it will study a wide variety of objects, ranging from our own solar system and galactic neighborhood to very distant objects near the edge of the observable universe.

The instrument team's highest priority for Astro-2 is the search for intergalactic helium thought to be left over from a primordial fireball that marked the birth of the universe about 10 to 20 billion years ago. HUT astronomers will attempt to analyze light shining through this gas by observing distant quasars.

The portion of the spectrum observed by the Hopkins telescope, coupled with the instrument's sensitivity, enables it to see a slice of the ultraviolet universe which other observatories are unable to detect. HUT's spectral region covers wavelengths shorter than those observed by the Hubble Space Telescope and the International Ultraviolet Explorer and longer than the Extreme Ultraviolet Explorer satellite.

HUT uses a 36-inch (0.9 meter) mirror, located in the back of the telescope tube, to focus ultraviolet light from astronomical objects into a spectrograph set in the middle of the telescope. The spectrograph "spreads" ultraviolet light into a spectrum which can be studied in detail, in much the same way as a prism separates visible light into a rainbow of colors. It then measures the brightness of the light at each wavelength.

By analyzing how the brightness varies across the wavelengths, scientists can determine the elements present in the object, the relative amounts of each element, and the temperature and density of the object. From this, astronomers can gain a better understanding of the physical processes occurring in or near the object being studied.

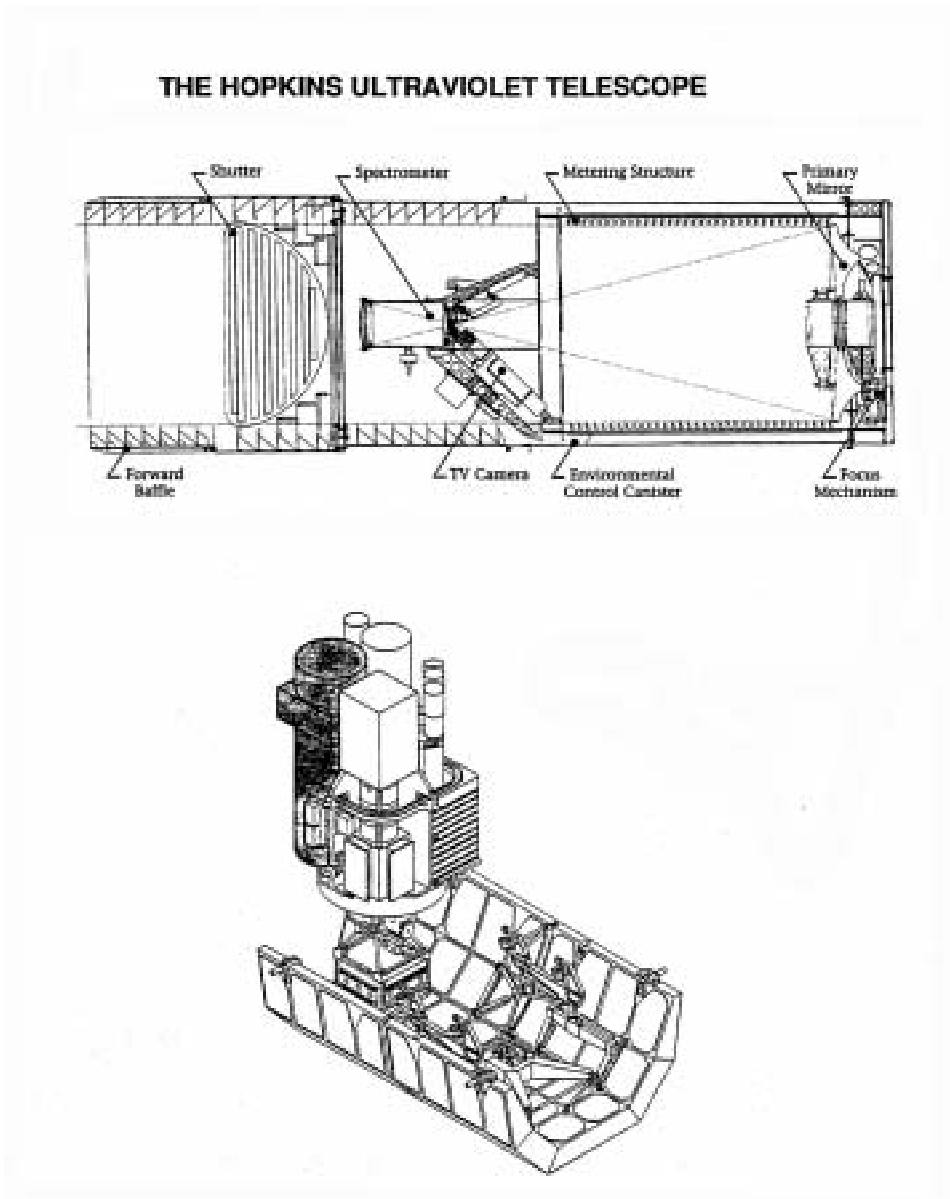
HUT was designed and built by Johns Hopkins University astrophysicists and engineers at the university's Applied Physics Laboratory in Laurel, MD. More than two dozen faculty, staff and students from Johns Hopkins currently are involved in the project.

During Astro-1, HUT made numerous observations of active galactic nuclei, quasars, cataclysmic variables, nebulae, supernova remnants, solar system objects and other astronomical objects, many of which had never been studied before in the energy range unique to HUT.

The telescope has been improved significantly for Astro- 2, and the science team expects it to be about three times more sensitive to the far ultraviolet spectrum than it was on its first mission. This will allow them to obtain higher quality spectra and to observe fainter objects. The primary mirror has been coated with silicon carbide, which is much more reflective to far ultraviolet light than the iridium coating on the original HUT mirror. The spectrograph grating also has been coated with silicon carbide.

Each time the Astro-2 telescopes point for a new observation, astronauts and ground controllers will use visible-light images on HUT's closed circuit TV camera to identify the desired targets and to verify that the telescope is pointing accurately.

Spectra from the observations will be downlinked to the HUT science team in Huntsville, where Johns Hopkins scientists will record the data. About 60 days after landing all of the science and engineering data will be sent to Baltimore. Scientists there will continue the detailed process of analyzing their collected information.



Hopkins Ultraviolet Telescope (HUT)

Telescope Optics:	Silicon carbide-coated parabolic mirror
Aperture:	36 inches (90 centimeters)
Focal Ratio:	f/2
Guide TV Field of View:	10 arc-minutes
Spectral Resolution:	3.0 Angstroms
Wavelength Range:	830 to 1860 Angstroms (limited sensitivity in 500 to 750 Angstrom range)
Magnitude Limit:	16
Detector:	Prime Focus Rowland Circle Spectrograph with microchannel plate intensifier And electronic diode array detector
Weight:	1,736 pounds (789 kilograms)
Dimensions:	44 inches (1.1 meter) diameter 12.1 feet (3.7 meters) length

Wisconsin Ultraviolet Photo-Polarimeter Experiment (WUPPE)

Principal Investigator: Dr. Arthur D. Code
University of Wisconsin, Madison, WI

The Wisconsin Ultraviolet Photo-Polarimeter Experiment (WUPPE) measures the polarization and intensity of ultraviolet radiation from celestial objects.

Photometry is the measurement of the intensity (brightness) of the light, while polarization is the measurement of the orientation (direction) of the vibrating light wave.

Light is made up of electric and magnetic waves that vibrate from side to side, up and down, and diagonally. The polarization of light is a measure of how much more the waves vibrate in one direction than the others.

Usually, light waves vibrate randomly, thus are said to be unpolarized. The waves become polarized when they encounter a particular object or force which causes them to vibrate in a preferred direction. For example, polarization occurs when light is emitted in the presence of a magnetic field or when it passes through clouds of dust grains aligned by an interstellar magnetic field. The light from a comet's tail is reflected sunlight that becomes polarized when it is scattered by the ice and dust particles left in the comet's wake. This is similar to the way that polarized sunglasses reduce the glare of scattered light.

Determining the amount and direction of polarization and how these change with wavelength can tell scientists what caused the light waves to vibrate in a preferred direction Ñ indicators of a celestial object's geometry and other physical conditions, or about the reflecting properties of tiny particles in the interstellar medium along the radiation's path.

The primary processes responsible for polarization within individual celestial objects are enhanced in observations of hotter, more energetic ultraviolet radiation. The background clutter common in visible light studies is greatly reduced, which is important since polarization of the interstellar medium usually is not as strong in ultraviolet as in visible wavelengths.

Natural light also can become polarized when it passes through a cloud containing dust grains aligned by an interstellar magnetic field. From this scientists learn about the kinds of grains and can map out the magnetic fields in space.
The Wisconsin Ultraviolet Photo-Polarimeter Experiment was built by scientists, engineers and students at the University of Wisconsin-Madison's Space Astronomy Lab in the 1980s.

Before the Astro-1 flight, only one single measurement of ultraviolet polarization had ever been made. WUPPE observations from Astro-1 gave astronomers the first measurements of the ultraviolet polarization of many types of astronomical objects. The instrument provided detailed spectral data on the polarization of some three dozen stars, interstellar clouds and galaxies, and ultraviolet spectra of an additional 20 stellar objects.

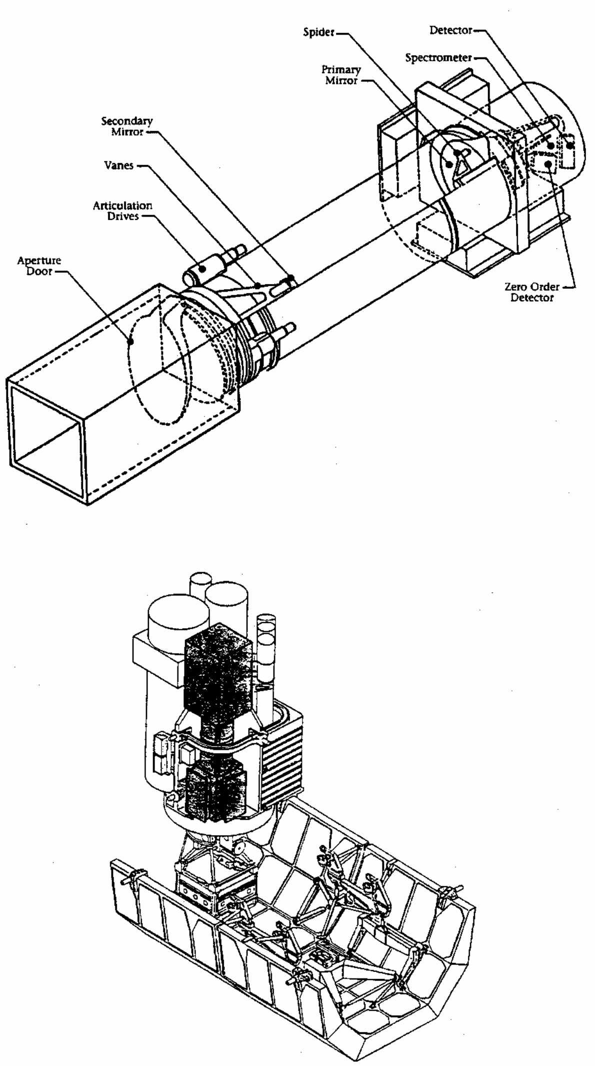
A major Astro-2 goal for WUPPE is to follow up on Astro-1 observations of the interstellar medium. The science team hope to learn more about the causes of polarization and the nature of "dust" grains in the space between stars. They also will follow up on observations of active galaxies and rapidly spinning stars.

The WUPPE telescope examines ultraviolet radiation from 1,400 Angstroms (around the mid-point of the far ultraviolet range) to 3,200 Angstroms (slightly shorter wavelengths than blue visible light). This is an area that has not been readily studied, especially for stars that are too bright for Hubble's Faint Object Spectrograph and for nebulae too large for Hubble's smaller spectrograph openings.

The telescope is a classical Cassegrain-type, meaning that light enters the tube and strikes a large, parabolic mirror near the back. The light then is reflected forward to a smaller, secondary mirror near the front of the telescope, which focuses the light back through a hole in the center of the large mirror. The secondary mirror can be adjusted in precise increments to refocus the telescope, to allow it to look at objects slightly offset from those other Astro instruments are studying, and to perform rapid small corrections to the telescope's pointing direction.

Behind the primary mirror, the beam passes through an ultraviolet spectrograph, a device which spreads out the radiation by wavelengths. A beam-splitting prism divides the resulting spectrum into two perpendicular planes of polarization, and the two spectra are recorded simultaneously on two separate detectors. Comparison of the two spectra is then used to study the polarization of the ultraviolet light as a function of wavelength.

THE WISCONSIN ULTRAVIOLET PHOTO-POLARIMETER EXPERIMENT



Wisconsin Ultraviolet Photo-Polarimeter Experiment (WUPPE)

Telescope Optics:	Cassegrain system
Aperture:	20 inches (50 centimeters)
Focal Ratio:	f/10
Spectral Resolution:	6 Angstroms
Wavelength Range:	1,400 to 3,200 Angstroms
Magnitude Limit:	16
Detectors:	Spectropolarimeter with dual electronic diode array detectors
Weight:	981 pounds (446 kilograms)
Dimensions:	28 inches (70 centimeters) diameter 12.14 feet (3.7 meters) length

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Ultraviolet Imaging Telescope (UIT)
Principal Investigator: Theodore P. Stecher
NASA Goddard Space Flight Center, Greenbelt, MD

The Ultraviolet Imaging Telescope makes deep, wide-field photographs of objects in ultraviolet light. This type of imagery is a primary means for recognizing fundamentally new phenomena or important examples of known astrophysical objects in ultraviolet wavelengths. Before Astro-1, very few ultraviolet images had been made and those that were available were taken during brief rocket flights.

The Ultraviolet Imaging Telescope observes a field of view two-thirds of a degree across, an area larger than the full Moon. This is considered “wide field” for astronomers; each UIT photo covers an area more than 250 times the size of the Hubble Space Telescope’s Wide Field/Planetary Camera, though at lower angular resolution and sensitivity. For many galaxies or star clusters, this is large enough to encompass the entire object in a single photo frame. In addition, the UIT suffers much less interference from visible light, since it is provided with “solar blind” detectors.

Images made in the ultraviolet spectrum clearly show the dynamic events taking place beyond our world. The clutter of objects which produce most of their radiation in visible light disappears. Hot stars leap into prominence, the spiral arms of distant galaxies snap into clearer resolution, and the material hidden between the stars comes into view. UIT’s wide-field images are ideal for investigating astronomical questions such as the shapes of nearby galaxies as revealed in ultraviolet light, the properties of massive hot stars, the evolution of low-mass stars, and the nature of interstellar dust and gas. UIT galaxy-wide images are sky surveys that can locate bright ultraviolet stars for further more detailed study by the Hubble Space Telescope.

The Ultraviolet Imaging Telescope was developed at NASA’s Goddard Space Flight Center, Greenbelt, MD. During Astro-1, UIT obtained a large number of images, including clusters of young, hot massive stars; globular clusters containing old stars, some of which are unusually hot; spiral galaxies rich with star-forming activity; and smaller “irregular” galaxies that can experience sudden bursts of star formation. Astro-2 will continue the important work of imaging the ultraviolet sky.

UIT is a powerful combination of telescope, image intensifier and camera. Unlike data from the other Astro instruments, which will be electronically transmitted to the ground, UIT images will be recorded directly on very sensitive astronomical film. The film will be processed and analyzed after Endeavour returns to Earth.

Light is reflected from a 15-inch (38-centimeter) primary mirror, at the middle of the telescope tube, to a secondary mirror near the front. The secondary mirror is linked to an image motion compensation system, which adjusts it slightly as necessary to offset any motion or jitter in the spacecraft. This is critical since any motions would blur the resulting photographs.

Reflected from the secondary mirror, the light passes through filter wheels containing six filters each. These different filters allow specific wavelengths of the ultraviolet spectrum to be selected. By comparing two images of the same area with different filters, the UIT team can measure the temperature as well as the brightness of every object in the field.

The light then enters one of the telescope's two image intensifier/film transport units. The image intensifiers amplify and convert the ultraviolet light into a visible image that can be recorded on astronomical film. Each unit contains 1,000 film frames.

A 30-minute exposure can record a blue star of 25th magnitude, about 100 million times fainter than the faintest visible light star which could be seen by the naked eye on a clear, dark night. Developed after the mission, each frame of film is digitized to form an array of 2,048 x 2,048 picture elements, called pixels, for computer analysis. This analysis produces quantitative information about the objects whose images appear on the film.

Ultraviolet Imaging Telescope (UIT)

Telescope Optics:	Ritchey-Chretien
Aperture:	15 inches (38 centimeters)
Focal Ratio:	f/9
Field of view:	40 arc-minutes
Angular Resolution:	2 arc-seconds
Wavelength Range:	1,200 to 3,200 Angstroms
Magnitude Limit:	25
Detectors:	Two image intensifiers with 70-millimeter film, 1,000 frames each, IIaO astronomical film
Weight:	1,043 pounds (474 kilograms)
Dimensions:	32 inches (81 centimeters) diameter 12.1 feet (3.7 meters) length

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The Astro-2 Mission

Like Astro-1, the Astro-2 observatory will be housed inside the Shuttle's payload bay, with astronomers serving as payload specialists operating the telescopes from the aft flight deck of the Shuttle. As the Shuttle Endeavour orbits 220 miles above Earth, a large contingent of scientists and engineers will guide the mission from NASA's Spacelab Mission Operations Control Center at Marshall Space Flight Center in Huntsville.

The ultraviolet telescope assembly rests on two Spacelab pallets in Endeavour's cargo bay. The Shuttle and Spacelab systems provide power, pointing and communications links for the observatory.

The telescopes are mounted on the Instrument Pointing System (IPS), which was part of the Spacelab equipment developed for NASA by the European Space Agency. It has been used twice before, on Spacelab 2 in 1985 and on Astro-1 in late 1990.

The IPS furnishes a stable platform, keeps the telescopes aligned, and provides various pointing and tracking capabilities to the telescopes. During Astro-1 the IPS had some difficulties locking onto guide stars properly, although an alternate technique allowed the astronauts to manually point the IPS and track targets. In general, the astronauts were able to provide pointing stability of about 2 to 3 arc seconds or better. However, in "optical hold", the IPS should be able to achieve sub-arc-second stability. A special task team put together by mission management at Marshall has extensively modified and tested the IPS software and made other improvements to ensure the IPS works properly for Astro- 2.

Marshall’s image motion compensation system, designed to eliminate jitter caused by crew motions and thruster firings during observations, will refine pointing and stability even further for the photo-polarimeter and the imaging telescope. When the system senses unwanted motion in the instruments, it sends signals which adjust the telescopes’ mirrors to reduce jitter. This is particularly important for UIT to maintain the quality of its imagery, since the pictures are recorded on film and a single exposure can last as long as 30 minutes.

After launch, the plan calls for a roughly 20-hour checkout period, though fine-tuning the observatory could take somewhat longer. Observations will begin immediately after checkout is complete and continue throughout the mission, with only brief interruptions for activities such as waste-water dumps and Shuttle tests.

The night launch will allow the Shuttle Endeavour to pass through the so-called South Atlantic Anomaly, where high- energy radiation dips closer to the Earth than usual, mainly on the daylit side of its orbit. High energy particles affect instrument operation and increase the background levels in electronic detectors. The “natural” background, such as scattered light and ultraviolet residual airglow emissions, is also higher on the daylit side. The nighttime launch therefore preserves orbital night passes Ñ when Earth is between the Shuttle and the Sun Ñ for observations of the faintest, and often highest priority, astronomical targets. Brighter targets will be observed during the day.

The mission timeline, a detailed “blueprint” of the flight’s science activities, is divided into two-orbit (three- hour) blocks. One of the three telescope teams will have priority for the entire time block and will select the observations during that period. Generally, the other two telescopes will observe the same object or something nearby, though some targets may be too bright for the imaging telescope to view.

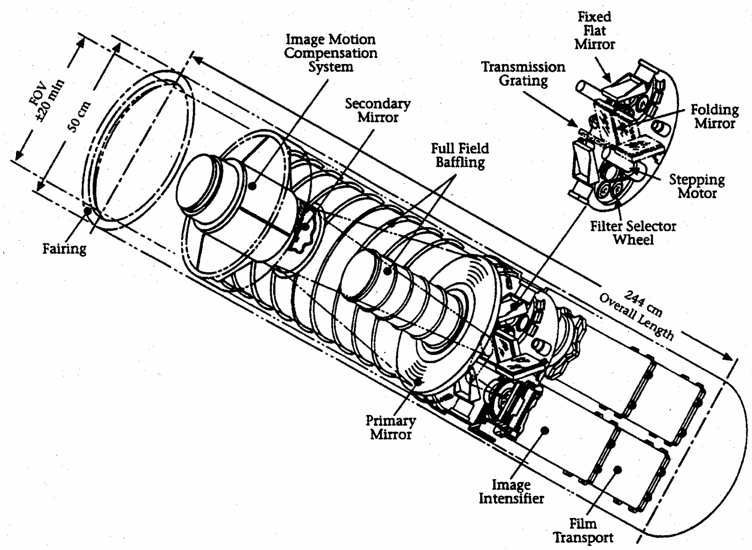
The seven-member Astro-2 crew will be split into two 12- hour shifts, so astronomical observations can continue around the clock.

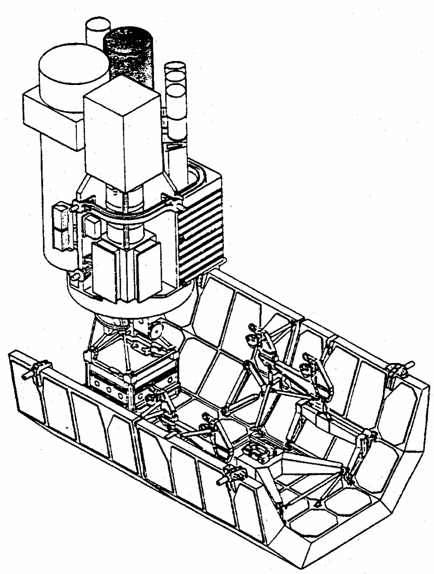
To begin an observation, an Orbiter crew member will maneuver the Shuttle’s payload bay to point toward the celestial object being studied.

The two science crew members on each shift, a NASA mission specialist and a payload specialist (an astronomer chosen from among the experiment teams), will have the option of using a pre-programmed, automatic sequence to maneuver the Instrument Pointing System and lock onto guide stars, or they may choose to acquire the target manually using a joystick- type device. Generally, the mission specialist will be responsible for pointing the telescope assembly, and the payload specialist will control the actual instrument set-ups and observations.

Astronomers on each instrument team will receive telescope data at Spacelab control and adjust their observations as needed to obtain the best possible results. If the data reveal something unexpected, or if an unforeseen astronomical event occurs (like the cataclysmic variable outburst during Astro-1), the instrument teams will work with Marshall payload controllers to develop changes in the timeline. This allows the investigators to explore the unexpected and take advantage of science opportunities that may arise during the mission.

THE ULTRAVIOLET IMAGING TELESCOPE





Guest Investigators

One new feature for Astro-2 is "community involvement." Although each of the instruments was developed by a team of scientists and engineers at a particular university or government facility, "guest investigators" also will use the Astro telescopes for their own observations. In 1993 NASA solicited proposals from the general astronomical community for participation in the observatory's second flight. After scientific and technical peer review, NASA selected ten proposals for inclusion into the scientific program. This has produced an even broader range of observations that will be attempted and scientific investigations that will be carried out.

Astro-2 principal guest investigators and their experiments are:

The Near UV Properties of Galaxies Which Have Low Optical Surface Brightness (UIT)
Dr. Gregory D. Bothun
University of Oregon
Eugene, OR

Ultraviolet Extinction and Polarization of Interstellar Dust in the Large Magellanic Cloud (HUT, WUPPE)
Dr. Geoffrey C. Clayton
University of Colorado
Boulder, CO

O-VI Emission and Broad-Band UV Spectra of Symbiotic Systems
(HUT, WUPPE)
Dr. Brian R. Espey
The Johns Hopkins University
Baltimore, MD

Investigations of Lyman Line Profiles in Hot DA White Dwarfs
(HUT)
Dr. David S. Finley
EUREKA Scientific, Inc.
Oakland, CA

An Ultraviolet Survey/Atlas of Spiral Galaxies (UIT)
Dr. Wendy L. Freedman
Carnegie Institution of Washington
Pasadena, CA

Astro-2 Observations of the Moon (UIT)
Dr. George R. Gladstone
Southwest Research Institute
San Antonio, TX

HUT Observations of the Lyman Continuum in Starburst Galaxies (HUT)
Dr. Claus H. Leitherer
Space Telescope Science Institute
Baltimore, MD

Far UV Observations of Interstellar Shocks (HUT)
Dr. John C. Raymond
Smithsonian Institution Astrophysical Observatory
Cambridge, MA

The Extended Atmospheres of Wolf-Rayet Stars (HUT, WUPPE)
Dr. Regina E. Schulte-Ladbeck
University of Pittsburgh
Pittsburgh, PA

A Reconnaissance of O3 Spectra in the 900-1200 Angstrom Region (HUT)
Dr. Nolan R. Walborn
Space Telescope Science Institute
Baltimore, MD

ASTRO-2 MANAGEMENT TEAM

Headquarters, Washington, DC

Program Manager	James McGuire
Program Scientist	Dr. Robert Stachnik

Marshall Space Flight Center

Mission Manager	Dr. Robert Jayroe
Mission Scientist	Dr. Charles Meegan
Deputy Mission Scientist	Dr. Eugene Urban
Assistant Mission Scientist	Dr. John Horack
Chief Engineer	David Jacobson
Assistant Mission Manager	Stuart Clifton
Lead Payload Operations Director	Lewis Wooten

GET AWAY SPECIAL (GAS)

The Get Away Special (GAS) project is managed by NASA's Goddard Space Flight Center, Greenbelt, MD. NASA began flying these small self-contained payloads in 1982. The project gives an individual an opportunity to perform experiments in space on a Shuttle mission. Students, individuals and people from private industry have taken advantage of this unique project. Space is available for upcoming flights, and GAS presents an educational opportunity for students. There is one experiment in two payloads on this flight. Following is a brief description of the payloads.

G-387 & G-388
Customer: Australian Space Office, Depart. of Industry Science & Technology
Customer Manager: Dr. John S. Boyd, Deputy Executive Director, Australian Space Office
NASA Technical Manager: Charlie Knapp

Endeavour, an Australian space telescope, is very significant to the Australian space program as it makes its second flight aboard Space Shuttle Endeavour on mission STS- 67. The telescope previously flew in January 1992.

Coincidentally, the Australian payload has the same name as the Shuttle Endeavour. Both were named after the sailing ship which the Captain James Cook commanded during an expedition to explore the Pacific Ocean. In doing so he discovered the eastern coast of Australia and pioneered the way for the first settlement in Australia by Europeans.

Endeavour is the most significant space payload built by the Australian space industry in more than two decades. This is the program on which many Australian engineers learned their space skills. This is particularly true for Auspace, the prime contractor for this project. More than 200 Australian companies also contributed to this pioneering space project. The Australian Space Office of the Department of Industry Science and Technology, which administers the Australian space program, provided the funds for the Endeavour program.

Outside the influence of the Earth's atmosphere, Endeavour will take images in the ultraviolet spectrum of targets which include star-forming regions, nearby galaxies and violent galactic events. Such images cannot be taken from ground- based telescopes because the radiation at these wavelengths is absorbed by the Earth's atmosphere. The Australian Space Telescope is housed in two GAS canisters that are mounted on the side of the Shuttle cargo bay and are interconnected by means of a cable harness. One of the canisters is fitted with a Motorized Door Assembly which protects the payload during launch and opens to allow observations to be made. This canister houses the telescope, the detector and the control computer.

Endeavour is a 100 mm binocular reflecting telescope. One side of the telescope allows all the light from celestial targets to enter the other side allows only light in a narrow spectral band. Thus, by the subtraction of the two signals, the narrow band image can be studied in detail as the brighter background is removed.

The detector is a very sensitive photon counting array which comprises an image tube, a fiber optic image dissector and charged coupled arrays. The detector counts individual photons, the smallest indivisible packet of light to obtain maximum efficiency at the low light level produced by these distant galaxies.

The second canister contains the battery to supply electrical power to the payload and video cassette recorders to record the images for processing on the ground after landing. The telescope has a field-of-view of two degrees and relies on the Shuttle for pointing. Shuttle motion during exposures can be removed by subsequent ground image processing.

The managing director of Auspace, Mr. T. Stapinski, said "Endeavour is a very important space project for Auspace. It is a very complex payload of over 180 kg. (396 lbs.) and we learned a lot during its manufacture and testing.

"The expertise learned on Endeavour has enabled Auspace engineers to make major contributions on other electro-optical space instrumentation such as the Along Track Scanning Radiometer for the European Remote Sensing satellite. The Flight of Endeavour is very important as it will demonstrate the capability of the Australian space industry to produce top quality space hardware."

COMMERCIAL MDA ITA EXPERIMENTS (CMIX-03)

Overview

The third in a series of six commercial experiments, known as CMIX, will fly aboard Endeavour during STS-67. CMIX- 03 includes biomedical, pharmaceutical, biotechnology, cell biology, crystal growth and fluids science investigations.

These experiments will explore ways in which microgravity can benefit drug development and delivery for treatment of cancer, infectious diseases and metabolic deficiencies. These experiments also will include protein and inorganic crystal growth, secretion of medically important products from plant cells, calcium metabolism, invertebrate development and immune cell functions.

CMIX represents an innovative dual agreement program between NASA Headquarters and the University of Alabama in Huntsville (UAH) Consortium for Materials Development in Space (CMDS). UAH is one of NASA's eleven Centers for the Commercial Development of Space (CCDS). The goals of the program are to provide increased access to space for NASA's CCDS investigators and their industry affiliates and to facilitate private sector utilization of space. Through a subsequent agreement between UAH and Instrumentation Technology Associates (ITA), of Exton, PA, ITA provides flight hardware to UAH for its associated investigators and industry affiliates in exchange for flight opportunities. ITA markets both the flight opportunity and hardware as a turnkey commercial service to both domestic and international users.

On STS-67, UAH and ITA will fly more than 30 individual experiment investigations totaling some 400 samples on CMIX- 03.

The most significant UAH CMDS/NASA CCDS experiments on this mission deal with microgravity research into aging, multi-drug resistance and neuro-muscular development.

The most significant ITA commercial experiments on this flight involve the growth of urokinase protein crystals as the first step for use in developing an inhibitor drug to combat breast cancer metasis, and the microencapsulation of drugs as a drug delivery system for cancer therapy.

UAH CMDS Experiments

Experiments being conducted by the UAH CMDS and collaborating scientists on the STS-67 CMIX-03 payload include aging, multi-drug effects on cells, neuro-muscular development, gravity sensing and calcium metabolism, production of plant cell products, and protein crystal growth. Some of the data expected from the CMIX-03 microgravity experiments can be used by industry to understand processes which can enhance the quality of life on Earth, and contribute to the health and welfare of the increasing numbers of persons spending time in space.

Aging

Evidence from previous microgravity experiments indicates that gravity affects single cells. No matter what effect any environmental factor produces on living systems, it begins with single cells or a group of single cells acting together. Microgravity appears to slow cell growth. How this affects the aging process will be tested using human lymphocytes.

Multi-drug Resistance

The broad objective of drug resistance experiments is to gain an understanding of the role of gravity and effect of microgravity on cell membranes. Drugs must cross cell membranes to be effective; however, many drugs lose their effectiveness after several years of use because patients develop multi-drug resistance. Researchers believe that the mechanisms of multi-drug resistance may be more easily understood for cells in microgravity where cellular metabolism is slowed.

Neuro-muscular Development

There are a number of diseases which result from faulty nerve-muscle interactions and these disorders are a target for pharmaceutical and biotechnology industry research. The development of nerve tissue is influenced by the communication between nerve and muscle cells and depends on membrane interactions. Previous flight experiments have shown that microgravity slows the growth and development of these cells and significantly alters the cytoskeleton. Frog cells will be flown as a model to investigate development of membrane associated interactions.

Gravity Sensing and Calcium Metabolism

Calcium is known to regulate many cellular activities leading to growth, differentiation, and transduction of signals from the cell membrane to produce genetic responses. The UAH investigation will fly an experiment using the Bioprocessing Modules to evaluate the development of gravity in understanding calcium dynamics in cells and has economical value in the area of calcium and bone metabolism.

Production of Plant Cell Products

Pharmaceutical products from plants have been used for treatment of various types of cancer. These plant products include vinblastin and taxol. Cultured cells from soy bean plants will be flown in the MDA minilabs to assess the effect of microgravity on growth, development and production of secondary metabolites. These cells, grown in ground-based tests, produce a product with strong anti-colon cancer activity. Preliminary evidence suggests that microgravity may provide an advantage for higher production of this material.

Protein Crystal Growth

Protein crystal growth experiments will be flown to gain information on the specific structure and growth characteristics of selected economically important proteins. Information will be used to develop more complex experiments on future missions.

COMMERCIAL ITA EXPERIMENTS

The private sector commercial experiments on CMIX-03 utilizing the ITA hardware have three main thrusts: biomedical research involving the growth of protein crystals for cancer research; the microencapsulation of drugs; and an ITA- sponsored student space education program.

Urokinase Breast Cancer Experiment

The most significant commercial experiment on the CMIX-03 payload is an experiment to grow large protein crystals of urokinase for breast cancer research. Urokinase is an enzyme which is present when breast cancer spreads (cancer metastasis). ITA, with its team of scientists and engineers, will dedicate 60 to 90 space experiments to the growth of large protein crystals of at least 100 microns for analysis. Small urokinase protein crystals have been grown on the CMIX- 01 (STS-52) and CMIX-02 (STS-56) Shuttle flights. The crystals were not large enough for analysis. Urokinase protein crystals grown on the ground are not large enough for analysis. If a 100+ micron protein crystal can be obtained on the CMIX-03 mission, the three-dimensional structure will be determined in the laboratories of crystallographers. A cancer research center has agreed to try to develop and test drugs to inhibit urokinase and hence breast cancer metastasis.

The scientists and engineers on the research team believe that the chance of achieving their goal of large urokinase crystals is enhanced because the STS-67 mission is twice as long (16 days) as the previous CMIX missions and the growth rate is believed to be linear. In addition, the hardware has been modified to provide two temperatures and four separate crystal growth techniques.

Microencapsulation of Drugs

The second major commercial thrust is experiments involving the encapsulation of drugs or living cells for new medical therapies. This series of commercial microencapsulation experiments will continue the studies conducted on STS-52 (CMIX-01) and STS-56 (CMIX-02) wherein an anti-tumor drug (cis-platinum) was co-encapsulated with a radiocontrast medium into spherical, multilayer liquid microcapsules. This is a commercial joint venture with the Institute for Research, Houston, TX.

The objectives of the Microgravity Encapsulation of Drugs (MED) are for experiments on microcapsules to enable testing against tumors in mice as a necessary step towards clinical studies in cancer patients.

Another separate group of microencapsulation experiments involves the mixing of polymer solutions which ultimately may be used to encapsulate pancreatic islet cells to facilitate transplantation into diabetic patients.

Student Space Education Program

The third major thrust involves school students as part of ITA's Student Space Education Program to increase awareness and interest in science and space technology. ITA is donating a portion of its hardware and personnel on every CMIX mission to flying student experiments as a "hands-on" experience for students. To date, some 400 students and 30 teachers from seven states have participated in this private sector- sponsored program for students to conduct Space Shuttle microgravity experiments on the CMIX payload.

CMIX-03 Payload Hardware

The CMIX-3 hardware consists of four Materials Dispersion Apparatus (MDA) Minilabs, two of which will contain experiments developed by the UAH CMDS and its industry affiliates. Additional hardware to fly on this mission includes ITA's Liquids Mixing Apparatus and UAH's BioProcessing Modules. The other two Midas, commercially marketed by ITA, will contain experiments developed by ITA's customers, international users, and university research institutions.

Dr. Marian Lewis, of the UAH/CMDS, is the Project Manager for the CMIX Program and Mr. John M. Cassanto, President of ITA, is the Program Manager for the commercial half of the CMIX payload.

PROTEIN CRYSTAL GROWTH EXPERIMENTS

The STS-67 mission will carry two systems in Shuttle middeck lockers to continue space-based research into the structure of proteins and other macromolecules. Vapor Diffusion Apparatus trays will be housed within a temperature- controlled Thermal Enclosure System, which fills the area normally occupied by two lockers. The Protein Crystallization Apparatus for Microgravity will be housed in a Single-locker Thermal Enclosure System.

Proteins are important, complex biochemicals that serve a variety of purposes in living organisms. Determining the molecular structure of proteins will lead to a greater understanding of how the organisms function. Knowledge of the structures also can help the pharmaceutical industry develop disease-fighting drugs.

X-Ray crystallography currently offers the best route to determine the three-dimensional structure of macromolecules, particularly proteins. In this technique, researchers grow crystals of purified proteins, then collect X-Ray diffraction data on the crystals. The three-dimensional structure is then determined by analysis of this data. 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 Ñ away from gravity’s distortions Ñ are larger and have fewer defects. The experiments help develop techniques and methods to improve the protein crystallization process on Earth as well as in space.

Both systems will grow crystals using the vapor diffusion method, which has been highly effective in previous Shuttle experiments. In vapor diffusion, water evaporates from a protein solution and is absorbed by a more concentrated reservoir solution contained in a wicking material. As the protein concentration rises, the protein crystals form.

Vapor Diffusion Apparatus Experiments
Dr. Larry DeLucas University of Alabama at Birmingham
Birmingham, AL

This investigation continues a very successful series of space-based protein crystal growth experiments, which has produced some of the highest-quality crystals of several proteins. Previous experiments have helped determine the structures of porcine elastase, used to study emphysema; gamma-interferon, which stimulates the immune system and is used to treat cancer and viral diseases; and Factor D, important in understanding the body’s defenses against infection.

On STS-67, the Vapor Diffusion Apparatus experiments will be contained in a Thermal Enclosure System (TES), which is the size of two mid-deck lockers. The TES, set at 72 degrees Fahrenheit (22 degrees Celsius), will contain four vapor diffusion apparatus trays, each containing 20 individual crystallization chambers. Each experiment chamber includes a double-barreled syringe containing protein solution in one barrel and precipitant solution in the other. A reservoir of concentrated precipitant solution is contained in the wicking material lining the experiment chamber.

To activate the experiments at the beginning of the mission, a crew member will turn a ganging mechanism on the side of each tray to push the syringe pistons forward and extrude the protein droplets onto the syringe tip. During the course of the experiments, water molecules will migrate from the drops through the vapor space to the more concentrated reservoirs, increasing the protein and precipitant concentrations in the drops. The increased concentration in the drops will initiate crystal growth. At the end of the mission, the experiments will be deactivated by drawing the protein drops and crystals back into the syringes.

Some of the proteins to be grown in the Vapor Diffusion Apparatus Experiments include:

Protein	**Affiliation**	**Description**
Pyruvate Kinase	University of Texas Medical Branch at Galveston	Pyruvate kinase is an important control enzyme in the pathway that generates energy from glucose. The three dimensional structure of this enzyme will contribute to the understanding of the function of this important regulatory enzyme.
PEP Carboxykinase	University of Saskatchewan, Saskatoon, Saskatchewan, Canada	This is an important enzyme in the production of glucose from non-carbohydrate sources by living systems. Structural information about this protein will provide insight into the mechanisms of this process.
Mur b	Bristol-Myers Squibb	This protein, a product of the E. coli bacteria, is a potential therapeutic target for the development of new antibiotic ***[additional text is missing from all known sources]***
Aldehyde Reductase	University of Alabama at Birmingham	This enzyme has been implicated in diabetic complications of the eyes and the kidneys. Its three-dimensional structure is a key factor in developing inhibitors to the enzyme's damaging activity.
Thaumatin	University of Alabama at Birmingham	Thaumatin is a sweet tasting protein isolated from an African plant. It has commercial potential as a sweetener because of its potency and stability over a wide pH range.
Aminoglycoside Phosphotransferase type III	McMaster University, Hamilton, Ontario, Canada	This enzyme phosphorylates a group of antibiotics and renders them clinically ineffective. The three-dimensional structure of the protein will provide information about antibiotic resistance and may aid in designing strategies to circumvent this problem.
HIV-(1)-Protease	Vertex Pharmaceuticals, Inc.	HIV-(1)-Protease is a critical enzyme in the life cycle of the human immunodeficiency virus. It is an important target in the search for a vaccine for HIV and for drug treatments for AIDS.

Protein Crystallization Apparatus for Microgravity
Dr. Daniel Carter
Marshall Space Flight Center
Huntsville, AL

The Protein Crystallization Apparatus for Microgravity (PCAM) is the second test of a new design for growing large quantities of protein crystals in orbit. It first flew aboard STS-63 in February 1995. The apparatus holds more than six times as many samples as are normally accommodated in the same amount of space.

A controlled-temperature enclosure occupying a single Shuttle mid-deck locker, called the Single-locker Thermal Enclosure System (STES), will hold six cylinders containing a total of 378 samples Ñ one of the largest quantities in any single protein crystal growth experiment to date. In most experiments of this type, a single locker accommodated a maximum of 60 samples. The STES will maintain temperatures at 72 degrees Fahrenheit (22 degrees Celsius).

Each cylinder contains nine trays held in position by guide rods and separated from each other by bumper plates with springs. The trays are sealed by an adhesive elastomer. Each tray holds seven sample wells, surrounded by a donut-shaped reservoir with a wicking material to absorb the protein carrier solution as it evaporates.

To start the experiment, a crew member will open the front of the thermal enclosure, then rotate a shaft on the end of the cylinder with a ratchet from an orbiter tool kit. This will allow diffusion to start and protein crystal growth to begin. Near the end of the mission, a crew member will rotate the shaft in the opposite direction to stop diffusion.

A few of the candidate proteins for this flight of the PCAM are human cytomegalovirus assemblin (a factor in virus duplication), parathyroid hormone antagonist (a controlling factor in bone growth), pseudoknot 26 (a potential HIV inhibitor), human antithrombin III (a blood clotting factor), and an HIV protease/drug complex (a factor in viral replication).

MIDDECK ACTIVE CONTROL EXPERIMENT

The Middeck Active Control Experiment (MACE) is designed to study the active control of flexible structures in space. In this experiment, a small, multi-body platform will be assembled and free-floated inside the Space Shuttle. Tests will be conducted on the platform to measure how disturbances caused by a payload impacts the performance of another nearby payload which is attached to the same supporting structure.

MACE consists of three separate hardware elements: The Multi-body Platform, the Experiment Support Module, and the Ku- Band Interface Unit. The Multi-body Platform consists of a long flexible polycarbonate structure. A two axis gimbaling payload is located at either end, and a three-axis torque wheel/rate gyro platform is located in the center. By swapping out certain components, the platform can be reconfigured into more complex geometries, thereby increasing the complexity of the control problem. Actuators consisting of 7 motors and two piezoelectric bending elements and sensors, consisting of rate gyros, strain gauges, and encoders, are distributed along the structure to facilitate active control. The Experiment Support Module contains all the electronics necessary to conduct the experiment. The Ku-Band Interface Unit allows downlink and uplink of data from the middeck.

On-orbit, the astronaut will set-up the test article and attach it to the Experiment Support Module. A series of tests will be performed by using a hand-held terminal for selecting and controlling programmed test protocols. The astronaut will monitor the experiment and videotape its operation. At the end of each test day, the astronaut will select several of the test result data files for downlink via the Ku-Band Interface System. The MACE ground team will use this data to adjust the test protocols during the mission. These new protocols will be later uplinked and run on the hardware. MACE is expected to take 44 hours of on-orbit time. Mission Commander Steve Oswald and Pilot William Gregory will operate the hardware on orbit.

MACE is an IN-STEP (In-Space Technology Experiments Program) experiment, sponsored by NASA's Office of Space Access and Technology, that was developed by the Massachusetts Institute of Technology in collaboration with Payload Systems, Inc., NASA's Langley Research Center, and Lockheed Missiles and Space Company. The experiment will provide a fundamental understanding of the effects of microgravity on the interaction between the dynamics of structures and attached payloads and validate control strategies and algorithms that will be applicable to a wide range of future space missions.

SHUTTLE AMATEUR RADIO EXPERIMENT (SAREX)

Students from 26 schools in the U.S., South Africa, India and Australia will have a chance to speak via amateur radio with astronauts aboard Endeavour during the STS-67 mission. Ground-based amateur radio operators ("hams") will be able to contact the Shuttle through automated computer-to-computer amateur (packet) radio links. There also will be voice contacts with the general ham community as time permits.

Shuttle Commander Stephen S. Oswald (call sign KB5YSR), pilot William G. Gregory, (call sign KC5MGA), mission specialists Tamara E. Jernigan (call sign KC5MGF) and Wendy B. Lawrence (KC5KII) and Payload Specialists Ron Parise (WA4SIR) and Sam Durrance (N3TQA) will talk with the students.

Students in the following schools will have the opportunity to talk directly with orbiting astronauts for approximately 4 to 8 minutes:

- Brewton Elementary School, Brewton, AL (WD4SBV)
- Watson Elementary School, Huntsville, AR (W5TM)
- Fullbright Avenue Elementary, Canoga Park, CA (W6SD)
- Tri City Christian Schools, Vista, CA (KK6FX)
- Plymouth Center School, Plymouth, CT (KD1OY)
- Bishop Planetarium & South Florida Museum, Bradenton, FL (KB4SYV)
- Renfroe Middle School, Decatur, GA (KM4LS)
- Pearl City High School, Pearl City, HI (AH6IO)
- Waihe'e Elementary School, Wailuku, HI (KH6HHG)
- Highland Park H. S., Highland Park, IL (W9MON)
- Kentucky Tech, Montgomery County Area Vocational Education Center, Mt. Sterling, KY (WD4EUD)
- U. S. Naval Academy, Annapolis, MD (W3ADO)
- Lutherville Elementary/Ridgely Middle School, Lutherville, MD (WA3GOV)
- Silver Spring/Burtonsville Schools, Silver Spring, MD (N3CJN)
- William Bryant Elementary, Blue Springs, MO (WA0NKE)
- Plank Road South School, Webster, NY (KB2JDS)
- Lockport H. S., Lockport, NY (N2IQL)
- Saint Peters School, Greenville, NC
- Washington Senior H. S., Washington C.H., OH (N8MNB)
- Bethany Middle School, Bethany, OK (KB5KIJ)
- Tarkington Middle School, Cleveland, TX (N5AF)
- Chisum Jr./Sr. H.S., Paris, TX (KA5CJJ)
- J. J. Fray Elementary School, Rustburg, VA (K4HEX)
- Group of Scholars from South Africa, South Africa (ZS5AKV)
- Little Lilly's English School, Bangalore, India (VY2RMS)
- Cobram Secondary College, Cobram, Australia (VK3KLN)

The radio contacts are part of the SAREX project, a joint effort by NASA, the American Radio Relay League (ARRL), and the Radio Amateur Satellite Corp.

The project, which has flown on 15 previous Shuttle missions, is designed to encourage public participation in the space program and support the conduct of educational initiatives to demonstrate the effectiveness of communications between the Shuttle and low-cost ground stations using amateur radio voice and digital techniques.

Several audio and digital communication services have been developed to disseminate Shuttle and SAREX-specific information during the flight.

The ARRL ham radio station (W1AW) will include SAREX information in its regular voice and teletype bulletins.

The amateur radio station at the Goddard Space Flight Center, (WA3NAN), will operate around the clock during the mission, providing SAREX information, retransmitting live Shuttle air-to-ground audio, and retransmitting many SAREX school group contacts.

Information about orbital elements, contact times, frequencies and crew operating schedules will be available during the mission from NASA ARRL (Steve Mansfield, 203/666- 1541) and AMSAT (Frank Bauer, 301/286-8496). AMSAT will provide information bulletins for interested parties on the Internet and amateur packet radio.

Current Keplerian elements to track the Shuttle are available from the NASA Spacelink computer information system, computer bulletin board system (BBS) (205) 895-0028 or via the Internet: spacelink.msfc.nasa.gov., and the ARRL BBS (203) 666-0578. The latest element sets and mission information are also available via the Johnson Space Center (JSC) ARC BBS or the Goddard Space Flight Center (GSFC) BBS. The JSC number is (713) 244-5625, 9600 Baud or less. The GSFC BBS is available via Internet. The address is wa3nan.gsfc.nasa.gov.

STS-67 SAREX Frequencies

Routine SAREX transmissions from the Space Shuttle may be monitored on a worldwide downlink frequency of 145.55 MHz.

The voice uplink frequencies are (except Europe):
144.91 MHz
144.93
144.95
144.97
144.99

The voice uplink frequencies for Europe only are:
144.70
144.75
144.80

Note: The astronauts will not favor any one of the above frequencies. Therefore, the ability to talk with an astronaut depends on selecting one of the above frequencies chosen by the astronaut.

The worldwide amateur packet frequencies are:

Packet downlink	145.55 MHz
Packet uplink	144.49 MHz

The Goddard Space Flight Center amateur radio club planned HF operating frequencies are:

3.860 MHz	7.185	14.295	21.395	28.650

STS-67 CREWMEMBERS

STS067-S-002 -- Official STS-67 preflight crew portrait. In front are astronauts (left to right) Stephen S. Oswald, mission commander; Tamara E. Jernigan, payload commander; and William G. Gregory, pilot. In the back are (left to right) Ronald A. Parise, payload specialist; astronauts Wendy B. Lawrence, and John Grunsfeld, both mission specialists; and Samuel T. Durrance, payload specialist. Dr. Durrance is a research scientist in the Department of Physics and Astronomy at Johns Hopkins University, Baltimore, Maryland. Dr. Parise is a senior scientist in the Space Observatories Department, Computer Sciences Corporation, Silver Spring, Maryland. Both payload specialists flew aboard the Space Shuttle Columbia for STS-35/ASTRO-1 mission in December 1990.

PHOTO CREDIT: NASA or National Aeronautics and Space Administration.

BIOGRAPHICAL DATA

STEPHEN S. OSWALD, 43, will lead STS-67's seven-member crew, serving as Commander. This is his third space flight.

Selected as an astronaut in 1985. Oswald was born in Seattle, WA, but considers Bellingham, WA, to be his hometown. He received a bachelor of science degree in aerospace engineering from the U.S. Naval Academy in 1973 and was designated as a naval aviator in September 1974. Following training in the A-7 aircraft, he flew the Corsair-II aboard the USS Midway from 1975-1977. In 1978, he attended the U.S. Naval Test Pilot School at Patuxent River, MD. Upon graduation, he remained at the Naval Air Test Center conducting flying qualities, performance and propulsion flight tests on the A-7 and F/A-18 aircraft through 1981.

Oswald resigned from active Navy duty and joined Westinghouse Electric Corp. as a civilian test pilot. During 1983-1984, he was involved in developmental flight testing of various airborne weapons systems for Westinghouse, including the F-16C and B-1B radars. He has logged over 6,000 flight hours in 40 different aircraft.

Oswald joined NASA in 1984 as an aerospace engineer and instructor pilot. Since being selected as an astronaut, he has served as Pilot for STS-42 and STS-56, flown in January 1992 and April 1993, respectively. The International Microgravity Laboratory-1, the primary payload on STS-42, included major microgravity experiments conducted over the eight-day flight in Discovery's Spacelab module. STS-56 was the second Atmospheric Laboratory for Applications and Science mission. This nine-day flight also included the deployment and retrieval of the SPARTAN spacecraft. With the completion of his second mission, Oswald has logged more than 400 hours in space.

WILLIAM G. GREGORY (Lt. Col., USAF), 37, will serve as Pilot for STS-67. This is his first shuttle mission.

Born in Lockport, NY., Gregory received a bachelor of science degree in engineering science from the Air Force Academy in 1979, a master of science degree in engineering mechanics from Columbia University in 1980 and a master of science degree in management from Troy State University in 1984.

Between 1981 and 1986, Gregory served as an operational fighter pilot flying the D and F models of the F-111. In this capacity, he served as an instructor pilot at RAF Lakenheath, U.K., and Cannon Air Force Base, NM. He attended the USAF Test Pilot School in 1987. Between 1988 and 1990, Gregory served as a test pilot at Edwards Air Force Base, flying the F-4, A-7D and all five models of the F-15. He has accumulated more than 3,500 hours of flight time in more than 40 types of aircraft. Gregory was selected for the astronaut corps in 1990.

JOHN M. GRUNSFELD, Ph.D., 36, also will be making his first space flight on STS-67. Grunsfeld will serve as Mission Specialist 1.

Grunsfeld was born in Chicago, IL, and received a bachelor of science degree in physics from the Massachusetts Institute of Technology in 1980. He earned a master of science degrees and a doctor of philosophy degree in physics from the University of Chicago in 1984 and 1988, respectively.

Grunsfeld has held a variety of academic positions at institutions including the University of Chicago, California Institute of Technology and the University of Tokyo/Institute of Space and Astronautical Science. His research has covered X-Ray and gamma-ray astronomy, high energy cosmic ray studies, and development of new detectors and instrumentation. He also has studied binary pulsars and energetic X-Ray and gamma ray sources using NASA's Compton Gamma Ray Observatory, X-Ray astronomy satellites, radio telescopes and optical telescopes. Grunsfeld was selected as an astronaut in 1992.

BIOGRAPHICAL DATA

WENDY B. LAWRENCE, Commander (Select), USN, will serve as flight engineer and will carry the designation Mission Specialist 2 during her first shuttle flight.

Lawrence, 35, was born in Jacksonville, FL, and received a bachelor of science degree in ocean engineering from the U.S. Naval Academy in 1981. She earned a master of science degree in ocean engineering from the Massachusetts Institute of Technology and the Woods Hole Oceanographic Institution in 1988.

Lawrence was designated as a naval aviator in July 1982 and has more than 1500 hours of flight time. She also has conducted more than 800 shipboard landings in six different types of helicopters. While stationed at Helicopter Combat Support Squadron SIX, she was one of the first two female helicopter pilots to make a long deployment to the Indian Ocean as part of a carrier battle group. In October 1990, she reported to the U.S. Naval Academy where she served as a physics instructor. Lawrence is a member of the astronaut class of 1992.

TAMARA E. JERNIGAN, Ph.D., 35, will serve as the Payload Commander and Mission Specialist 3 during her third space flight.

Born in Chattanooga, TN, Jernigan received a bachelor of science degree with honors in physics in 1981, and a master of science degree in engineering science in 1983, both from Stanford University. She earned a master of science degree in astronomy from the University of California-Berkeley in 1985 and earned her doctorate in space physics and astronomy from Rice University in 1988.

After graduating from Stanford, Jernigan served as a research scientist in the Theoretical Studies Branch at NASA's Ames Research Center from June 1981 to July 1985. Her research interests have included the study of bipolar outflows in regions of star formation, gamma ray bursts and shock wave phenomena in the interstellar medium.

Selected as an astronaut candidate in 1985, Jernigan has held a wide variety of technical assignments including software verification in the Shuttle Avionics Integration Laboratory, operations coordination on secondary payloads, spacecraft communicator for five shuttle flights, lead astronaut for flight software development, and chief of the Astronaut Office Mission Development Branch.

Jernigan's first shuttle flight was STS-40 in June 1991, a nine-day mission called Spacelab Life Sciences-1, the first mission dedicated to investigating how the human body adapted to microgravity. Her second mission, STS-52 in October 1992, was a 10-day flight during which crew members deployed the Laser Geodynamics Satellite and operated the U.S. Microgravity Payload-1. Jernigan has logged about 455 hours in space.

BIOGRAPHICAL DATA

SAMUEL T. DURRANCE, Ph.D., 51, will be returning to space for a second time as one of two payload specialists for the ASTRO-2 mission. He first flew in that capacity on the ASTRO- 1 mission aboard Columbia on the STS-35 flight in December 1990. Durrance will carry the designation Payload Specialist 1.

Durrance was born in Tallahassee, FL, but considers Tampa, to be his hometown. He earned a bachelor of science and mater of science degrees in physics from California State University, Los Angeles, in 1972 and 1974, respectively. He then received a doctor of philosophy degree in astrogeophysics from the University of Colorado in 1980.

Durrance is a Principal Research Scientist in the Department of Physics and Astronomy at Johns Hopkins University, Baltimore, MD. He is co-investigator for the Hopkins Ultraviolet Telescope, one of the instruments flying as part of the ASTRO Observatory.

Durrance has made International Ultraviolet Explorer satellite observations of Venus, Mars, Jupiter, Saturn and Uranus. He has directed a program to develop adaptive optics instrumentation resulting in the design and construction of the Adaptive Optics Coronagraph, which is now being used at the Palomar Observatory in California. In addition, he participated in the design construction, calibration and integration of the Hopkins Ultraviolet Telescope and the ASTRO Observatory. His main astronomical interests are in the origin and evolution of planets, both in our own solar system and around other stars.

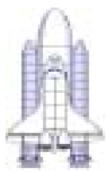
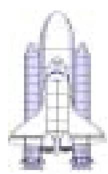
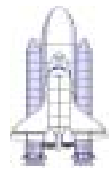
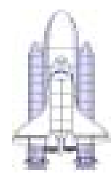
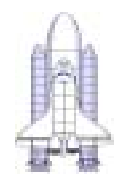
RONALD PARISE, Ph.D., rounds out the STS-67 crew as Payload Specialist 2. Parise will be making his second space flight, having first flown during the ASTRO-1 mission in December 1990.

Parise, 43, was born in Warren, OH, and received his bachelor of science degree in physics with minors in mathematics, astronomy and geology from Youngstown State University in 1973. He received a master of science degree and a doctor of philosophy degree in astronomy from the University of Florida in 1977 and 1979, respectively.

Parise currently is a senior scientist in the Space Observatories Department of Computer Sciences Corporation in Silver Spring, MD. He also is a member of the research team for the Ultraviolet Imaging Telescope, one of the ASTRO-2 instruments. Parise has been involved in all aspects of flight hardware development, electronic systems design and mission planning activities for the Ultraviolet Imaging Telescope. He has studied the circumstellar material in binary star systems using the Copernicus satellite as well as the International Ultraviolet Explorer. His current research involves the study of the later stages of the evolution of low mass stars in globular clusters.

SHUTTLE FLIGHTS AS OF MARCH 1995

67 TOTAL FLIGHTS OF THE SHUTTLE SYSTEM -- 42 SINCE RETURN TO FLIGHT

OV-102 **Columbia** **(17 flights)**	**OV-099** **Challenger** **(10 flights)**	**OV-103** **Discovery** **(20 flights)**	**OV-104** **Atlantis** **(13 flights)**	**OV-105** **Endeavour** **(7 flights)**
		STS-63 02/03/95 - 02/11/95		
		STS-64 09/09/94 - 09/20/94		
		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-66 11/03/94 - 11/14/94	
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	
STS-28 08/08/89 - 08/13/89	STS-51F 07/29/85 - 08/06/85	STS-29 03/13/89 - 03/18/89	STS-37 04/05/91 - 04/11/91	
STS-61C 01/12/86 - 01/18/86	STS-51B 04/29/85 - 05/06/85	STS-26 09/29/88 - 10/03/88	STS-38 11/15/90 - 11/20/90	STS-68 09/30/94 - 10/11/94
STS-9 11/28/83 - 12/08/83	STS-41G 10/05/84 - 10/13/84	STS-51-I 08/27/85 - 09/03/85	STS-36 02/28/90 - 03/04/90	STS-59 04/09/94 - 04/20/94
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