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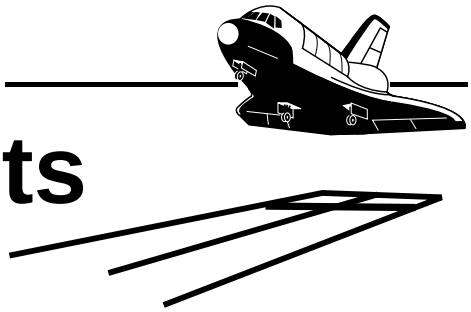
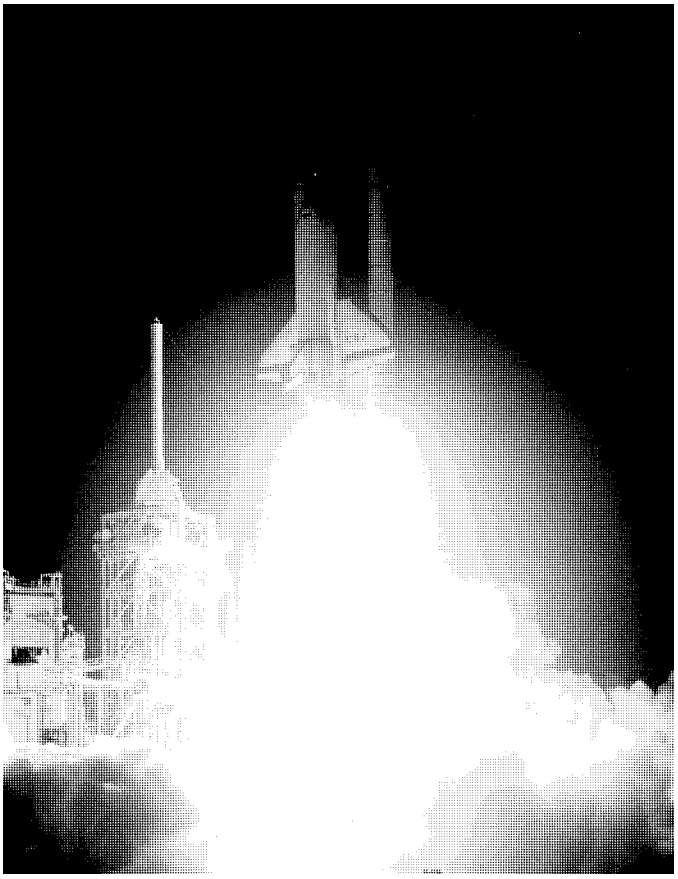
Mission Highlights STS-35



Space Shuttle Columbia

December 2-10, 1990

Commander: Vance D. Brand
Pilot: Guy S. Gardner, Col. USAF
Mission Specialists:
John M. Lounge
Jeffery A. Hoffman, PhD
Robert A. R. Parker, PhD
Payload Specialists:
Samuel T. Durrance, PhD
Ronald A. Parise, PhD



Spectacular Night Launch of STS-35

Major Mission Accomplishments

- Astro-1 was the first dedicated Space Shuttle mission for astronomy. It has provided the most detailed information to date on the chemistry, temperature, structure, and energetics of stars, the matter between the stars, and galaxies.

- The Hopkins Ultraviolet Instrument made more than 100 observations of seventy-five hot stars, galactic nuclei, and quasars. (Center for Astrophysical Sciences and the Applied Physics Laboratory of the Johns Hopkins University in Baltimore, MD.)

- The Ultraviolet Imaging Telescope collected more than 900 images of supernovae, planetary nebulae, galaxies, and clusters of galaxies. (NASA Goddard Space Flight Center, Greenbelt, MD.)

- The Wisconsin Ultraviolet Photo-Polarimeter Experiment gathered data on more than seventy objects including galactic clusters and supernova remnants. (Space Astronomy Lab at the University of Wisconsin, Madison, WI.)

- The Broad Band X-Ray Telescope collected data on more than seventy-five objects including active galactic nuclei, quasars, and accretion disks. (NASA Goddard Space Flight Center, Greenbelt, MD.)

- Hundreds of radio contacts were made through the Shuttle Amateur Radio Experiment. (American Radio Relay League and Amateur Radio Satellite Corporation.)

- A live Space Classroom lesson from space was conducted with students in Alabama and Maryland.

Experiments and Payloads

Astro-1 was an ambitious dedicated astronomy mission concentrating on astronomical observations in the ultraviolet and X-ray regions of the electromagnetic spectrum. Earth's atmosphere acts as a filter to screen out these important wavelengths of light, hampering Earth-based astronomers in developing a complete understanding of the objects that emitted them. Riding high above Earth's atmosphere, Astro-1's instruments gained a clear and unimpeded view of galaxies, quasars, planetary atmospheres, and a broad range of star types from white dwarfs to red super giants.

The Astro-1 payload consisted of four astronomical instruments. Three of the instruments were designed for ultraviolet astronomy and one instrument was designed for X-ray studies. The ultraviolet instruments were mounted on two U-shaped Spacelab pallets placed in the middle of Columbia's payload bay. These instruments consisted of the Hopkins Ultraviolet Telescope (HUT), Ultraviolet Imaging Telescope (UIT), Wisconsin Ultraviolet Photo-Polarimeter Experiment (WUPPE), and the Broad Band X-Ray Telescope (BBXRT). The first three instruments functioned as a team and were mounted on a common instrument pointing system that was supplied by the European Space Agency. The BBXRT had its own mounting structure and a separate pointing system that was controlled from the ground.

Though beset with numerous technical difficulties, the Astro-1 crew, experimenters, and mission controllers worked as a closely linked team to meet all challenges. They demonstrated the need for a human presence in a research and development environment. By flight's end, a wealth of scientific data was gathered that scientists from across the nation will spend years analyzing. More than 390 observations of 135 space objects were made by the crew, making Astro-1 a highly productive mission.

The ***Hopkins Ultraviolet Telescope*** was developed by the Center for Astrophysical Sciences and the Applied Physics Laboratory of the Johns Hopkins University in Baltimore, MD. It studied far ultraviolet radiation coming from a wide variety of space objects to provide new information on the evolution of galaxies and quasars and the physical properties of extremely hot stars and accretion disks (hot swirling matter transferred from one star to another) around black holes, white dwarfs, and neutron stars. Among its many targets, the HUT observed Comet Levy. The ancient comet, rounding the

STS-35 Crew
(back row) Robert A.R. Parker, Ronald Parise, Jeffrey A. Hoffman, Samuel Durrance (front row) Guy Gardner, Vance Brand, John M. Lounge

Sun on its 100,000 year orbit, yielded information that will permit astronomers to gain some insights to the chemical abundances that were present at the formation of our solar system. According to Art Davidson, the HUT principal investigator, "We have an enormous amount of very high quality data, unique data, obtained at wavelengths that have never been observed before...We are peeking into a new window that's been opened in the universe."

The ***Ultraviolet Imaging Telescope*** was a combination telescope, image intensifier, and camera. It was used to make up to 30 minute exposures of stars as faint as 25th magnitude (100 million times fainter than the faintest star visible to the human eye). UIT had a field of view wide enough to encompass star clusters, entire galaxies, and clusters of very distant galaxies. During the mission more than 900 photographs were recorded and returned to Earth for processing. Data contained in these photographs should provide valuable insights on the evolution of stars as well as determining the properties of interstellar dust in different galaxies. Some of the UIT's pictures will show groupings of one thousand galaxies in a single frame and star clusters of thousands of bright stars and white dwarf stars. The UIT was developed by the NASA Goddard Space Flight Center in Greenbelt, MD.

The ***Wisconsin Ultraviolet Photo-Polarimeter Experiment*** was developed at the Space Astronomy Lab of the University of Wisconsin, Madison, WI. Light from distant objects

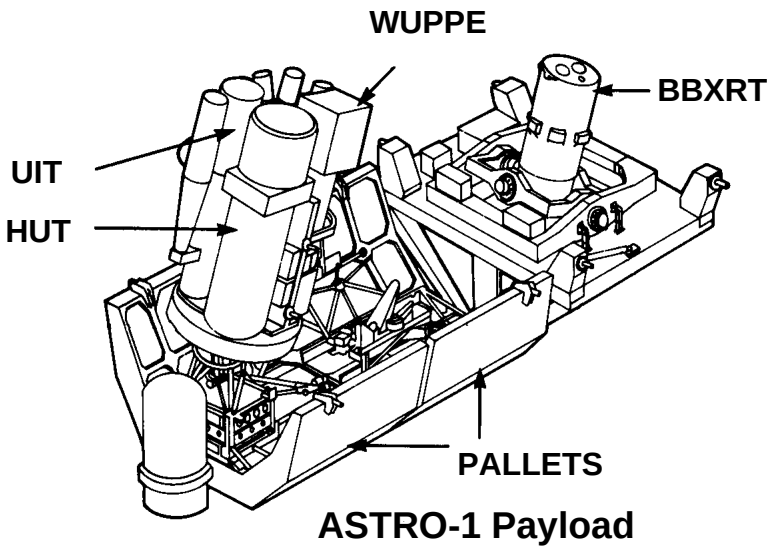
passed into this instrument through polarizing filters (similar to polarizing sunglasses) to detectors for analysis. The nature of the light waves that reached the detector provided information to astronomers on the geometry of stars that emitted the radiation. WUPPE also gathered information about dust scattered throughout the galaxy. Astronomers have little understanding of the nature of interstellar dust but they know it has a big effect on many physical processes in astronomy. According to project scientist Geoff Clayton, "no one has ever observed the polarization of interstellar dust in the ultraviolet before....The data we're getting now disagrees with all previous predictions."

The ***Broad Band X-Ray Telescope***, designed by the NASA Goddard Space Flight Center, Greenbelt, MD, provided astronomers with their first high-quality spectra of many X-Ray sources that were discovered in the late 1970s by the orbiting Einstein Observatory. Because celestial X-Rays are filtered out by Earth's atmosphere, it is essential to orbit above it in order to capture X-Rays for spectral analysis. Greg Madjeski, BBXRT team member, reported during the flight "Our instrument is performing even better than we expected." Among its many observations, the BBXRT provided indirect evidence of an accretion disk of swirling matter being sucked into a massive black hole. The instrument also looked for signs of heavy elements in the remnants of supernovae (exploding stars). All matter on Earth and in its life forms came from such remnants.

Students attending Space Classroom, Assignment: The Stars at the NASA Marshall Space Flight Center in Alabama

During the flight, several hundred amateur radio operators from around the world (HAM operators) made direct contact with Columbia through the ***Shuttle Amateur Radio Experiment (SAREX).*** On several occasions, radio and telephone links were established with schools across the United States permitting children to ask questions of the crew. The experiment also provided the opportunity for the crew to speak with their families in Houston, Texas.

In an exceptional opportunity for education, crew members of STS-35 conducted a live classroom lesson from space for two classes of 8th and 9th grade students. ***Space Classroom, Assignment: The Stars,*** was held for students from Alabama and surrounding states at the Marshall Space Flight Center and students from Maryland at the Goddard Space Flight Center. The class began with Astro-1 crew members explaining the purpose of the astronomical research they were conducting and with demonstrations to explain important concepts. The live lesson from orbit was followed by a laboratory lesson on the electromagnetic spectrum taught by Alabama teacher Karen Widenhofer. Following the second lesson, students at both classroom sites spoke to Astro-1 crew members and asked them questions about their work. *Space Classroom, Assignment: The Stars* was carried live via satellite so that thousands of students in schools across the nation could participate in the experience.



ASTRO-1 Payload

Mission Facts

Orbiter: Columbia
Mission Dates: December 2-10, 1990
Commander: Vance D. Brand
Pilot: Guy S. Gardner, Col. USAF
Mission Specialist: Jeffery A. Hoffman, PhD
Mission Specialist: John M. Lounge
Mission Specialist: Robert A. R. Parker, PhD
Payload Specialist: Samuel T. Durrance, PhD
Payload Specialist: Ronald A. Parise, PhD
Mission Duration: 8 days, 23 hours
Distance Traveled: 3,728,636 statute miles
Orbit Inclination: 28.45 degrees
Orbits of Earth: 142
Orbital Altitude: 190 nautical miles
Orbiter Weight Up: 263,901 pounds
Orbiter Weight Down: 225,886 pounds
Landed: Concrete runway 22, Edwards Air Force Base, CA.
Payloads and Experiments:
ASTRO-1
SAREX
Educational Activites:
Space Classroom videoconference

STS-35 Crew Patch

Crew Biographies

Commander: Vance D. Brand. Vance Brand was born in Longmont, CO and earned a bachelor of science degree in business and aeronautical engineering from the University of Colorado and a master of science degree in business administration from the University of California at Los Angeles. Brand has flown on the Apollo-Soyuz Test Project and the STS-5 and STS-41-B missions.

Pilot: Guy S. Gardner (Col. U.S.A.F.). Guy Gardner was born in Alta Vista, VA and received a bachelor of science degree in engineering sciences, astronautics, and mathematics from the U.S.A.F. Academy and a master of science degree in astronautics from Purdue University. Gardner has flown on the STS-27 mission.

Mission Specialist: Jeffery A. Hoffman (PhD). Jeffrey Hoffman was born in Brooklyn, NY and earned a bachelor of arts degree in astronomy from Amherst College. He earned a masters degree in materials science from Rice University and a doctorate in astrophysics from Harvard University. Hoffman has flown on the STS-51-D mission.

Mission Specialist: John M. Lounge. "Mike" Lounge, born in Burlington, CO, received a bachelor of science degree in physics and mathematics from the U.S.N. Academy and a master of science in astrogeophysics from the University of CO. Lounge has flown on the STS-51-I and STS-26 missions.

Mission Specialist: Robert A. R. Parker (PhD). Robert Parker earned a bachelor of arts degree in astronomy and physics from Amherst College and a doctorate in astronomy from the California Institute of Technology. Parker grew up in Shrewsbury, MS. He has flown on the STS-9 mission.

Payload Specialist: Samuel T. Durrance (PhD). Samuel Durrance is a research scientist in the Department of Physics and Astronomy at Johns Hopkins University. Durrance was born in Tampa, FL. He received a bachelor of science degree in physics from California State University and a doctorate in astrogeophysics from the University of Colorado.

Payload Specialist: Ronald A. Parise (PhD). Ronald Parise is a senior scientist in the Space Observatories Department of the Computer Science Corporation in Silver Spring, MD. Parise is from Warren, OH and earned a bachelor of science degree in physics from Youngstown State University and a master of science degree and a doctorate in astronomy from the University of Florida.