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Mission Highlights STS-95

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STS-95 Science Spans Inner Universe to Outer Space

The Shuttle *Discovery* lifted off into a cloudless sky on a nine-day scientific research mission. More than thirty-six years after he made history as the first American to orbit the Earth, Senator John H. Glenn, Jr., returned to space as part of the multi-national crew aboard *Discovery*.

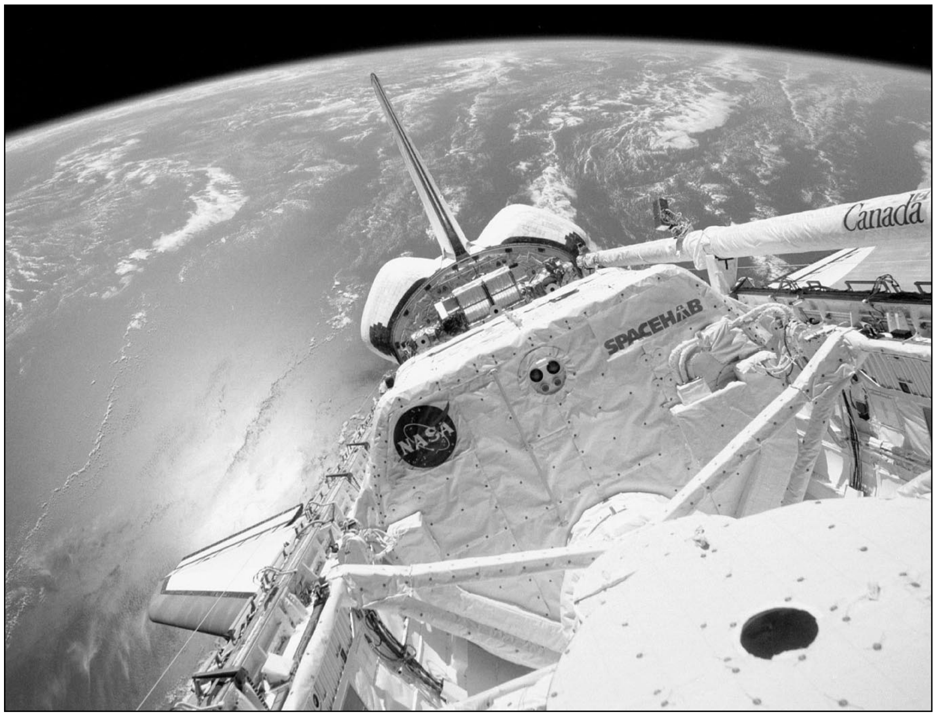
The flight involved more than eighty scientific experiments investigating mysteries that span the realm from the inner universe of the human body to studies of our own Sun and its solar activity.

Mission Events

The Shuttle *Discovery* launched from Kennedy Space Center at 1:20 p.m. CST on October 29. Over the course of the mission the crew worked with more than eighty payloads and experiments.

Primary mission objectives were to successfully perform operations of the four primary payloads. The four payloads were the SPACEHAB, SPARTAN-201, HOST, and IEH-03.

During one of these experiments, Mission Specialist Steve Robinson using *Discovery*'s robotic arm, lifted the Spartan satellite from the shuttle's cargo bay and released it into orbit at 12:59 p.m. CST on November 1. After a two-day solar science mission the Spartan satellite was captured and returned to its berth in the shuttle.



NASA Photo STS095-702-057

The horizon of a blue and white Earth forms the backdrop for this view of the cargo bay of the Space Shuttle *Discovery*.

Space Shuttle *Discovery*

October 29 – November 7, 1998

Commander:	Curtis L. Brown
Pilot:	Steven W. Lindsey
Mission Specialists:	Stephen K. Robinson
	Scott E. Parazynski
	Pedro Duque
Payload Specialists:	Chiaki Mukai
	John H. Glenn, Jr.

STS095-E-5054

Commander Curtis Brown holds a handful of vials as he checks a notebook.

Discovery ended its mission with a landing at the Kennedy Space Center on November 7 at 11:04 a.m. CST.

CARGO BAY PAYLOADS

THE SPACEHAB–Single Module (SPACEHAB-SM) provided a total cargo capacity of up to 4,800 pounds and contained systems necessary to support the habitat for the astronauts, such as ventilation, lighting, and limited power. The STS-95 SPACEHAB payload consisted of rack-mounted experiments, soft stowage bags, lockers, and supporting subsystems.

THE SPARTAN (SPARTAN 201-5) carrier was a simple, reusable vehicle that carried a variety of scientific instruments at a relatively low cost. After it was deployed from the orbiter in space, it provided its own power, pointing, and data recording as it performed a pre-programmed mission. In addition to solar experiments, the SPARTAN spacecraft was programmed to conduct stellar astronomy, Earth fine pointing, spacecraft technology experiments and demonstrations, and microgravity science and technology experiments. Observations were coordinated with observations made from the Solar and Heliospheric Observatory (SOHO) satellite, a cooperative mission of the European Space Agency (ESA) and NASA.

THE HUBBLE SPACE TELESCOPE (HST) ORBITAL SYSTEMS TEST (HOST) platform was an on-orbit test bed for hardware that will be installed on the orbiting telescope during the third HST servicing mission. The primary objective of the HOST mission was to demonstrate that electronic and thermodynamic equipment slated for installation on the Hubble Telescope in 1999 would work in the radiation and microgravity environment.

INTERNATIONAL EXTREME ULTRAVIOLET HITCHHIKER (IEH-3) The primary purpose of the IEH was to investigate the magnitude of the absolute solar extreme ultraviolet (EUV) flux and EUV emitted by the plasma torus system around Jupiter and stellar objects. It also studied the Earth's thermosphere, ionosphere, and mesosphere.

PETITE AMATEUR NAVAL SATELLITE (PANSAT) PANSAT a non-recoverable satellite was basically a small telecommunications satellite. It was used to enhance the education of military officers at the school by giving them hands-on experience in developing and operating a small satellite. It will also serve as a space-based laboratory for officers. The PANSAT principal investigator was the Naval Postgraduate School in Monterey, CA.

THE CRYOGENIC THERMAL STORAGE UNIT FLIGHT EXPERIMENT (CRYOTSU) payload demonstrated the functionality of four important spacecraft thermal control devices in microgravity: the 60K Thermal Storage Unit, the Cryogenic Capillary Pumped Loop, the Cryogenic Thermal Switch and the Phase Change Upper End Plate. Overall, the payload was a “toolbox” of thermal control elements that aerospace designers selected from to determine ways of reliably solving complex spacecraft thermal design problems with minimum expenditures of power, weight and cost.

CRYOTSU was designed jointly by NASA’s Goddard Space Flight Center, Greenbelt, MD, and the U.S. Air Force Research Laboratory, Kirtland AFB, NM. The principal investigator for CRYOTSU was NASA Goddard Space Flight Center.

THE INTEGRATED VEHICLE HEALTH MONITORING-HUMAN EXPLORATION AND DEVELOPMENT OF SPACE (HEDS) TECHNOLOGY DEMONSTRATION (IVHM) was essentially an evolution of a traditional vehicle instrumentation system which consisted of sensors (pressure, temperature, voltage, strain, accelerometers, discretes, etc.); wiring; signal conditioning devices; multiplexing devices and recording devices. IVHM took it a step further by providing capabilities to process data versus merely recording data.

The purpose of the orbiter Integrated Vehicle Health Monitoring (IVHM) – Human Exploration and Development of Space (HEDS) Technology Demonstration (IVHM HTD) was to demonstrate competing, modern, off-the-shelf sensing technologies in an operational environment to make informed design decisions for the eventual orbiter upgrade IVHM. The objective was to reduce planned ground processing, streamline problem troubleshooting (unplanned ground processing), enhance visibility into systems operation, and improve overall vehicle safety.

SPACE EXPERIMENT MODULE (SEM–4) STS-95 was the fifth flight of the SEM payload. A canister containing eight student experiment modules remained in *Discovery*’s payload bay.

IN-CABIN PAYLOADS

THE SLEEP EXPERIMENTS (SLEEP-2) payload evaluated the normal sleep patterns of four payload crew members before, during and after spaceflight to identify the factors contributing to sleep disturbances known to occur during spaceflight. SLEEP-2 assessed the effects of Melatonin on sleep and next day mood, alertness, vigilance and cognitive performance. During sleep, a polysomnograph recording of the crewmembers made several physiologic measurements including ECG (electrocardiogram), EMG (electromyography) and EOG (electro-oculography), as well as respiration measurements. The principal investigators were Harvard Medical School and Brigham & Women's Hospital, Boston, MA.

THE PROTEIN TURNOVER DURING SPACE FLIGHT (PTO) EXPERIMENT studied the effects of space flight on whole-body and skeletal muscle protein metabolism. The experiment studied stress metabolism under stress-light stress in 0g-before, during and after space flight.

The experimenters studied body composition preflight, as well as in-flight on flight days three and seven. This study provided evidence regarding the neuroendocrine mechanisms affecting protein turnover during space flight, and crucial information for the establishment of a viable ground-based model for protein metabolism. In turn, this provided the capability of testing potential countermeasures and determining nutritional requirements for future extended-duration missions. The principal investigator was the University of Texas Medical Branch, Galveston, TX.

POST-FLIGHT RECOVERY OF POSTURAL EQUILIBRIUM DSO605 The "Balance" Experiment was conducted both before and after the mission with four crew members participating. Information from the post-flight tests were compared to those conducted before the mission to see how well the astronauts were able to regain their sense of balance after nine days in space. Researchers hoped to use this information to design ways to restore lost orientation and control capabilities. This information was also used by the National Institute of Health/National Institute of Deafness and Communication Disorders to better understand how the balance organs of the inner ear recover and possibly improve treatment. The principal investigators were the NASA Johnson Space Center, Houston, TX, and Dow Neurological Sciences Institute, Legacy Portland Hospital, Portland, OR.

PROTEIN CRYSTAL GROWTH (PCG) One of the objectives of the PCG experiment was to grow and retrieve highly structured protein crystals that are large enough to be used to analyze the molecular structures of various proteins. The experiment was also designed to obtain information on the dynamics of protein crystallization so scientists can determine the parameters necessary to optimize the methods of producing large, high-quality, well-ordered crystals.

BIOLOGICAL RESEARCH IN CANISTERS (BRIC) 13 was the latest in a series of life sciences experiments designed to examine the effects of microgravity on a wide range of physiological processes in higher order plants and arthropod animals. The BRIC-13 investigation contributed to researchers' understanding of how the weightlessness of space affects the development of plants. The principal investigator for BRIC was the University of Tennessee, Knoxville, TN.

ELECTRONIC NOSE (E-NOSE) was a new, miniature environmental monitoring instrument that detects and identifies a wide range of organic and inorganic molecules down to the parts-per-million level. The objective on STS-95 was to flight-test E-NOSE and assess its ability to monitor changes in Discovery's middeck atmosphere. The principal investigator for E-NOSE was the Jet Propulsion Laboratory.

SOLAR EXTREME ULTRAVIOLET HITCHHIKER (SEH) was developed by the University of Southern California for NASA's Solar System Exploration Division, the SEH measured the wavelengths of non-visible light with an extreme ultraviolet (EUV) solar spectrometer and photographed the EUV region of the solar spectrum between 250 and 1,700 angstroms.

On IEH-3, the solar system response to the solar input was observed by a complementary set of instruments, UVSTAR and SEH. Both were international cooperative experiments.

The UVSTAR instrumentation provided Jovian system extreme ultraviolet/far ultraviolet data, and SEH provided the required solar flux data for proper interpretation. The data from these four instruments was combined to reveal the absolute solar flux.

STS095-E-5180

Commander Curtis Brown (left), stands by on the aft flight deck as payload specialist John Glenn talks with ground controllers in Houston.

S05-E-5004

Astronauts Scott Parazynski (left) and Pedro Duque on *Discovery*'s mid deck.

ULTRAVIOLET SPECTROGRAPH TELESCOPE FOR ASTRONOMICAL RESEARCH (UVSTAR) The UVSTAR instrument complement consisted of two telescopes with imaging spectrographs that covered overlapping spectral regions of 500 to 900 angstroms and 850 to 1,250 angstroms. The telescopes were capable of spectral imaging of extended plasma sources.

UVSTAR carried an instrument called the extreme ultraviolet imager (EUVI), which measured the Earth's atmosphere in EUV wavelengths. The EUVI allowed scientists to obtain precise measurements of the Earth's ionosphere and plasmosphere. The principal investigators were the University of Arizona and the University of Trieste.

SPECTROGRAPH/TELESCOPE FOR ASTRONOMICAL RESEARCH STAR-LITE was a telescope and imaging spectrograph that studied astronomical targets in the ultraviolet. Targets of scientific investigation included diffuse sky background emissions, scattered dust, and recombination emission lines from the hot and interstellar medium, supernova remnants, planetary and reflecting nebulae, star-forming regions in external galaxies and the torus formed around Jupiter by volcanic emissions of its moon Io. The University of Arizona was the principal investigator.

COSMIC DUST AGGREGATION EXPERIMENT (CODAG) The CODAG experiment was designed to simulate the aggregation of dust particles and dynamics of dust clouds that occurred in the early stages of the formation of our solar system. Scientists hope that understanding the dust growth process in the early solar system will enable them to answer questions about planet formation. CODAG was sponsored by the University of Bremen, Germany, and ZARM (Zentrum fur Angewandte Raumfahrttechnologie und Mikrogravitation).

SOLAR CONSTANT EXPERIMENT (SOLCON) **SOLCON**'s measurements were used to calibrate instruments on satellites that are continuously monitoring the total solar irradiance. The measurement of total solar irradiance was an important tool for researchers who are studying the effects of global warming. The SOLCON flight operators worked with the Belgian Space Remote Operation Center at the Royal Meteorological Institute of Belgium and performed experiments in preparation for scientific research on board the International Space Station. The Royal Meteorological Institute was the principal investigator.

MICROGRAVITY RESEARCH PROGRAM STS-95 featured eight microgravity experiments sponsored by the Space Product Development Office of the Microgravity Research Program. The mission also included five microgravity science experiments, as well as the Space Acceleration Measurement System and the Microgravity Science Glovebox facility sponsored by the Microgravity Research Program.

SINGLE LOCKER THERMAL ENCLOSURE SYSTEM (STES) The STES was a refrigeration and incubation module for conducting microgravity and biotechnology research in the orbiter crew compartment. It was sponsored by NASA's Office of Life and Microgravity Sciences and Applications. The payload was developed and managed by the Center for Macromolecular Crystallography.

CREW BIOGRAPHIES

Commander: Curtis L. Brown, Jr. (Lieutenant Colonel, USAF). Brown, 42, was born in Elizabethtown, NC. He received a bachelor of science degree in electrical engineering from the United States Air Force Academy.

Brown became an astronaut in 1988 and has logged more than 1,191 hours in space. He was the pilot on STS-47, STS-66, STS-77 and was spacecraft commander on STS-85 and STS-95.

STS-47 was Spacelab-J, an eight-day cooperative mission between the United States and Japan, which focused on life sciences and materials processing experiments in space. STS-66 was the Atmospheric Laboratory for Applications and Science-3 (ATLAS-3) mission.

The STS-77 crew performed a record number of rendezvous sequences, one with a SPARTAN satellite and three with a deployed Satellite Test Unit. The STS-85 crew deployed and retrieved the CRISTA-SPAS payload, operated the Japanese Manipulator Flight Demonstration robotic arm, studied changes in the Earth's atmosphere and tested technology destined for use on the future International Space Station.

This mission supported a variety of research payloads including deployment of the Spartan solar-observing spacecraft, the Hubble Space Telescope Orbital Systems Test Platform, and investigations on space flight and the aging process. STS-95 was the 25th flight of *Discovery* and the 92nd mission flown since the start of the Space Shuttle program in April 1981.

Pilot: Steven W. Lindsey (Lieutenant Colonel, USAF). Lindsey, 38, was born in Arcadia, CA. He received a bachelor of science degree in engineering sciences from the United States Air Force Academy and a master of science degree in aeronautical engineering from the Air Force Institute of Technology. Lindsey became an astronaut in 1996. He flew on STS-87 and STS-95 and has logged more than 590 hours in space.

STS-87 was the fourth U.S. Microgravity Payload flight and focused on experiments designed to study how the weightless environment of space affects various physical processes, and on observations of the Sun's outer atmospheric layers. During an EVA, Lindsey piloted the first flight of the AERCam Sprint, a free-flying robotic camera.

STS095-328-031

In-flight portrait of Commander Curtis Brown, appears right center in the pyramid. Clockwise from there, are Steven Lindsey, Stephen Robinson, Pedro Duque, Chiaki Mukai, Scott Parazynski and John Glenn.

Payload Commander: Stephen K. Robinson. Robinson, 43, was born in Sacramento, CA. He received a bachelor of science degree in mechanical/aeronautical engineering from the University of California at Davis; master of science degree in mechanical engineering from Stanford University and doctorate in mechanical engineering, with a minor in aeronautics and astronautics from Stanford University.

Robinson became an astronaut in 1995, and has logged more than 498 hours of space flight. On STS-85 the crew deployed and retrieved the CRISTA-SPAS payload, operated the Japanese Manipulator Flight Demonstration (MFD) robotic arm, studied changes in the Earth's atmosphere and tested technology destined for use on the future International Space Station.

Mission Specialist: Scott E. Parazynski (M.D.). Parazynski, 37, was born in Little Rock, AR. He received a bachelor of science degree in biology from Stanford University, continuing on to graduate with honors from Stanford Medical School.

Parazynski became an astronaut in 1992, and in his three flights has logged more than 735 hours in space including over 5 hours of EVA.

STS-66 was the Atmospheric Laboratory for Applications and Science-3 (ATLAS-3) mission. STS-86 was the seventh docking mission with the Mir Space Station. Parazynski and Vladimir Titov conducted a space walk to retrieve four Mir Environmental Effects Packages mounted on the docking module in March.

Mission Specialist: Pedro Duque, ESA Astronaut. Duque, 35, was born in Madrid, Spain. He received a degree in aeronautical engineering from the Escuela Técnica Superior de Ingenieros Aeronáuticos, Universidad Politécnica in Madrid, Spain.

Duque was selected to join the Astronaut Corps of the European Space Agency based at the European Astronauts Centre in Cologne, Germany, in 1992. Duque trained in preparation for the joint ESA-Russian EUROMIR 94 mission. He qualified as Research Astronaut for Soyuz and Mir. Duque has logged more than 213 hours of U.S. space flight.

STS-95
Quick Look

Launch Date: Oct. 29, 1998
Time: 1:20 p.m. CST
Site: KSC Pad 39B

Orbiter: *Discovery*
OV-103 – 25th flight

Orbit/In.: 300 naut. miles
28.45 degrees

Mission Duration: 8 days, 21 hrs, 44 mns.

Landing Date: Nov. 7, 1998
Time: 11:04 a.m. CST
Site: Kennedy Space Center

Crew: Curtis L. Brown (CDR)
Steven W. Lindsey (PLT)
Stephen K. Robinson (MS1)
Scott E. Parazynski (MS2)
Pedro Duque (MS3)
Chiaki Mukai (PS1)
John H. Glenn (PS2)

Mission Events: Primary objectives were performing a variety of microgravity research projects in a SPACEHAB single module. The crew deployed the Spartan-201 satellite for two days of free flight and also deployed the PANSAT non-recoverable satellite. They also conducted research with the Hubble Space Telescope Orbital Systems Test Platform (HOST), International Extreme Ultraviolet Hitchhiker (IEH-03), Cryogenic Thermal Storage Unit Flight Experiment (CRYOTSU), and two Get-Away Special (GAS) Carrier Payloads. Other activities included supporting a series of investigations designed to better understand the correlation between the aging process on Earth and the physiological effects of space flight on the human body.

Cargo Bay Payloads:
- Spacehab-SM
- Spartan-201
- HOST Orbital Systems Test
- International Extreme Ultraviolet Hitchhiker
- Cryogenic Thermal Storage Unit Flight Experiment

In-Cabin Payloads:
- SLEEP-2
- Protein Turnover During Space Flight (PTO)
- Post-Flight Recovery of Postural Equilibrium DSO605
- Protein Crystal Growth (PCG-STES)
- Biological Research in Canisters BRIC) 13
- Electronic Nose (E-NOSE)

Payload Specialist: Chiaki Mukai (M.D., Ph.D.), NASDA Astronaut. Mukai, 46, was born in Tatebayashi, Gunma Prefecture, Japan.
She received her doctorates in medicine and physiology from Keio University School of Medicine. In 1985, the National Space Development Agency of Japan (NASDA) selected Mukai as one of three Japanese Payload Specialist candidates for the First Material Processing Test (Spacelab-J) which flew aboard STS-47. She flew aboard STS-65, and is the first Japanese female to fly in space.

STS-65 was the second International Microgravity Laboratory (IML-2) flight. The mission consisted of 82 investigations of Space Life Science (Human Physiology, Space Biology, Radiation Biology, and Bioprocessing) and Microgravity Science (Material Science, Fluid Science and Research on the Microgravity Environment and Countermeasures).

Payload Specialist: John H. Glenn, Jr. (Colonel, USMC, Ret.). Glenn, 77, was born in Cambridge, Ohio. He attended Muskingum College in New Concord and received a bachelor of science degree in engineering. Muskingum College also awarded him an honorary doctor of science degree in engineering.

He has received honorary doctoral degrees from nine colleges or universities. He was elected to the United States Senate in November 1974, where he now serves. Glenn was assigned to the NASA Space Task Group at Langley, Virginia, in April 1959, after his selection as a Project Mercury Astronaut. Glenn flew on Mercury-6.

Glenn piloted the Mercury-Atlas 6 “Friendship 7” spacecraft on the first manned orbital mission of the United States.

The STS-95 crew patch was designed by the crew to reflect the scientific, engineering, and historic elements of the mission.

The Space Shuttle *Discovery* is shown rising over the sunlit Earth limb, representing the global benefits of the *Spartan* satellite.

The bold number “7” signifies the seven members of *Discovery*’s crew and also represents a historical link to the original seven *Mercury* astronauts.

STS-95 crew member John Glenn’s first orbital flight is represented by the *Friendship 7* capsule.

The rocket plumes symbolize the three major fields of science represented by the mission payloads: microgravity material science, medical research for humans on Earth and in space, and astronomy.