

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

# SPACE SHUTTLE MISSION STS-74

PRESS KIT  
NOVEMBER 1995



SHUTTLE MIR MISSION -2

## **STS-74 INSIGNIA**

*STS074-S-001 -- Designed by crewmembers, the STS-74 insignia depicts the space shuttle Atlantis docked to Russia's space station Mir. The central focus is on the Russian-built docking module, drawn with shading to accentuate its pivotal importance to both mission STS-74 and the NASA-Mir Program. The rainbow across the horizon represents Earth's atmosphere, the thin membrane protecting all nations, while the three flags across the bottom show those nations participating in STS-74 -- Russia, Canada and the United States. The sunrise is symbolic of the dawn of a new era in NASA space flight--that of Space Station construction.*

*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.*

*PHOTO CREDIT: NASA or National Aeronautics and Space Administration.*

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**RELEASE: 95-192**

## **U.S. SHUTTLE ATLANTIS AND RUSSIAN SPACE STATION MIR SET FOR SECOND MEETING IN SPACE**

The world's two greatest spacefaring nations will again meet in Earth orbit when Space Shuttle Atlantis docks to the Mir Space Station in November.

The STS-74 mission is the second of seven planned Space Shuttle-Mir link-ups between 1995 and 1997, including rendezvous and docking and crew transfers, which will pave the way toward assembly of the international Space Station beginning in November 1997.

The STS-74 crew will be commanded by Kenneth Cameron, who will be making his third Shuttle flight. James Halsell will serve as pilot and will be making his second space flight. The three STS-74 mission specialists aboard Atlantis will include Canadian astronaut Chris Hadfield, Mission Specialist-1, who will be making his first flight, Jerry Ross, Mission Specialist-2, who will be making his fifth flight and William McArthur, Mission Specialist-3, who will be making his second space flight.

This mission marks the first time astronauts from the European Space Agency, Canada, Russia and the U.S. will be in space on the same complex at one time -- a prime example of nations that will be represented on the international Space Station.

Launch of Atlantis on the STS-74 mission is currently targeted for no earlier than November 11, 1995, at approximately 7:56 a.m. EST from Kennedy Space Center's Launch Complex 39-A. The actual launch time may vary by a few minutes based on calculations of Mir's precise location in space at the time of liftoff, due to Shuttle rendezvous phasing requirements. The available launch period, or "window" to launch Atlantis, is approximately seven minutes each day.

The STS-74 mission is scheduled to last approximately 7 days, 20 hours, 47 minutes. Docking with Mir will occur on the fourth day of the flight, about 65 hours after launch.

STS-74's rendezvous and docking with the Mir actually begins with the precisely timed launch of Atlantis, setting it on a course for rendezvous with the Mir station. Over the next three days, periodic firings of Atlantis' small thruster engines will gradually bring the Shuttle closer to Mir.

Atlantis will carry the Russian-built Docking Module, which has multi-mission androgynous docking mechanisms at top and bottom. During the flight to Mir, the crew will use the Orbiter's Remote Manipulator System robot arm to hoist the Docking Module from the payload bay and berth its bottom androgynous unit atop Atlantis' Orbiter Docking System. Atlantis will then dock to Kristall using the Docking Module's top androgynous unit. After three days, Atlantis will undock from the Docking Module's bottom androgynous unit and leave the Docking Module permanently docked to Kristall, where it will provide clearance between the Shuttle and Mir's solar arrays during subsequent dockings.

Atlantis will deliver water, supplies, and equipment, including two new solar arrays -- one Russian and one jointly-developed -- to upgrade the Mir. It will return to Earth experiment samples, equipment for repair and analysis and products manufactured on the station.

Also flying aboard Atlantis is the GPP payload consisting of two experiments -- the GLO-4 experiment and the Photogrammetric Appendage Structural Dynamics Experiment (PASDE). The payload is managed by Goddard Space Flight Center's Special Payloads Division.

The GLO-4 will study the Earth's thermosphere, ionosphere and mesosphere energetics and dynamics using broadband spectroscopy. GLO-4 also will study spacecraft interactions with the atmosphere by observing Shuttle and Mir glow, Shuttle engine firings, water dumps and fuel cell purges.

Three PASDE canisters, located throughout the cargo bay, will photogrammetrically record structural response data of the Mir solar arrays during the docked phase of the mission. These data will be analyzed on the ground to verify the use of photogrammetric techniques to characterize the structural dynamics of the array, thus demonstrating that this technology can result in cost and risk reduction for the international Space Station on-orbit structural verification.

The STS-74 mission will be the 15th mission for Atlantis and the 73rd for the Space Shuttle system.

(END OF GENERAL RELEASE; BACKGROUND INFORMATION FOLLOWS.)

## **MEDIA SERVICES INFORMATION**

### **NASA Television Transmission**

NASA television is available through the Spacenet-2 satellite system. Spacenet-2 is located on Transponder 5, at 69 degrees West longitude, frequency 3880.0 MHz, audio 6.8 MHz.

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, and NASA Headquarters, Washington, DC. 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 database 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 each day. The updated NASA television schedule will indicate when mission briefings are planned.

### **Internet Information**

The NASA Headquarters Public Affairs Internet Home Page provides access to the STS-74 mission press kit and status reports. The address for the Headquarters Public Affairs Home Page is:

**[http://www.nasa.gov/hqpao/hqpao\\_home.html](http://www.nasa.gov/hqpao/hqpao_home.html)**

Informational materials, such as status reports and TV schedules, also are available from an anonymous FTP (File Transfer Protocol) server at **[ftp.hq.nasa.gov/pub/pao](ftp://ftp.hq.nasa.gov/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.

STS-74 mission information also can be obtained on the Space Shuttle Home Page. The address is:

**<http://shuttle.nasa.gov>**

Pre-launch status reports from KSC are found under **[ftp.hq.nasa.gov/pub/pao/statrpt/ksc](ftp://ftp.hq.nasa.gov/pub/pao/statrpt/ksc)**, and mission status reports can be found **under [ftp.hq.nasa.gov/pub/pao/statrpt/jsc](ftp://ftp.hq.nasa.gov/pub/pao/statrpt/jsc)**. Daily TV schedules can be found under **[ftp.hq.nasa.gov/pub/pao/statrpt/jsc/tvsked](ftp://ftp.hq.nasa.gov/pub/pao/statrpt/jsc/tvsked)**.

### **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.

## STS-74 QUICK LOOK

Launch Date/Site:	November 1995/KSC Launch Pad 39-A
Launch Time:	TBD
Launch Window:	Approx. 7 minutes (dependent on planar requirements)
Orbiter:	Atlantis (OV-104) - 15th flight
Orbit Altitude/Inclination:	160 nautical miles/51.6 degrees (Docking Altitude, 213 n.m.)
Mir Docking:	TBD
Mir Undocking:	TBD
Mission Duration:	7 days, 20 hours, 47 minutes
Landing Date:	November 1995
Landing Time:	TBD
Primary Landing Site:	Kennedy Space Center, FL
Abort Landing Sites:	Return to Launch Site - KSC Transoceanic Abort Sites - Zaragoza, Spain Ben Guerir, Morocco Moron, Spain Abort-Once-Around - KSC
Crew:	Ken Cameron, Commander (CDR) Jim Halsell, Pilot (PLT) Chris Hadfield, Mission Specialist 1 (MS 1) Jerry Ross, Mission Specialist 2 (MS 2) William McArthur, Mission Specialist 3 (MS 3)
Mir 20 Crew (aboard Mir):	Yuri Gidzenko, Commander Sergei Avdeyev, Flight Engineer Thomas Reiter, Cosmonaut-Researcher (ESA)
EVA Crewmembers (if required):	Jerry Ross (EV 1), William McArthur (EV 2)
Cargo Bay Payloads:	Docking Module Orbiter Docking System IMAX Cargo Bay Camera GLO
In-Cabin Payloads:	SAREX DSOs/DTOs

## **Developmental Test Objectives/Detailed Supplementary Objectives/ Risk Mitigation Experiments**

DTO 301D:	Ascent Structural Capability Evaluation
DTO 307D:	Entry Structural Capability
DTO 312:	ET TPS Performance
DTO 414:	APU Shutdown Test
DTO 624:	Radiator Performance
DTO 700-10:	Orbiter Space Vision System Video Taping
DTO 700-11:	Orbiter Space Vision System Flight Unit Testing
DTO 805:	Crosswind Landing Performance
DTO 829:	Plume Impingement and Contamination
DTO 832:	Target of Opportunity Navigation Sensors
DTO 1118:	Photographic and Video Survey of the Mir Space Station
DTO 1120:	Mated Shuttle and Mir Free Drift Experiment
DTO 1122:	APAS Thermal Data
DSO 485:	Inter-Mars Tissue Equivalent Proportional Counter
DSO 487:	Immunological Assessment of Crewmembers
DSO 604:	Visual-Vestibular Integration as a Function of Adaptation
DSO 621:	In-Flight Use of Florinef to Improve Orthostatic Intolerance Postflight
DSO 901:	Documentary Television
DSO 902:	Documentary Motion Picture Photography
DSO 903:	Documentary Still Photography
RME 1301:	Mated Shuttle and Mir Structural Dynamics Test
RME 1305:	Assessment of Space Station Environment
RME 1306:	Mir Wireless Network Experiment
RME 1308:	Photogrammetric Appendage Structural Dynamics Experiment
RME 1310:	Shuttle/Mir Alignment Stability Experiment

## STS-74 CREW RESPONSIBILITIES

<b>Payloads</b>	<b>Prime</b>	<b>Backup</b>
Docking Module	Ross	Hadfield
Orbiter Docking System	Hadfield	McArthur
Orbiter Space Vision System	Hadfield	McArthur
GLO/PASDE	Hadfield	Ross
SAREX	McArthur	Cameron, Ross
Electronic Still Camera	Halsell	Ross
Science and Logistics Transfers	Ross, Hadfield	Others
Water Transfer	Halsell	Hadfield, Cameron
Food Transfer	Ross	Halsell, Cameron
IMAX Cargo Bay Camera	Ross	Hadfield
 <b><u>Other Activities</u></b>		
Remote Manipulator System	Hadfield	McArthur
Earth Observations	Hadfield	Ross
EVA (if needed)	Ross (EV 1)	McArthur (EV 2)
Intravehicular Crewmember	Halsell	
Rendezvous	McArthur	Hadfield, Ross
 <b><u>DTOs/DSOs/RMEs (Risk Mitigation Experiments)</u></b>		
DTO 301D	Cameron	Halsell
DTO 307D	Cameron	Halsell
DTO 312	Cameron	Halsell
DTO 700-10	Hadfield	McArthur
DTO 829	McArthur	Hadfield
DTO 1118	Ross	Cameron
DTO 1120	Halsell	Cameron, Ross
DTO 1122	Halsell	Hadfield
DSO 485	Cameron	Halsell
RME 1301	Halsell	Cameron, Ross
RME 1303	Halsell	Cameron
RME 1305	Hadfield	Ross
RME 1306	McArthur	Cameron

## 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-74 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 the Kennedy Space Center, FL.
- Transatlantic Abort Landing (TAL) -- Loss of one or more main engines midway through powered flight would force a landing at either Zaragoza, Spain; Ben Guerir, Morocco; or Moron, Spain.
- Return-To-Launch-Site (RTL) -- Early shutdown of one or more engines, and without enough energy to reach a TAL site, would result in a pitch around and thrust back toward KSC until within gliding distance of the Shuttle Landing Facility.

## **PAYLOAD AND VEHICLE WEIGHTS**

	<b><u>Pounds</u></b>
Orbiter (Atlantis) empty and 3 SSMEs	173,191
Docking Module with Solar Arrays	9,011
Orbiter Docking System	4,016
Remote Manipulator System	994
GLO Experiment	648
IMAX Cargo Bay Camera	633
SAREX	28
Detailed Test/Supplementary Objectives	219
Risk Mitigation Experiments (RMEs)	83
Shuttle System at SRB Ignition	4,511,797
Orbiter Weight at Landing	205,000

## MISSION SUMMARY TIMELINE

### **Flight Day 1**

Launch/Ascent  
OMS-2 Burn  
Docking Module Activation  
Rendezvous Burn

### **Flight Day 2**

RMS Checkout  
EMU Checkout  
Cabin Depress (for EVA Contingency)  
Orbiter Space Vision System Checkout  
Centerline Camera Alignment  
Rendezvous Burns

### **Flight Day 3**

Orbiter Docking System Checkout  
Docking Module Unberth and ODS Installation  
ODS Preparation for Ingress  
Cabin Repress  
Rendezvous Tool Checkout  
Rendezvous Burn

### **Flight Day 4**

Rendezvous and Docking  
Hatch Opening and Welcome Ceremony  
Supply Transfers

### **Flight Day 5**

Gift Exchange  
Supply and Logistics Transfers  
Risk Mitigation Experiments

### **Flight Day 6**

Supply and Logistics Transfers  
Risk Mitigation Experiments  
Crew News Conference

### **Flight Day 7**

Farewell Ceremony  
Hatch Closing  
Undocking  
Shuttle Flyaround of Mir Station  
Separation Maneuver

### **Flight Day 8**

Flight Control System Checkout  
Reaction Control System Hot-Fire  
Stowage of Mir Transfer Items  
Cabin Stow

### **Flight Day 9**

Deorbit Prep  
Deorbit Burn  
Entry  
KSC Landing

## **STS-74 ORBITAL EVENTS SUMMARY**

Exact times for major events on STS-74 and other Phase I Shuttle-Mir docking missions will not be determined until after launch because of the rendezvous requirements needed for Atlantis to reach the Mir space station.

## **U.S./RUSSIA SPACE COOPERATION**

### **The International Space Station Program is Underway**

The international Space Station will be the preeminent, permanent orbiting science institute in space. It is being developed and assembled in three phases, each designed to maximize joint space experience and permit early utilization and return on a large joint investment involving 13 nations.

In Phase I, Americans and Russians will work together in laboratories on Mir and the Shuttle. They will conduct joint spacewalks and practice Space Station assembly by adding new modules to Mir. American astronauts will live and work on Mir for months beside their Russian counterparts, amassing the first U.S. long-duration space experience since Skylab (1973-1974).

International Space Station Phase I began with Russian cosmonaut Sergei Krikalev's flight aboard the Space Shuttle Discovery in February 1994 on STS-60. In February 1995, on the STS-63 mission, Discovery flew around the Russian Mir space station with cosmonaut Vladimir Titov aboard. During the fly around, Discovery stopped 37 feet from Mir -- a rehearsal for the first docking between Space Shuttle Atlantis and Mir in June/July 1995.

In March 1995, U.S. astronaut Dr. Norman Thagard flew to Mir for a three-month plus stay with two Russian cosmonauts, arriving there March 16. Thagard and his Russian crew mates returned to Earth aboard Atlantis 115 days later during the STS-71 mission, which saw the first docking between the U.S. Space Shuttle and Mir.

### **Phase I Impact on Phases II and III**

The goal of Phase I is to lay the groundwork for international Space Station Phases II and III. Phase II beginning in 1997 will place in orbit a core space station with a U.S. laboratory module, the first dedicated laboratory on the station.

The U.S. laboratory will be put to work during utilization flights beginning in 1999 with Phase III, while assembly continues. Phase III ends when assembly is complete (scheduled for mid-2002). At that time, astronauts and cosmonauts from many countries will commence full time space research on the international Space Station.

Phase I is contributing to the success of Phases II and III in four major areas:

- Americans and Russians are working together on Earth and in space, practicing for the future international Space Station
- Integration of U.S. and Russian hardware, systems, and scientific aims over a long period of time
- Risk reduction-mitigation of potential surprises in operations, spacecraft environment, spacewalks, and hardware exchange
- Early initiation of science and technology research

### **The Space Station Mir**

Mir represents a unique capability -- an operational space station that can be permanently staffed by two or three cosmonauts. Visiting crews have raised Mir's population to six for up to a month.

Mir is the first space station designed for expansion. The 20.4-ton Core Module, Mir's first building block, was launched in February 1986. The Core Module provides basic services (living quarters, life support, power) and scientific research capabilities. It has two axial docking ports, fore and aft, for Soyuz-TM manned transports and automated Progress-M supply ships, plus four radial berthing ports for expansion modules.

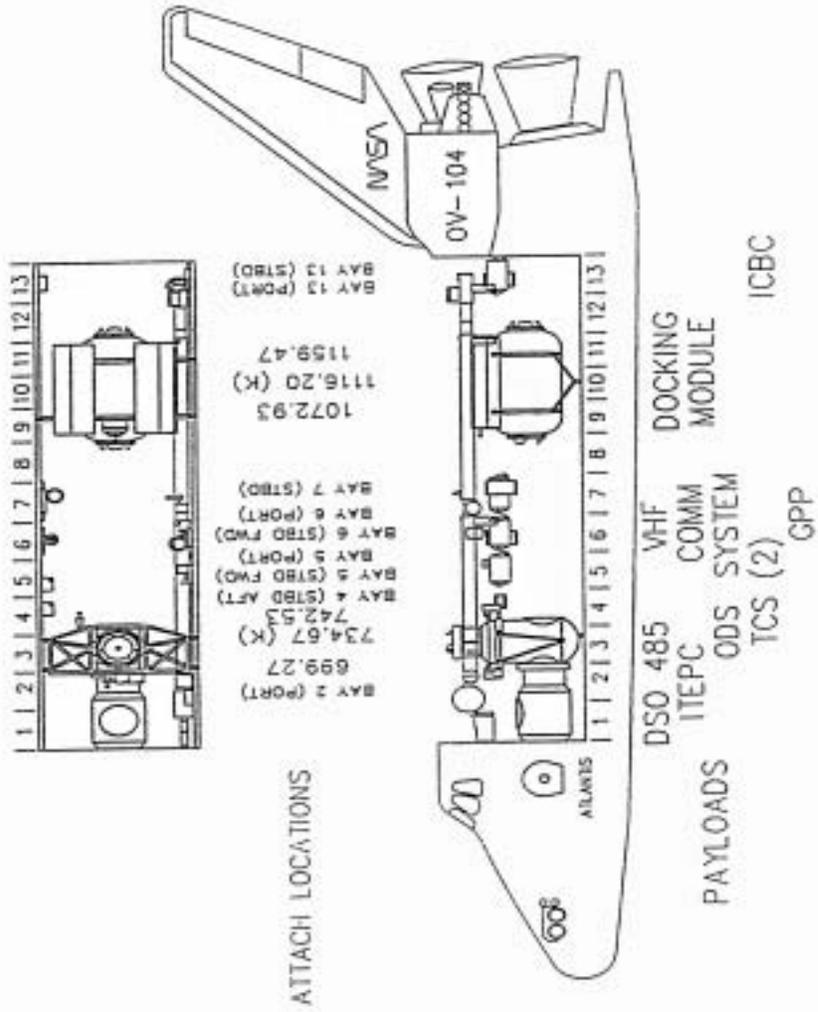
To date, the Russians have added four expansion modules to the Mir core:

- **Kvant.** Berthed at the core module's aft axial port in 1987, the module weighs 11 tons and carries telescopes and equipment for attitude control and life support.
- **Kvant 2.** Berthed at a radial port since 1989, the module weighs 19.6 tons and carries an EVA airlock, two solar arrays, and science and life support equipment.
- **Kristall.** Berthed opposite Kvant 2 in 1990, Kristall weighs 19.6 tons and carries two stowable solar arrays, science and technology equipment, and a docking port equipped with a special androgynous docking mechanism designed to receive heavy (up to about 100 tons) spacecraft equipped with the same kind of docking unit. The androgynous unit was originally developed for the Russian Buran Shuttle program. Atlantis will use the androgynous docking unit on Kristall.
- **Spektr.** Launched on a Russian Proton rocket from the Baikonur launch center in central Asia, Spektr was lofted into orbit on May 20. The module was berthed at the radial port opposite Kvant 2 after Kristall was moved out of the way. Spektr carries four solar arrays and scientific equipment (including more than 1600 pounds of U.S. equipment).

Two more modules, all carrying U.S. equipment, will be added to Mir in 1995-96 for international Space Station Phase I:

- **Docking Module.** The module will be launched in the payload bay of Atlantis and berthed at Kristall's androgynous docking port during the STS-74 mission. The Docking Module will provide clearance for future Shuttle dockings with Mir and will carry two solar arrays -- one Russian and one jointly developed by the U.S. and Russia -- to augment Mir's power supply.
- **Priroda.** Launch on a Russian Proton rocket is scheduled for Spring 1996. Priroda will berth at the radial port opposite Kristall and will carry microgravity research and Earth observation equipment (including 2,200 pounds of U.S. equipment).

After Priroda is added, Mir will have a mass of more than 100 tons. The station will consist of seven modules launched separately and brought together in space over 10 years. Experience gained by Russia during Mir assembly provides valuable experience for international Space Station assembly in Phases II and III.



CARGO ARRANGEMENT

## PHASE I SHUTTLE MISSION SUMMARIES

### STS-60

Launch: Feb. 3, 1994

Landing: Feb. 11, 1994

This mission inaugurated international Space Station Phase I. Veteran Russian cosmonaut Sergei Krikalev served as a mission specialist aboard Discovery. He conducted experiments beside his American colleagues in a Spacehab laboratory module carried in Discovery's payload bay.

### STS-63

Launch: Feb. 3, 1995

Landing: Feb. 11, 1995

Discovery maneuvered around Mir and stopped 37 feet from the Kristall module's special androgynous docking unit, which Atlantis used to dock with Mir on the STS-71 mission in June/July 1995. Cosmonauts on Mir and astronauts on Discovery beamed TV images of each other's craft to Earth. Cosmonaut Vladimir Titov served on board Discovery as a mission specialist, performing experiments beside his American colleagues in a Spacehab module in the Orbiter's payload bay.

For a time it appeared that minor thruster leaks on Discovery might keep the two craft at a pre-planned contingency rendezvous distance of 400 feet. However, mission control teams and management in Kaliningrad and Houston worked together to determine that the leaks posed no threat to Mir, so the close rendezvous proceeded. The minor problem became a major confidence builder and joint problem-solving experience for later international Space Station phases.

### STS-71

Launch: June 27 1995

Landing: July 7, 1995,

Atlantis was launched with seven crew members -- five U.S. astronauts and two Russian cosmonauts -- and, in its payload bay, a Spacelab module and an Orbiter Docking System for docking with Mir. The Orbiter Docking System is a cylindrical airlock with a Russian-built androgynous docking mechanism on top. The Orbiter Docking System will be carried on all docking missions. For STS-71, Atlantis docked with an identical androgynous unit on Mir's Kristall module.

The Space Shuttle was used for the first time to change a space station crew, a task that will become a routine part of its duties in later international Space Station phases. Atlantis dropped off cosmonauts Anatoliy Solovyev and Nikolai Budarin, and picked up Gennadiy Strekalov, Vladimir Dezhurov, and U.S. astronaut Norman Thagard for return to Earth. They were launched from Russia in the Soyuz-TM 21 spacecraft on March 14.

Thagard and his Russian colleagues completed a 115-day stay on Mir. Thagard was the first U.S. astronaut to have a long-duration stay on-orbit since the last U.S. Skylab mission in 1974. In fact, his mission broke the record for time on-orbit for a U.S. astronaut on June 6, 1995.

The joint crews carried out experiments similar to those planned for international Space Station Phases II and III. Atlantis was docked to Mir for five days.

**STS-74**

Planned launch: November 11, 1995

Planned landing: November 19, 1995

Atlantis will carry the Russian-built Docking Module, which has multi-mission androgynous docking mechanisms at top and bottom. During the flight to Mir, the crew will use the Orbiter's Remote Manipulator System robot arm to hoist the Docking Module from the payload bay and berth its bottom androgynous unit atop Atlantis' Orbiter Docking System. Atlantis will then dock to Kristall using the Docking Module's top androgynous unit. After two days, Atlantis will undock from the Docking Module's bottom androgynous unit and leave the Docking Module permanently docked to Kristall, where it will improve clearance between the Shuttle and Mir's solar arrays during subsequent dockings.

Atlantis will deliver water, supplies, and equipment, including two new solar arrays -- one Russian and one jointly-developed -- to upgrade the Mir. It will return to Earth experiment samples, equipment for repair and analysis and products manufactured on the station.

**STS-76**

Planned launch: March 1996

Atlantis will deliver U.S. astronaut Shannon Lucid to Mir for a five-month stay. The Orbiter will carry a Spacehab module in its payload bay and will remain docked to the Russian station for five days. Astronauts Linda Godwin and Rich Clifford will conduct the first U.S. spacewalk outside the Mir to attach four experiments to the station's docking module.

**STS-79**

Planned launch: August 1996

The Space Shuttle will pick up Lucid for her return to Earth and deliver her replacement, U.S. astronaut John Blaha, to Mir for approximately four months. U.S. astronauts will perform a spacewalk during the five-day docked phase. Atlantis will carry a Spacehab double module.

**STS-81**

Planned launch: December 1996

Blaha will return to Earth and astronaut Jerry Linenger will take up residence on Mir. Two Russians or an American and a Russian will perform U.S. experiments as part of a spacewalk during or after the five-day docked phase. Atlantis will carry a Spacehab double module.

**STS-84**

Planned launch: May 1997

Linenger, delivered on STS-81, will be picked up and another astronaut dropped off. Atlantis will carry a Spacehab double module and will remain docked to Mir for five days.

**STS-86**

Planned launch: September 1997

Atlantis will pick up the astronaut dropped off on STS- 84 and deliver a joint U.S.-Russian solar dynamic energy module. As many as two spacewalks by U.S. astronauts and Russian cosmonauts will be needed to deploy the energy module outside Mir. The solar dynamic system will heat a working fluid that will drive a turbine, generating more electricity than current photovoltaic solar arrays. The Mir solar dynamic energy module will test the system for possible use on the international Space Station. In addition, developing the solar dynamic energy module will provide joint engineering experience.

## **SHUTTLE-MIR RENDEZVOUS AND DOCKING**

STS-74's rendezvous and docking with the Russian space station Mir actually begins with the precisely timed launch of Atlantis on a course for the station, and, over the next four days, periodic small engine firings that will gradually bring Atlantis to a point eight nautical miles behind Mir, the starting point for a final approach to the station. The day before docking is planned, the crew will unberth and install the docking module scheduled to be left permanently attached to the Mir.

### **Docking Module Installation -- Flight Day Three**

Prior to installation operations, several preliminary spacewalk preparations will have been completed by the crew to shorten the amount of time required to begin a spacewalk in case one is needed to assist with the docking module installation. These include depressurizing the crew cabin to 10.2 pounds per square inch and performing a standard checkout of spacesuit equipment early in the flight. Also, on Flight Day three, the Shuttle middeck will be prepared for a spacewalk in case one is required. The extravehicular activity crew members are Mission Specialists Jerry Ross and Bill McArthur. However, Ross and McArthur will not begin donning any spacesuit gear unless a spacewalk is actually deemed necessary.

To install the docking module on Flight Day three, Mission Specialist Chris Hadfield will first maneuver Atlantis' mechanical arm into position to attach to a grapple fixture mounted on the module. Next, latches will be released that have held the module horizontal in the payload bay for launch, and Hadfield will lift the module out of the bay. Above the bay, he will rotate the module to a vertical position.

Hadfield will then begin to precisely align the docking system at the end of the module with the Orbiter Docking System (ODS) on Atlantis. During this operation, the Orbiter Space Vision System (OSVS), a precise alignment system for the mechanical arm that is being tested on STS-74, will be evaluated as well. The OSVS, a Detailed Test Objective on STS-74, consists of a series of large dots placed on the exterior of the docking module and the ODS. Using digitized television camera views of the dots, the OSVS generates a display on a laptop computer aboard the Shuttle that indicates alignment both graphically and digitally. McArthur will oversee operations of the OSVS during the module installation.

For the installation, Hadfield, using a view from a camera mounted in the center of the ODS, will slowly lower the docking module toward the ODS, aligning it at a point about 30 inches above Atlantis' docking mechanism and pausing at that point. Next, he will lower it to a point only five inches above the docking ring. Atlantis' reaction control system jets will be turned off during these operations to avoid any inadvertent movement of the arm and module.

To engage the docking mechanism, Hadfield will put the arm into a test mode that essentially turns off brakes on the joints and leaves them free to move. With the arm in this limp mode, Commander Ken Cameron will reactivate Atlantis' steering jets and fire a short downward pulse to move Atlantis the final few inches to the module and engage the docking mechanism. Once the module is installed, it will be pressurized and leak checks will be performed. Once these are complete, the arm will be detached from the module and moved to an extended park position overnight, and the centerline camera will be moved up to be mounted in the center of the module's docking mechanism.

### **Mir Rendezvous -- Flight Day Four**

About two hours before the scheduled docking time on Flight Day Four of the mission, Atlantis will reach a point about eight nautical miles behind the Mir Space Station. Just prior to that time, the mechanical arm will be moved from the extended park position to a poised for docking position, extended out from the right-hand side of Atlantis. This position will allow the arm's elbow camera, a camera mounted at the middle arm

joint, to be used by the crew for a lateral view of the docking mechanism and Mir approach. Also about this time, Atlantis' crew will begin air-to-air communications with the Mir 20 crew.

At a point eight nautical miles behind Mir, a Terminal Phase Initiation (TI) burn will be fired and the final phase of the rendezvous will begin. Atlantis will close the final eight nautical miles to Mir during the next orbit. As Atlantis closes in, the Shuttle's rendezvous radar system will begin tracking Mir and providing range and closing rate information to Atlantis.

As Atlantis closes the final eight nautical miles, the Shuttle will have the opportunity for four small successive engine firings to fine-tune its approach using its onboard navigation information. Identical to the STS-71 Mir rendezvous, Atlantis will aim for a point directly below Mir, along the Earth radius vector (R-Bar), an imaginary line drawn between the Mir center of gravity and the center of Earth. Approaching along the R-Bar, from directly underneath the Mir, allows natural forces to brake Atlantis' approach more than would occur along a standard Shuttle approach from directly in front of Mir. During this approach, the crew will begin using a handheld laser-ranging device to supplement distance and closing rate measurements made by Shuttle navigational equipment. Also, as Atlantis reaches close proximity to Mir, the Trajectory Control Sensor, a laser-ranging device mounted in the payload bay, will supplement the Shuttle's onboard navigation information by supplying additional data on the range and closing rate.

The manual phase of the rendezvous will begin just as Atlantis reaches a point about a half-mile below Mir when Cameron takes the controls. Cameron will fly the Shuttle using the aft flight deck controls as Atlantis begins moving up toward Mir. Because of the approach along the R-bar, from underneath Mir, Cameron will have to perform very few braking firings. However, if such firings are required, the Shuttle's jets will be used in a mode called "Low-Z," a technique that uses slightly offset jets on Atlantis' nose and tail to slow the spacecraft rather than firing jets pointed directly at Mir. This technique avoids contamination of the space station by exhaust from the Shuttle steering jets.

Using the centerline camera fixed in the center of the module's docking mechanism, Cameron will center the module docking device with the Mir docking device, continually refining this alignment as he approaches within 170 feet of the station. At 170 feet, Cameron will halt the approach while Mir maneuvers into docking attitude. After consulting with Russian flight controllers, NASA flight controllers will give Cameron permission to continue in.

At a distance of about 30 feet from docking, Cameron will stationkeep momentarily to adjust the docking mechanism alignment if necessary. From that point on, the crew will use ship-to-ship communications with Mir constantly to inform the station crew of the Shuttle's status and keep them informed of major events, including confirmation of contact, capture and conclusion of damping. Damping, the halt of any relative motion between the spacecraft after docking, is performed by springs and motors within the docking device.

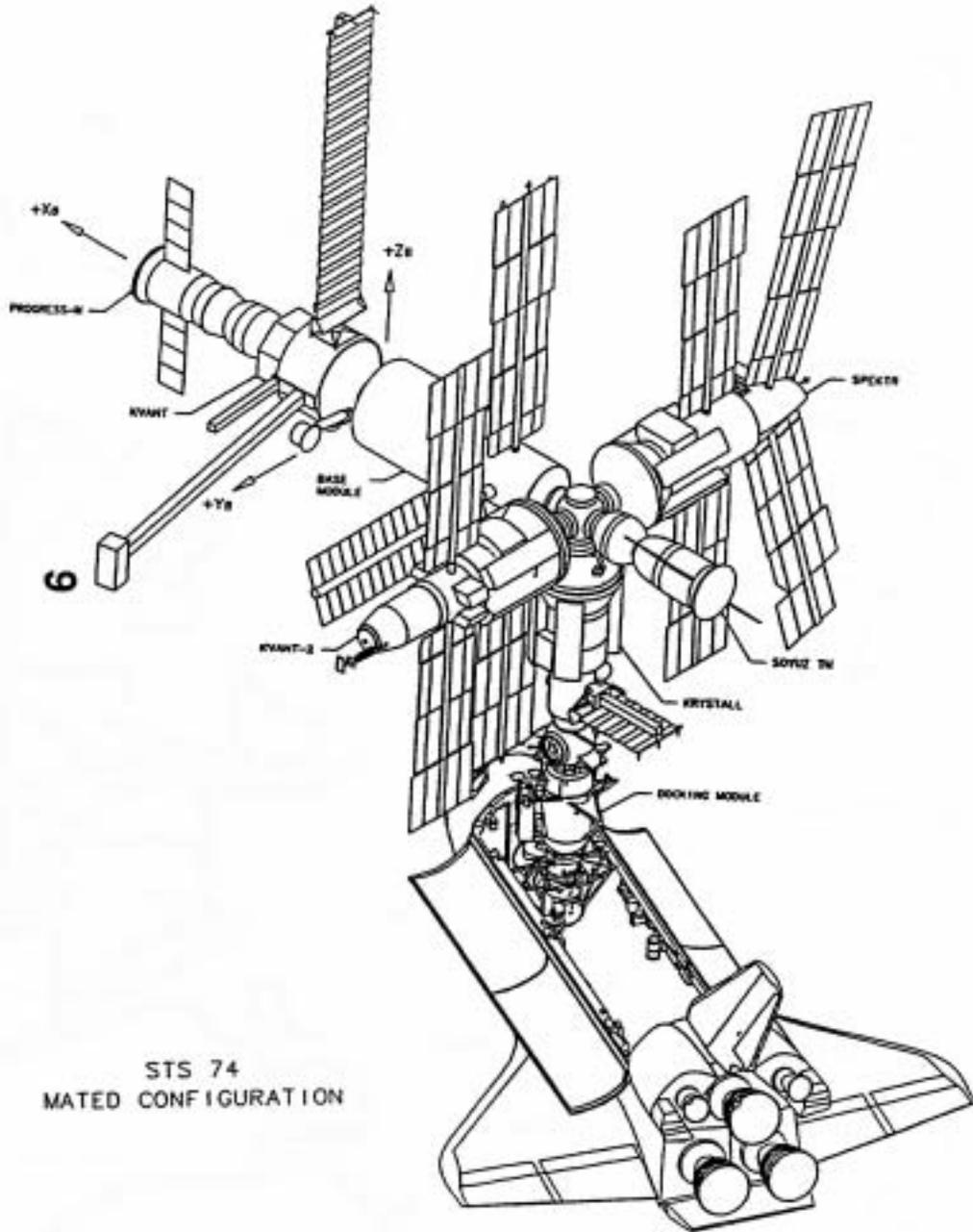
Due to the length of the docking module, the elbow camera on the mechanical arm will provide the only direct view for Atlantis' astronauts of the docking mechanism's operation during the final docking sequence.

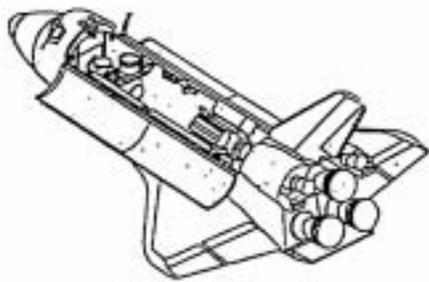
### **Undocking, Separation and Mir Fly-Around**

Once Atlantis is ready to undock from Mir, the initial separation will be performed by springs that will slightly push the Shuttle away from the docking mechanism. Both the Mir and Atlantis will be in a mode called "free drift" during the undocking, a mode that has the steering jets of each spacecraft shut off to avoid any inadvertent firings.

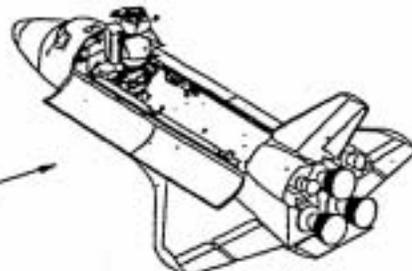
Once the docking mechanism's springs have pushed Atlantis away to a distance of about two feet from Mir -- when the docking devices will be clear of one another -- Cameron will turn Atlantis' steering jets back on. Immediately thereafter, he will slightly fire the Shuttle's jets in the Low-Z mode to begin moving very

slowly away from Mir. Atlantis will continue away from Mir to a distance of about 400 feet, where Halsell will begin a flyaround of the station. At that distance, Atlantis will circle Mir twice, the crew performing a photographic survey of Mir, before firing its jets again to depart the vicinity of the station.

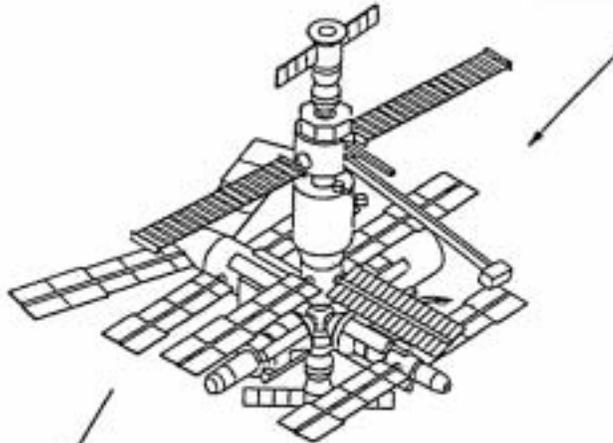




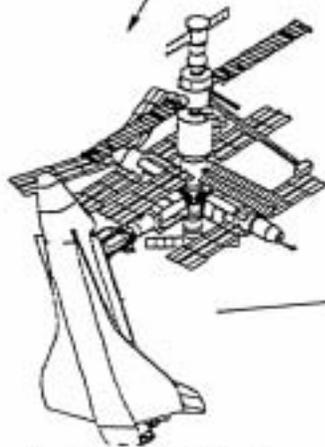
DOCKING MODULE STOWED



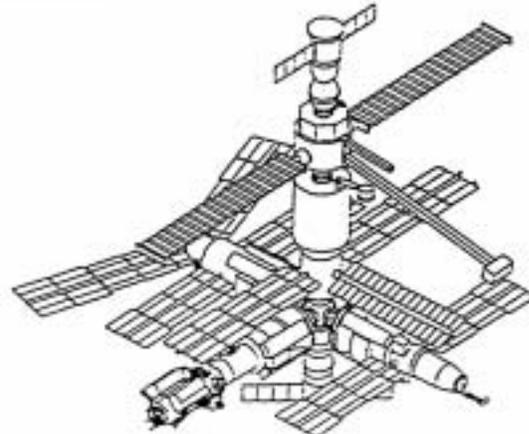
DOCKING MODULE INSTALLED



MIR CONFIGURATION 3



MIR DOCKED TO DOCKING MODULE



MIR CONFIGURATION FOLLOWING SHUTTLE DEPARTURE

## **ORBITER DOCKING SYSTEM**

The Russian-built Docking Module (DM), to be carried aloft by Atlantis and left attached to the Kristall module of the Mir Space Station, is designed to allow Shuttle-Mir dockings with the Kristall module located at the Mir radial port.

Without the DM, Kristall would have to be moved to the longitudinal axis of Mir to provide clearance for each Shuttle docking. The longitudinal axis location is undesirable for Kristall because the longitudinal port is normally a location for Progress resupply modules and Soyuz spacecraft. In addition, it is not desirable to continually move the Kristall from port to port in preparation for a Shuttle docking.

The 15.4-foot long DM will allow clearance for the Shuttle to dock with Kristall located at the radial axis of Mir. The module will not be moved from that location once STS-74 is complete. All further Shuttle dockings will take place using the DM. It may also be used for future Soyuz dockings.

### **Docking Module Structure**

The DM is mounted in Atlantis' aft cargo bay and held in place by four latches, three on the sides, and one keel latch. A Remotely Operated Electrical Umbilical (ROEU) supplies Shuttle power to the module while it is mounted horizontally in the cargo bay. The ROEU is released before the module is unberthed from the bay and mounted in position for the Mir docking. Power to the DM is not supplied during Atlantis' launch, but will be turned on after reaching orbit.

The DM is 15.4 feet long from tip to tip of the identical Androgynous Peripheral Docking Systems (APDS) located on either end. For identification purposes, APDS-1 is the system that will be attached to Kristall and APDS 2 will be attached to Atlantis. The DM diameter is 7.2 feet, and the module weighs approximately 9,011 pounds.

The DM is constructed of aluminum alloy covered on the exterior by Screen Vacuum Thermal Insulation (SVTI) and a micrometeoroid shield over the body of the module. A truss structure is attached to the module to provide latching to the Shuttle while horizontal in the cargo bay, and the truss will remain attached to the module after the cargo bay latches are released and the DM is unberthed.

On the exterior of the module, two Mir solar array containers are attached to transport solar arrays to the Mir. The solar array containers are attached on either side of the top of the module as it will be situated while in the cargo bay of Atlantis. The solar arrays will be removed from the containers and attached to the Mir during a spacewalk by the Mir cosmonauts after STS-74.

The two solar arrays are different types. One is called the Cooperative Solar Array (CSA) and was built as a cooperative effort between NASA and Russia. The other is a Russian Solar Array (RSA). The Cooperative Solar Array uses Russian structures and NASA photovoltaic modules and was designed as part of the Phase 1 operations of the international Space Station Program. The array is expected to provide greater power and longer life expectancy over existing arrays and will help to power U.S. experiments aboard the Mir.

A grapple fixture also is attached to the topside exterior of the DM for use with the Shuttle's mechanical arm to unberth the DM from the cargo bay. Also attached to the exterior are several extravehicular activity (EVA) handholds for use during spacewalks.

An external camera is mounted to the DM for use as a backup during docking on STS-74 if an interior centerline camera fails.

### **Docking Module Avionics Subsystem**

The DM's Avionics System is connected to Atlantis to receive power and telemetry by the ROEU while in the cargo bay and by the docking system when attached to the Orbiter Docking System in preparation for Mir docking.

The module is pressurized at all times during ascent and unberthing from the cargo bay, and telemetry information is provided to Atlantis on pressure, temperatures, fan operations and information on the APDS. Commanding also can be performed via the avionics system of the APDS mechanisms, valves, fans, closed circuit television and other equipment.

Power supply, commanding and telemetry for the DM will be switched from Atlantis to Mir after Atlantis has docked. However, Atlantis retains a backup commanding capability for the DM and APDS mechanisms.

### **Docking Module Thermal Subsystem**

The thermal control of the DM is performed by passive thermal blankets on the exterior, a fluid cooling loop and fans for avionics equipment and the APDS window.

The APDS window fan mounts near the bracket that will hold an interior centerline camera and prevents the window from fogging during docking operations.

### **Docking Module History**

Concept discussions for the DM began with RSC Energia in November 1993, and were finalized in June 1994.

Assembly of the DM flight unit began in February 1995 and final assembly and functional testing was completed in May 1995. The DM arrived at KSC in June 1995 in preparation for STS-74.

## SHUTTLE-MIR SCIENCE

### STS-74 SCIENCE OVERVIEW

STS-74 marks the second of seven planned missions to dock an American Space Shuttle with Russia's Mir space station. During three days of joint operations, astronauts and cosmonauts will transfer the American biomedical and microgravity science samples and data collected by the Mir 18, Mir 19, and Mir 20 resident crews, from the space station to the Shuttle. After return to Earth, the information will be analyzed by researchers on the ground. Included in the items being returned are some samples from an ongoing European Space Agency mission -- continuing the international cooperation in space that will carry on into the future.

Crew members also will transfer hardware and supplies to Mir for future biomedical and environmental investigations. Data and samples gathered from those investigations will be retrieved during future Shuttle/Mir missions. All materials gathered during STS-74, and other planned missions, will provide important information in the design, development, and operation of future space stations.

Water, food, and science instruments will be transferred to Mir for resupply and to support experiments to be conducted on board the space station by the resident Mir 20 crew and the following Mir 21 crew in early 1996. American astronaut Shannon Lucid is then scheduled to launch on the Shuttle (STS-76) in March 1996, and join the Mir 21 crew to continue these investigations that will focus on life sciences, microgravity science, space science, Earth science and technology.

Phase 1 of the International Space Station (ISS) Program, which includes the seven Shuttle missions to Mir and the long duration missions of five American astronauts onboard the Mir, will perform over 75 science and research investigations, most of them during the long duration missions on board the Mir. Four investigations -- Mir Source & Reclaimed Waters; Shuttle/Mir Alignment Stability Experiment; Mir Wireless Network Experiment; Mir Audible Noise Measurement -- will be conducted during the docked phase of STS-74. A protein crystal growth experiment delivered by STS-71 in July also will be recovered and replaced with another unit that will continue this line of research.

Water samples collected from Mir will be returned to Earth for analysis to help determine its purity. The Mir Source and Reclaimed Waters investigations will provide researchers with information to be used in designing, developing, and evaluating water purification units for the ISS. Samples of Mir's potable, reclaimed hygiene water, unprocessed hygiene water, and humidity condensate all will be analyzed postflight to determine their chemical and microbiological characteristics.

The Shuttle/Mir Alignment Stability Experiment will use guidance and control information from both the Shuttle and the Mir station to understand the dynamics of the docked configuration of these two spacecraft. Together, the combined mass of over 200 tons is the largest spacecraft ever flown in space. The stability of this mass under the combined forces of gravity, rocket firings, and gyrodyne operation will allow engineers to certify their models for the control of ISS.

Two other investigations also support space station habitability disciplines. The Mir Audible Noise Measurement and Mir Wireless Network Experiment both have applications for use on the international Space Station.

Astronauts will take measurements that will allow researchers to characterize Mir's acoustic environment. Using a sound level meter, tape recorder and headphones, noise measurements will be gathered at various locations on the space station, including the exercise area, work station, and habitation module. Postflight analysis will help ISS designers determine if additional acoustic mitigation efforts might be required in specific areas of the space station.

The Mir Wireless Network Experiment is a test of a computer communications network which uses radio waves to pass information between unconnected devices. It is planned for use on the international Space Station. A notebook computer will be used to monitor file transfer rates at various locations on the space station.

The Protein Crystal Growth - Dewar experiment launched on STS-71 will be swapped out with a new Dewar by the STS-74 crew. The sample crystals have been growing passively without crew attention since being left on the Mir space station in July. New frozen samples on board Atlantis will be transferred to an undisturbed spot on Mir where they will thaw naturally. As the crystals thaw, diffusion and crystal growth begin. Upon return to Earth, these crystals will be studied and compared to those grown on Earth and over shorter periods during previous Shuttle missions.

The Greenhouse Integrated Plant Experiment began with the Mir 19 crew and was continued by the resident Mir 20 crew. The studies, which are expected to be complete prior to the arrival of Atlantis, are designed to study how plants grow in microgravity and determine how space flight affects plant reproduction, metabolism and productivity. This investigation will provide data that could validate the use of oxygen-generating plants in an advanced life support system for future space stations.

## **Earth Sciences**

### **Visual Earth Observations**

#### **Experiment Description:**

The Earth's surface is changing dramatically everyday, but due to our limited view, these phenomenal events cannot be observed or recorded on a large scale. With space flight and long term habitation in a space station, there is a platform available for continual observations from low-Earth orbit. Sites are selected to document geologic structures using variable Sun angles, seasonal events such as biomass burning, longer-term changes like the rise and fall of lake levels, gradual changes in land-use patterns, dynamic patterns in the ocean surface waters, and globally distributed episodic events like tropical storms, floods, forest fires, volcanic eruptions and dust storms.

#### **Experiment Objectives**

To monitor observable Earth surface changes and image ephemeral events (hurricanes, plankton blooms, volcanic eruptions) to incorporate into a 30+ year database of human observations.

#### **Mission Assignments:**

STS-74

Mir 21

#### **Researchers**

Dr. K. Lulla of the NASA Johnson Space Center

Dr. C. Evans of the Lockheed-Martin Corporation

Dr. L. Desinov of the Russian Academy of Sciences

## **Fundamental Biology Greenhouse**

### **Experiment Description:**

Plants can be grown in microgravity and can be used effectively in life support systems. The goal of this investigation is to study plant growth in microgravity and determine the effects of space flight on the ontogenesis, reproductive function, metabolism, and productivity in higher plants.

The Greenhouse experiment is conducted in the Russian/Slovakian-developed plant growth facility called the "Svet." The U.S. has added new lighting and watering systems to enhance plant growth conditions. In addition, the U.S. has added an instrumentation system to the Svet to gather information on how microgravity affects the gas exchange process in plants. Plant development is monitored by daily observations and photographs taken by crewmembers. Plant samples are collected at six specific developmental stages and at final harvesting. All samples are returned to Earth for postflight analysis.

### **Experiment Objectives**

To investigate the effects of microgravity on the productivity of a crop plant, specifically dwarf wheat. To identify the chemical, biochemical, and structural changes in plant tissues induced by microgravity. To determine microgravity's effect on plant processes such as photosynthesis and water use. To evaluate current facilities for plant growth aboard the Mir.

### **Mission Assignments:**

Mir 18

Mir 19

STS-74 (return items and experiment resupply)

Mir 20

Mir 21

### **Researchers**

Dr. F. Salisbury of the Utah State University

Dr. M. Levinskikh of the Russian Institute of Biomedical Problems

## **Human Life Sciences Analysis of Volatile Organic Compounds**

### **Experiment Description:**

This experiment will attempt to characterize the volatile organic compounds (VOCs) in air samples collected on the Mir during the NASA/Mir program. Samples will be collected onto special cartridges using the U.S. Solid Sorbent Air Sampler (SSAS). Also, grab samples will be collected using U.S. Grab Sample Containers. Samples will then be transferred from Mir to the Shuttle and, when back on Earth, to a laboratory at NASA Ames Research Center for analysis. The results of the analyses will reveal detailed information on the types and concentrations of VOCs in the Mir environment. The results also will have a number of uses for advanced life support research, including the demonstration of new technology for air quality monitoring, support of toxicological evaluations of the Mir environment, and support of correlation studies to link the presence of particular VOCs with certain materials, human presence, and biological experiments.

### **Experiment Objectives**

To provide instrumental resources and analytical expertise for the characterization of volatile organic compounds (VOCs) in the atmosphere and support of environmental science research on the Mir station.

To characterize VOCs on the Mir station through sampling and analysis.

To demonstrate new technology for on-line, real-time monitoring of trace levels of VOCs.

To document the types and concentrations of VOCs on the Mir station and analysis of the results in collaboration with other science investigators.

### **Mission Assignments:**

STS-74 (up items for Mir 21)

Mir 21

### **Researchers**

Dr. P. Palmer of San Francisco State University

Dr. V. Savina of the Russian Institute for Biomedical Problems

### **Human Life Sciences Collecting Mir Source and Reclaimed Waters**

#### **Experiment Description:**

In this investigation, the water on the Mir space station will be analyzed in detail to study the effectiveness of the Mir purification system. Potable water, water used to maintain hygiene, and water that accumulates from humidity condensate will be analyzed to confirm that any potentially harmful contaminants are maintained at acceptably safe levels. The information gathered by this research will support the development and evaluation of water purification units, water quality standards, and in-flight water sampling hardware for the international Space Station.

#### **Experiment Objectives**

To characterize the chemical purity of Mir water. To support the design and operation of water purification and monitoring units and the establishment of water quality standards for the international Space Station.

#### **Mission Assignments:**

Mir 20

STS-74 (return items and experiment resupply)

Mir 21

#### **Researchers**

Dr. R. Sauer of the Johnson Space Center

Dr. Y. Sinyak of the Russian Institute of Biomedical Problems

## **Human Life Sciences Eye/Head Coordination During Target Acquisition**

### **Experiment Description:**

The eyes work in conjunction with the vestibular (balance system) in the inner ear, as well as with the other senses, to allow a person to track visual targets while the head and body are moving. Prolonged stays in microgravity change the way the brain responds to eye and head movements when attempting to follow an object with the eyes. This research will quantify these disruptions, continue to allow us to understand limitations, and help devise countermeasures.

All testing of the crewmembers occurs before and after flight. Eye movements are measured by placing electrodes above and below the crewmembers' eyes to measure eye movements. A sensor on the head measures angular head movements. The crewmember is asked to visually fixate on stationary targets or track a moving target by moving only the eyes, only the head, or both eyes and head. These eye-head coordination tests are designed to study the effects of space flight on eye movement mechanisms controlled by the visuo-motor and vestibular systems, specifically how these systems function separately and how they work together.

### **Experiment Objectives**

To determine how exposure to microgravity affects the ability of the eyes to follow a target, the reflex movement of the eyes during head movements, and the coordination between eye and head movements while visually tracking an object.

### **Mission Assignments:**

Mir 18  
Mir 19  
STS-74 (return items)

### **Researchers**

Dr. J. Bloomberg of the NASA Johnson Space Center  
Dr. I. Kozlovskaya of the Russian Institute of Biomedical Problems

## **Human Life Sciences Humoral Immunity**

### **Experiment Description:**

The human immune system is comprised of two components, the humoral and cell-mediated immunity. Humoral immunity involves the production and action of antibodies, and cell-mediated immunity involves sensitized lymphocytes. Humoral immunity occurs within minutes or hours of exposure to an antigen.

Cell-mediated immunity, on the other hand, is a delayed reaction occurring days after initial exposure; a good example is a positive reaction seen in the skin 24 to 48 hours after a tuberculosis test injection.

Researchers hypothesize that the humoral component of immunity is depressed during space flight, and that antibody production is significantly reduced. Research of this nature is important to establish and protect the health of the crew during space flight, and also leads to a greater understanding of the human immune system.

In this investigation, baseline blood and saliva samples are collected. Crew members then receive immunizations (injections of certain antigens), and blood and saliva samples are taken at timed intervals after the injections are given. Antibodies will be made in response to the injections, and the amounts of antibodies produced are measured in the blood and saliva samples. Data from all the blood and saliva samples should provide researchers with the effectiveness, extent, and time course of the antibody response.

### **Experiment Objectives**

To investigate the humoral component of the immune system to determine if its function is compromised by the microgravity environment. To investigate whether antibodies are produced in response to antigen introduction by vaccination and the time course of the response after exposure to microgravity.

### **Mission Assignments:**

Mir 18  
Mir 19  
STS-74 (return items)

### **Researchers**

Dr. C. Sams of the NASA Johnson Space Center  
Dr. I. Konstantinova of the Russian Institute of Biomedical Problems

## **Human Life Sciences Inflight Radiation Measurements**

### **Experiment Description:**

The United States and Russia have different methods of detecting and calculating radiation exposures to their crews and spacecraft. This experiment calls for each country's researchers to obtain radiation information in their usual manner. Comparison of the techniques used by the U.S. and Russia for radiation calculations and dosimetry calibrations will enable both countries to validate their radiation detection procedures and identify any differences that exist within their respective protocols. The radiation measurements that occur during this investigation allow scientists to gather additional information about two radiation sources -- galactic cosmic rays and protons trapped by the Earth's magnetic field.

Both crews will wear passive dosimeters (one American and one Russian device) during the Mir missions to measure the radiation to which they are exposed. The crews also will place several American and Russian radiation monitoring devices throughout the Mir space station and the Shuttle.

### **Experiment Objectives**

To correlate space radiation measurements made by NASA with those made by the Russian Institute of Biomedical Problems. To compare the NASA and Institute of Biomedical Problems space flight dosimeter calibration techniques.

### **Mission Assignments:**

Mir 18  
Mir 19  
STS-74 (return items)

## **Researchers**

Dr. G. Badhwar of the NASA Johnson Space Center  
Dr. V. Petrov of the Russian Institute of Biomedical Problems

## **Human Life Sciences Magnetic Resonance Imaging**

### **Experiment Description:**

When muscles are not used regularly, they begin to deteriorate and weaken, an effect called atrophy. Measurements on the crew of the Spacelab-Japan mission (STS- 47) showed that there was significant muscle atrophy after only eight days in weightlessness. Bed-rest studies have documented the degree of expected atrophy after several months of muscle disuse. This investigation will document the degree of muscle weakening during long-duration space flight following a stay on the Mir space station. Measurements will be made before and after flight using Magnetic Resonance Imaging (MRI).

The spine, or backbone, supports the body against gravity. During upright activity on Earth, the downward pull of gravity actually compresses the spine and the spinal discs. When it is not in use, such as when a person is lying down while sleeping, the spine expands. Weightlessness also results in expansion of the spine, which causes the astronauts to become taller and is believed to cause back pain and discomfort. This investigation also will study the relationship between spinal expansion and back pain in astronauts.

### **Experiment Objectives**

To measure and analyze the bone marrow of the spine, and the muscle volumes of the calf, thigh, back, and neck before and after space flight. To compare the results from actual long duration stays in weightlessness to data from bed rest studies with and without exercise. To measure the size of the intervertebral discs before and after long duration space flight to determine if spinal discs remain expanded or enlarged beyond their normal size, after return to Earth's gravity. To document the occurrence of back discomfort during and after flight and study its association with expansion of the spinal discs caused by space flight.

### **Mission Assignments:**

STS-74 (up items for Mir 21)  
Mir 21

## **Researchers**

Dr. A. LeBlanc of the NASA Johnson Space Center  
Dr. I. Kozlovskaya of the Russian Institute for Biomedical Problems

## **Human Life Sciences Microbial Investigations**

### **Experiment Description:**

Microbes are an integral part of our surroundings and they thrive everywhere on Earth. Researchers are interested to learn which microbes inhabit the Mir space station, if the microbes are affected in any way by the lack of gravity, and if concentrations of microbes differ on the Mir compared to on Earth. Before the Mir 18, STS-71, and Mir 19 flights, researchers developed a profile of the bacteria and fungi that each crewmember might introduce into the space environment. The crewmembers are sampled again after these flights to detect any changes in their microbial populations. Air, water, and surface samples are collected

during the flights to monitor changes in the microbial ecology as the mission proceeds. All samples are returned to Earth for analysis by researchers.

### **Experiment Objectives**

To characterize the microbial profile of each crewmember and the environment of the Mir. To investigate any changes associated with the microbe physiology or characteristics of the space environment.

### **Mission Assignments:**

Mir 18 Mir 20 STS-74 (return items)

### **Researchers**

Dr. D. Pierson and R. Sauer of the NASA Johnson Space Center

Drs. N. Novokova, A. Viktorov, and V. Skuratov of the Russian Institute of Biomedical Problems

## **Human Life Sciences Protein Metabolism**

### **Experiment Description:**

The human body responds to stressful situations in many ways. One response is an increase in protein metabolism. During Shuttle flights, studies have shown that the whole body protein synthesis rate increases dramatically. This experiment uses the <sup>15</sup>N-glycine method, which involves ingesting glycine labeled with a stable isotope of nitrogen, collecting urine samples, measuring body weight, and maintaining dietary logs throughout the experimental period.

### **Experiment Objectives**

To determine the duration of the metabolic stress response associated with space flight. To determine how long it takes for protein metabolism to return to the preflight state after a long duration mission.

### **Mission Assignments:**

STS-74 (up items for Mir 21)

Mir 21

### **Researchers**

Dr. P. Stein of the University of Medicine and Dentistry of New Jersey

Dr. I. Larina of the Russian Institute of Biomedical Problems

## **Human Life Sciences Posture and Locomotion**

### **Experiment Description:**

Gravity is used as a frame of reference for our sensory-motor response. When gravity is absent, such as during space flight, the sensory-motor system is disrupted. These disturbances are compensated for by the brain, and ultimately the human body adapts to them. After returning to Earth, a readjustment period occurs in which balance and locomotion functions are temporarily disturbed until the brain once again learns to use gravity as a frame of reference. This investigation examines these sensory-motor changes and adjustments. The results should assist researchers in devising countermeasures to reduce the time of adjustment.

This experiment has three parts. The Posture Study will occur before, during, and after the Mir missions. Crewmembers will wear shoes with inflatable bladders to provide pressure to their feet, which simulates one aspect of gravity. They will then do arm raises, both with and without the shoes, while electromyograms are recorded. Researchers will test whether the crewmembers had a muscle response anticipating the arm movement while wearing the shoes.

The second part is the Equilibrium Study, which occurs before and after the Mir missions. This part of the experiment is performed with a specially designed platform capable of modifying sensations from the visual and vestibular (inner ear) systems, and from nerves in the joints.

The third part, the Locomotion Study, is also conducted before and after the Mir missions. For this, crewmembers will walk and run on a treadmill while their movements are videotaped to record changes in their biomechanics.

### **Experiment Objectives**

The objective of the Posture Study is to investigate the effects of space flight on the role of foot pressure in triggering muscle responses in anticipation of performing balancing body movements (in this experiment, arm raises). The objective of the Equilibrium Study is to quantify the loss of balance control that crewmembers often experience following space flight. The objective of the Locomotion Study is to characterize the effects of space flight on eye, head, and body movements, and muscle activation patterns during walking and running.

### **Mission Assignments:**

Mir 18  
Mir 20  
STS-74 (return items)

### **Researchers**

Drs. J. Bloomberg, W. Paloski, D. Harm, M. Reschke, C. Layne and V. McDonald of the NASA Johnson Space Center

Drs. I. Kozlovskaya, I. Tchekirda, M. Borisov, A. Voronov, T. Sirota, and A. Ivanov of the Russian Institute of Biomedical Problems

### **Human Life Sciences Renal Stone Risk Analysis**

#### **Experiment Description:**

It has been suggested that space flight increases the risk of kidney (renal) stone formation, and that the risk is greater during long-duration space flight. This risk is assessed using methods similar to those used on Earth; urine samples are collected over time and analyzed. The concentrations of electrolytes and minerals present in the urine indicate the risk of renal stone formation. Factors contributing to renal stone formation include the urinary concentrations of citrate, oxalate, sulfate, potassium, sodium, calcium, magnesium, phosphate, uric acid, urinary pH, and total urine volume.

In this investigation urine samples are collected and analyzed before, during, and after flight. Measurements of the components mentioned above are made and compared to determine if an increased risk for stone formation occurs during space flight. It is expected that the in-flight samples will provide direct evidence of the effects of microgravity on the risk of renal stone development. These data are necessary to implement possible countermeasures to prevent renal stone development on future long-duration missions.

## **Experiment Objectives**

To determine the in-flight risk of renal stone formation during extended stays in microgravity.

## **Mission Assignments:**

Mir 18  
STS-74 (up items for Mir 21)  
Mir 21

## **Researchers**

Dr. P. Whitson of the NASA Johnson Space Center  
Dr. G. Arzamov of the Russian Institute of Biomedical Problems  
Dr. A. S. Kreavoy of the Aviation Hospital in Moscow, Russia

## **Human Life Sciences Trace Chemical Contamination**

### **Experiment Description:**

The atmosphere and the water supply on the Mir space station are closely related due to the closed environment. Trace chemicals that contaminate the air and water on Mir are removed by several methods. Researchers are interested in characterizing the effectiveness of these methods. The knowledge gained from this investigation will provide additional information about the relationship of the air and water on spacecraft and will assist scientists and engineers in developing improved water and air purification units for future space stations. For this experiment, samples are taken at different intervals during the Mir missions, and during STS-74. Researchers will use these samples to determine levels of carbon monoxide, methane, hydrogen, and low molecular weight hydrocarbons. Levels of formaldehyde in the atmosphere are determined by monitors worn by the crewmembers, while other organic compounds are detected by a piece of hardware called the Solid Sorbent Air Sampler (SSAS), which concentrates volatile organic materials from the air. Potable water samples are also taken at several intervals in flight.

### **Experiment Objectives**

To study the characteristics of the Mir atmosphere, representing years of a partially- closed air revitalization operation. To explore the changes in Mir's atmosphere that occur over a 12-week testing interval. To characterize the chemical purity of Mir potable water. To provide an in-flight demonstration of hardware currently being developed to collect water samples on the international Space Station. To develop a better understanding of the interaction between atmospheric and water contaminants.

### **Mission Assignments:**

Mir 18  
Mir 19  
Mir 20  
STS-74 (return items)

## **Researchers**

Dr. John James and R. Sauer of the NASA Johnson Space Center Drs. L. Mukhamedieva, V. Savina, and Y. Sinyak of the Russian Institute of Biomedical Problems

## **Human Life Sciences Viral Reactivation**

### **Experiment Description:**

Once a person is infected with a virus, it may be present in the body for the remainder of that person's life and can be reactivated by several factors, including stress. Researchers do not fully understand what factors cause a latent virus to reactivate, but they believe that environmental stress can stimulate reactivation. One example of this viral reactivation is when a person gets a cold sore during a period when they are under stress.

This investigation's goal is to determine if the stresses associated with space flight cause viral reactivation in crewmembers. Blood samples are collected from the crewmembers before and after the flight. Using a technique called Enzyme Linked Immunosorbent Assay (ELISA), the samples are analyzed to determine viral antibody titers to several types of viruses. In addition, saliva samples are collected before, during, and after the flight and are analyzed by polymerase chain reaction to determine a viral pattern for each crewmember. If crewmembers exhibit symptoms of viral reactivation, additional samples will be collected.

### **Experiment Objectives**

To determine if the stresses associated with long term exposure to microgravity cause an increased incidence of viral reactivation.

### **Mission Assignments:**

Mir 18  
Mir 19  
STS-74 (return items)

## **Researchers**

Dr. D. Pierson of the NASA Johnson Space Center  
Dr. I. Konstantinova of the Russian Institute of Biomedical Problems

## **International Space Station Risk Mitigation Mir Audible Noise Measurements**

### **Experiment Description:**

Besides weightlessness, there are many stress factors that bombard astronauts and cosmonauts inhabiting long duration vehicles. With increased stress levels, stress sensitivity increases. One of the goals of the ISS discipline is to minimize the environmental stress factors as much as possible. This experiment measures the acoustical signatures in the exercise area, workstations, and habitation modules within the Mir space station. Questionnaires are also filled out by the crew to ensure thoroughness. With this information, protective steps can be implemented and sound dampening measures incorporated into the international Space Station.

### **Experiment Objectives**

To ensure the Mir environment does not exceed the acoustic emission requirements. To account for where acoustic mitigation may be required to assure crew protection.

### **Mission Assignments:**

Mir 20  
STS-74

### **Researchers**

C. Parsons of the NASA Johnson Space Center

## **International Space Station Risk Mitigation Mir Wireless Network Experiments**

### **Experiment Description:**

This experiment tests a wireless network system in the Mir environment as a possible network for remote microgravity sensors that are to be used on the international Space Station. The network monitor program measures performance and consists of three mobile computer nodes: a wireless network server, a subnotebook computer, and a Personal Digital Assistant.

### **Experiment Objectives**

To evaluate the function of this system as part of remote communications for the international Space Station.

### **Mission Assignments:**

Mir 20  
STS-74

### **Researchers**

Y. Gawdiak of the NASA Ames Research Center

## **International Space Station Risk Mitigation Shuttle/Mir Alignment Stability**

### **Experiment Description:**

Star tracker systems and inertial measurement units are integral to the navigation systems of both the Mir and the Shuttle. The Shuttle/Mir Alignment Stability Experiment entails multiple three-hour data collection periods during the docked phase when navigational-dependent events occur (i.e. thruster firings, IMU alignments, or inertial attitude hold). These data will be used to determine the stability of, and sources of any instability between, the Shuttle and Mir navigation systems while the two vehicles are docked. Characterization of Shuttle/Mir relative alignment stability will enable mission planners to determine the feasibility of transferring attitude data between Shuttle and Mir, or Shuttle and the international Space Station.

## **Experiment Objectives**

To characterize the Shuttle/Mir docked configuration and relative alignment stability.

## **Mission Assignments:**

Mir 20  
STS-74

## **Researchers**

R. Yates of the NASA Johnson Space Center  
Dr. S. Shitov, NPO Energia

## **Microgravity Protein Crystal Growth Dewar**

### **Experiment Description:**

Growing crystals in microgravity can provide significant advantages over processes used on Earth. Development of crystals in space is of interest to researchers because the crystals grown are more pure and generally more free of defects than those that crystallize in our gravitational environment on Earth.

Before a Mir docking Shuttle flight, frozen solutions from which the crystals will grow are loaded into the Dewar, launched on the Shuttle, and then transferred to the Mir after Shuttle docking. Once onboard the Mir, the samples slowly thaw and the crystallization process is initiated. Crystals are grown aboard Mir using several different methods of growth, and the samples are returned to Earth for analysis. The Space Acceleration Measurement System (SAMS) unit is used to monitor any vibration in the vicinity of the crystal experiment.

### **Experiment Objectives**

To obtain crystals of sufficient size and purity that their quality and other crystallographic properties may be evaluated and compared with corresponding crystals grown on Earth. To evaluate the effectiveness of crystal growing techniques used in long-duration space flight. To compare crystals grown using the in-flight methods to crystals grown using the methods typically used on Earth.

### **Mission Assignments:**

Mir 18  
Mir 19  
Mir 20  
STS-74 (return items and experiment resupply)  
Mir 21

### **Researchers**

Drs. A. McPherson and S. Koszelak of the University of California, Riverside  
Dr. A. Mitichkin of Russia's NPO Energia Microgravity Space Acceleration Measurement System

## **Space Acceleration Measurement System**

### **Experiment Description:**

Materials science experiments require a very stable environment to yield the best results. Thruster firings and movements of the crewmembers cause random vibrations and accelerations which can affect an experiment, possibly compromising the results. The Space Acceleration Measurement System (SAMS) records these fluctuations in the microgravity environment so that researchers can apply this information when interpreting the results of an investigation. By characterizing the acceleration environment of the space vehicle, researchers can learn where regions of high acceleration forces exist, avoiding those areas for experiment placement.

### **Experiment Objectives**

To measure and record low-level perturbations to the microgravity environment at or near the experiment hardware.

### **Mission Assignments:**

Mir 18  
Mir 19  
Mir 20  
STS-74 (return items and experiment resupply)  
Mir 21

### **Researchers**

Dr. R. DeLombard of the NASA Lewis Research Center  
Dr. S. Ryaboukha of the Russian Institute of Biomedical Problems

## **IMAX CARGO BAY CAMERA (ICBC)**

During the STS-74 mission, the crew will use an IMAX Cargo Bay Camera to document Atlantis' rendezvous and docking with the Mir station. After the mission, selected still images from the film will be made available to the public via the Internet. Sections of the film will be transferred to videotape and will be broadcast on NASA-TV.

NASA is using the IMAX film medium to document its space activities and better illustrate them for the public. This system, developed by IMAX Systems, Corp., Toronto, Canada, uses specially designed motion picture cameras and projectors to record and display high definition, large screen pictures.

NASA has flown IMAX camera systems on many Shuttle missions, including the recent STS-63 Shuttle-Mir rendezvous and STS-71 Shuttle-Mir docking. Film from previous missions was used to create the productions, *The Dream is Alive*, *The Blue Planet*, and *Destiny in Space*.

The IMAX Cargo Bay Camera is a space-qualified, 65 mm color motion picture camera system consisting of a camera, lens assembly, and a film supply magazine containing approximately 3500 feet of film and an empty take-up magazine. The camera is housed in an insulated, pressurized enclosure with a movable lens window cover. The optical center line of the 30 mm camera lens is fixed and points directly out of the payload bay along the Orbiter Z axis with a 23 degree rotation towards the Orbiter nose. Heaters and thermal blankets provide proper thermal conditioning for the camera electronics, camera window and film magazines.

The 65 mm film will be transferred to 70 mm motion picture film and will be included in a future large-format feature film about the cooperative program with the Russians. An audio tape recorder with microphones will be used in the crew compartment to record middeck audio sounds and crew comments during camera operations. The audio sound is then transferred to audio tapes or compact discs for playing in coordination with the motion picture.

The camera system is operated by the crew from the Aft Flight Deck with the enhanced Get Away Special Autonomous Payload Controller (GAPC). Commands such as on/off, camera standby, and camera run/stop may be initiated by the crew. Additional commands for camera setups such as f/stop, focus, and frame rate status of exposed film footage also are accomplished by the crew using the GAPC. A light level measurement unit will be used by the crew to set the lens aperture. Seven aperture settings and a fixed focus zone are available for this flight.

The normal camera speed is 24 frames per second (fps). On this flight, this also can be changed to 6 fps for photographing slower moving objects. The 3500 feet of film in the ICBC will last approximately 10.5 minutes at 24 fps and much longer at 6 fps. Film cannot be changed in flight and ICBC operations are terminated when all film is exposed. ICBC is managed by Dick Walter of the Johnson Space Center.

## **GLOW-4 PASDE PAYLOAD (GPP)**

The GPP payload consists of two experiments, the GLO-4 experiment and the PASDE experiment. The payload is managed by Goddard Space Flight Center's Special Payloads Division.

The GLO-4 will study the Earth's thermosphere, ionosphere and mesosphere energetics and dynamics using broadband spectroscopy. GLO-4 also will study spacecraft interactions with the atmosphere by observing Shuttle and Mir glow, Shuttle engine firings, water dumps and fuel cell purges.

Three Photogrammetric Appendage Structural Dynamics Experiment (PASDE) canisters, located throughout the cargo bay, will photogrammetrically record structural response data of the Mir solar arrays during the docked phase of the mission. These data will be analyzed on the ground to verify the use of photogrammetric techniques to characterize the structural dynamics of the array thus demonstrating that this technology can result in cost and risk reduction for the ISSA on-orbit structural verification.

### **Shuttle Glo Experiment (GLO-4)**

This experiment originated as the "Shuttle Glow" experiment sponsored by the USAF/Phillips Laboratory. It is also referred to as the Arizona Airglow Experiment. The nature of the instrument makes it ideal for studies of Earth's thermosphere. Consequently, it has become a joint program with NASA's Space Physics Division of the Office of Space Science.

Scientists continue to investigate the mysterious shroud of luminosity, called the "glow phenomenon," observed by astronauts on past Shuttle missions. Theory suggests that the glow may be due to atmospheric gases on the windward or ram side surface of the Space Shuttle colliding and interacting with gaseous engine effluents and contaminate outgassing molecules. The glow intensity is weak, decreases with altitude and requires some special conditions for good detection -- both the Sun and Moon must be below the horizon, for example, so the spatial extent of the glow will be mapped precisely (0.1 degrees). The effects of ambient magnetic field, orbit altitude, mission elapsed time, Shuttle thruster firings, and surface composition on the intensity and spectrum of the glow also will be measured. An optical emission model will then be developed from the data.

The GLO experiment consists of imagers and spectrographs, which are boresighted to the imagers, so that both sensors are focused onto the same area of observations, e.g., the Shuttle tail. Imagers serve to unambiguously identify the source region of the glow spectrum as well as to map the spatial extent of the luminosity. Unique features of the sensors are their high spectral and spatial resolution. Each spectrograph employs a concave holographic grating that focuses and disperses light within a small field of view (0.1 by 8.5 degrees) over the wavelength range 115-1100 nanometers. The sensor is comprised of nine separate channels, each of which operates simultaneously and independently, to cover individual segments of the spectrum.

The Shuttle glow experiments are short compared to the total flight time of the mission; therefore, the remainder of the flight is dedicated to studies of Earth's atmosphere. The scientific objectives are related to the Ionosphere, Thermosphere and Mesosphere section of the NASA Space Physics Division. The NASA investigations using the GLO experiment are designed to measure the effects of solar extreme ultraviolet radiation on the Earth's atmosphere. The measurements will record temperature and temperature gradients and pressures of the major constituents of the atmosphere in order to validate global models.

Active participants who have ground-based instrumentation try to make observations throughout the campaign. The data are correlated and deposited in a data bank at the National Center for Atmospheric Research, Boulder, CO, for use by the community. The coordination of these data is important to relate local observation to the global picture provided by the GLO observations from the Shuttle.

The manager for the GLO program is Dr. David J. Knecht of Phillips Laboratory, Dr. Edmond Murad from the Phillips Laboratory and Dr. A. Lyle Broadfoot from the University of Arizona are co-principal investigators on GLO.

## **Photogrammetric Appendage Structural Dynamics Experiment (PASDE)**

The Photogrammetric Appendage Structural Dynamics Experiment (PASDE) is an experiment to mitigate technical risk and cost associated with passive, on-orbit, measurement of spacecraft appendages for the international Space Station (ISS) program. The experiment will demonstrate a photogrammetric method for making appendage structural measurements, provide engineering data on solar array designs expected to be used on the ISS, and verify that routine on-orbit spacecraft operations provide sufficient excitation for structural response testing.

On-orbit measurements of spacecraft structural response are often desired or necessary for structural verification and loads prediction. Typically, acceleration response time-history data are collected and processed on the ground. From these data, structural dynamic characteristics (structural mode frequencies, damping, and mode shapes) can be determined.

The use of photogrammetric measurements is a low cost alternative to dedicated accelerometer-based structural response measurement systems, especially when measurements are required for articulating or rotating spacecraft components such as solar arrays or thermal radiators. Elimination of accelerometers, wiring, signal conditioning and digital conversion electronics, etc., can greatly simplify the spacecraft electrical design and integration, with corresponding reduction in spacecraft cost.

For the international Space Station, on-orbit structural response measurements are required for loads validation and verification of structural mathematical models. Currently, accelerometer-based measurements of the US. primary truss and modules are being planned, however, accelerometer measurement of the US. solar arrays is not being considered because of cost and resource impacts. Since the current ISS design calls for numerous video cameras mounted at various external points, photogrammetric measurements of solar array structural responses may be a potential alternative.

The PASDE experiment will verify that photogrammetric measurements can provide measurement resolution and accuracy sufficient for ISS structural verification purposes. It is manifested as part of the ISS Phase I Risk Mitigation Program. ISS Phase I involves seven flights of the U. S. Space Shuttle to the orbiting Russian Space Agency Mir space station. Current plans call for PASDE to fly twice as part of the Phase I program.

The NASA Langley Research Center is funded by NASA Headquarters Code X for development and first flight of PASDE. PASDE hardware will be flown as a Class D, NASA Goddard Space Flight Center (GSFC) Hitchhiker payload. On STS-74, the second Space Shuttle flight to Mir, PASDE will fly along with the GLO-4 experiment as the Hitchhiker GLO-4/PASDE or GPP payload. For this flight, PASDE will obtain data from a solar array attached to the Kvant-II module of Mir. On STS-86, the seventh mission of Shuttle to Mir, PASDE hardware will again be used to obtain structural measurements as part of the Phase-I Risk Mitigation Program.

## SHUTTLE AMATEUR RADIO EXPERIMENT-II (SAREX-II)

Students in the U.S. will have a chance to speak via amateur radio with astronauts aboard the Space Shuttle Atlantis during STS-74. Ground-based amateur radio operators ("hams") will be able to contact the Shuttle astronauts through a direct voice ham radio link as time permits.

Shuttle Commander Ken Cameron (call sign KB5AWP) and mission specialists Jerry Ross (N5SCW), William McArthur (KC5ACR), Chris Hadfield (license pending) and Jim Halsell (license pending) will talk to students in five schools in the United States using "ham radio."

Students in the following schools will have the opportunity to talk directly to orbiting astronauts for approximately four to eight minutes:

- Franklin Jr. H.S., Pocatello, ID
- Connecticut-area schools (combined project)
  - Staples High School, Westport (contact site)
  - Western Middle School, Greenwich
  - Saxe Middle School, New Canaan
  - Columbus Magnet School, Norwalk
- Lake Street Elementary School, Crown Point, IN
- Magee Middle School, Round Lake Heights, IL
- Quimby Oak Jr. High School, San Jose, CA

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 Corporation (AMSAT).

The project, which has flown on 19 previous Shuttle missions since 1983, is designed to encourage public participation in the space program and support educational initiatives by demonstrating the effectiveness of communications between the Shuttle and low-cost ground stations using amateur radio voice and digital techniques.

### STS-74 SAREX Frequencies

**IMPORTANT NOTE:** Since the flight is a Shuttle-Mir docking mission, and SAREX and Mir amateur radio stations usually share the same downlink frequency (145.55), the SAREX Working Group has decided to make the following SAREX frequency changes for the STS-74 mission:

SAREX transmissions from the Space Shuttle may be monitored on a worldwide downlink frequency of 145.84MHz.

The voice uplink frequencies are: 144.45, 144.47 MHz

The crew will use separate receive and transmit frequencies. *Please do not transmit on the Shuttle's Downlink frequency.* The downlink is your receiving frequency. The uplink is your transmitting frequency.

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

## **Additional Information for Amateur Radio Operators**

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.

## **Shuttle Tracking**

Information about orbital elements, contact times, frequencies and crew operating schedules will be available during the mission. Current Keplerian elements to track the Shuttle are available from the following sources:

- NASA Spacelink computer information system  
BBS: (205) 895-0028  
Internet, Telnet, FTP, Gopher: [spacelink.msfc.nasa.gov](http://spacelink.msfc.nasa.gov)  
WWW: <http://spacelink.msfc.nasa.gov>
- NASA SAREX WWW Home Page: [http://www.nasa.gov/sarex/sarex\\_mainpage.html](http://www.nasa.gov/sarex/sarex_mainpage.html)
- American Radio Relay League  
Telephone: (860) 594-0301  
BBS: (860) 594-0306  
W1AW news bulletins ("FOR FURTHER INFORMATION")  
WWW: <http://www.arrl.org>
- AMSAT  
WWW: <http://www.amsat.org>
- NASA Johnson Space Center Amateur Radio Club  
BBS: (713) 244-5625
- Goddard Amateur Radio Club  
BBS: (301) 286-4137  
WWW: <http://garc.gsfc.nasa.gov/www/garc-home-page.html>  
Packet: WA3NAN on 145.090 MHz in D.C. area

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

3.860 MHz	7.185 MHz
14.295 MHz	21.395 MHz
28.650 MHz	

## STS-74 CREWMEMBERS



*STS074-S-002 -- These four NASA astronauts and one Canadian astronaut are in training for the STS-74 mission of the space shuttle Atlantis, scheduled later this year. Astronauts Kenneth D. Cameron (front right) and James D. Halsell Jr. (front left) are commander and pilot, respectively, for the flight. On the back row, left to right, as astronauts William McArthur Jr., Jerry L. Ross and Chris A. Hadfield, all mission specialists. Hadfield is an international mission specialist representing the Canadian Space Agency.*

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## BIOGRAPHICAL DATA

**KENNETH CAMERON** (Col., USMC), 45, is Atlantis' Commander for the STS-74 mission. This is Cameron's third flight.

Selected as an astronaut in 1984, Cameron served as the Pilot on the STS-37 mission in 1991, which featured the deployment of the Compton Gamma Ray Observatory and a pair of spacewalks, one of which advanced techniques for Space Station construction. Cameron then commanded the ATLAS-2 mission in 1993 which studied atmospheric and solar activity.

Cameron, whose hometown is Cleveland, OH, received a bachelor of science degree in aeronautics and astronautics from MIT in 1978 and a master's degree in aeronautics and astronautics from MIT in 1979. He enlisted in the Marine Corps in 1969, ultimately becoming an infantry platoon commander in Vietnam. Cameron served in a variety of roles as a test pilot, project officer and aviation instructor, earning special honors which include the Defense Superior Service Medal, the Distinguished Flying Cross and the Marine Corps Association Leadership Sword.

Most recently, Cameron served as the first NASA Director of Operations at the Gagarin Cosmonaut Training Center in Star City, Russia, where he worked with Russian training personnel and officials in setting up a support system for astronaut training and operations for the Phase I program.

Cameron has logged over 3400 hours of flying time in 47 different types of aircraft.

**JAMES HALSELL** (Lt. Col., USAF), 39, is Atlantis' Pilot for the STS-74 mission. Halsell is making his second flight into space in as many years.

Halsell, whose hometown is West Monroe, LA, graduated from the U.S. Air Force Academy in 1978 with honors in engineering and aeronautics and was assigned to Nellis Air Force Base, NV, where he served as an aircraft commander qualified in conventional and nuclear weapons delivery. After tours of duty as a test pilot and fighter pilot, Halsell became a test pilot at Edwards Air Force Base, CA, where he performed test flights with the F-4, F-16 and SR-71 aircraft.

Halsell was selected as an astronaut in 1990 and served as part of the Astronaut Support Personnel team at the Kennedy Space Center which prepares Space Shuttle vehicles for flight. Halsell also worked as a spacecraft communicator (CAPCOM) in Mission Control for several flights.

Halsell served as the Pilot on the STS-65 mission in 1994 in which seven astronauts spent 15 days conducting more than 80 microgravity research experiments in a Spacelab module in Columbia's cargo bay.

**CHRIS HADFIELD** (Major, Canadian Air Force), 36, is Mission Specialist 1 (MS 1) for Atlantis' flight. This is Hadfield's first mission.

Hadfield, from Sarnia, Ontario, Canada, graduated from the Royal Military College in Kingston, Ontario, Canada with a bachelor's degree in mechanical engineering with honors and earned a master's degree in aviation systems from the University of Tennessee after conducting post-graduate research at the University of Waterloo in Ontario, Canada.

In the 1970s, Hadfield taught skiing and ski racing for the better part of ten years and was an Air Cadet, flying both gliders and powered aircraft. Hadfield joined the Canadian Armed Forces in 1978, ultimately flying CF-18 "intercept" fighters for the North American Aerospace Command (NORAD). Hadfield attended test pilot school at Edwards Air Force Base, CA, testing F/A-18 and A-7 aircraft and served as an exchange officer with the U.S. Navy at Patuxent River Naval Air Station, MD. Hadfield was selected as one of four Canadian astronauts in 1992.

Hadfield's assignments with NASA have included technical and safety issues, Shuttle glass cockpit development and launch support at the Kennedy Space Center.

**JERRY ROSS** (Col., USAF), 47, is Mission Specialist 2 (MS 2) for Atlantis' flight. This is Ross' fifth space flight.

Ross first flew in 1985 on STS-61B in which three communications satellites were deployed. Ross also conducted two spacewalks to test Space Station construction techniques. Ross' second flight occurred on STS-27 in 1988, a dedicated mission for the Department of Defense. Ross flew again on STS-37 in 1991, in which the Compton Gamma Ray Observatory was deployed. On that flight, Ross performed two more spacewalks to help free a stuck antenna on the GRO and to test Space Station assembly hardware. Ross' last flight took place in 1993 on STS-55, in which he served as Payload Commander for the German-sponsored D-2 Spacelab mission.

Ross, from Crown Point, IN, graduated from Purdue University with bachelor of science and master's degrees in mechanical engineering in 1970 and 1972 before entering active duty with the Air Force. Ross graduated from the USAF Test Pilot School's Flight Test Engineer Course in 1976 and was assigned to duties at Edwards Air Force Base, CA. Ross served as the chief flight test engineer for the B-1 and performed mission planning for the B-1 offensive avionics test aircraft.

In February 1979, Ross was assigned to the Johnson Space Center as a payloads officer before being selected as an astronaut in 1980. His technical assignments have included work with extravehicular activity issues and the remote manipulator system, and he has worked as a spacecraft communicator (CAPCOM) in Mission Control and as Chief of the Mission Support Branch.

**WILLIAM MCARTHUR** (Lt. Col., USAF), 44, is Mission Specialist 3 (MS 3) for Atlantis' flight. McArthur is flying in space for the second time.

McArthur, whose hometown is Wakulla, NC, graduated from West Point with a bachelor of science degree in applied science and engineering in 1973 and a master's degree in aerospace engineering from Georgia Tech in 1983.

McArthur served in a tour with the U.S. Army in Fort Bragg, NC, before entering Army Aviation School in 1975. He was the top graduate of his flight class and was designated an Army aviator in 1976. He subsequently served in Korea before becoming a company commander, platoon leader and operations officer in Savannah, GA. In June 1987, McArthur graduated from the U.S. Naval Test Pilot School and was designated an experimental test pilot. McArthur is a Master Army Aviator.

He was assigned to the Johnson Space Center in 1987 as a Shuttle vehicle integration test engineer. McArthur served as a member of the Emergency Escape and Rescue Working Group before becoming an astronaut in 1990. McArthur has served in a number of capacities, including work as a technical adviser to the solid rocket booster and redesigned solid rocket motor projects and as a spacecraft communicator (CAPCOM) in Mission Control.

McArthur's first flight came in 1993 as a mission specialist on STS-58, a dedicated Space Life Sciences mission in which dozens of experiments were conducted to test the human body's adaptability to the microgravity environment.

