NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

SPACE SHUTTLE MISSION
STS-69

PRESS KIT
AUGUST 1995

WAKE SHIELD FACILITY-2
SPARTAN-201; CAPL-02/GBA; IEH

STS-69 INSIGNIA

STS069-S-001 -- Designed by the crewmembers, the STS-69 insignia symbolizes the multifaceted nature of the flight's mission. The primary payload, Wake Shield Facility (WSF), is represented in the center by the astronaut emblem against a flat disk. The insignia also signifies the importance of human beings in space exploration, reflected by the planned space walk supporting Space Station assembly. The two stylized space shuttles highlight the ascent and entry phases of the mission. Along with the two spiral plumes, the stylized space shuttles symbolize a NASA first - the deployment and recovery on the same mission of two spacecraft (both the Wake Shield Facility and the SPARTAN). The constellations Canis Major and Canis Minor represent the astronomy objectives of the SPARTAN and International Extreme Ultraviolet Hitchhiker (IEH) payload. The two constellations also symbolize the talents and dedication of the support personnel who make Space Shuttle missions possible.

S82-35627 -- The five points of the star in the STS-5 insignia represent the fifth, and first operational shuttle flight following four successful test flights.

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

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TWO DEPLOY/RETRIEVE PAYLOADS AND A SPACEWALK HIGHLIGHT FIFTH SHUTTLE MISSION OF 1995

The fifth Space Shuttle flight of 1995 will be highlighted by the deployment and retrieval of two scientific spacecraft and a spacewalk to practice for Space Station activities and evaluate space suit design modifications.

Leading the five-person STS-69 crew will be Mission Commander David M. Walker, making his fourth space flight. Pilot for the mission is Kenneth D. Cockrell, making his second flight. The three mission specialists are James S. Voss, serving as Payload Commander and Mission Specialist 1. Voss will be making his third flight. Jim Newman, Mission Specialist 2 is making his second flight and Michael L. Gernhardt, Mission Specialist 3 is making his first flight.

Launch of Endeavour is currently scheduled for August 5, 1995, at 10:45 a.m. EDT. The planned mission duration is 10 days, 20 hours and 29 minutes. An on-time launch on August 5 would produce a landing at 7:14 a.m. EDT on August 16 at the Kennedy Space Center’s Shuttle Landing Facility.

The STS-69 mission will mark the second flight of the Wake Shield Facility-2 (WSF-2), a 12-foot diameter, stainless steel disk which will be deployed and retrieved using the Shuttle robot arm. While the WSF flies free of the Shuttle, it will generate an “ultra-vacuum” environment in space within which to grow thin semiconductor films for next-generation advanced electronics. The commercial applications for these new semiconductors include digital cellular telephones, high- speed transistors and processors, fiber optics, opto-electronics and high-definition television.

The SPARTAN 201 free-flyer will be making its third flight aboard the Shuttle. The SPARTAN 201 mission is a scientific research effort aimed at the investigation of the interaction between the Sun and its outflowing wind of charged particles. SPARTAN’s goal is to study the outer atmosphere of the Sun and its transition into the solar wind that constantly flows past the Earth.

This flight of SPARTAN 201 is intended to coincide with the passage of the Ulysses spacecraft over the Sun’s north polar region. Ulysses, a cooperative deep space mission of the European Space Agency and NASA, was launched from the Space Shuttle in 1990 with the goal of studying the Sun at high heliographic latitudes.

Last year, Ulysses flew over the south pole of the Sun, becoming the first spacecraft ever to do so. The spacecraft returned a wealth of scientific information about this previously unexplored region. Recently, Ulysses data observed, for the first time, periodic oscillations originating from deep within the Sun’s interior.

STS-69 will see the first flight of the International Extreme Ultraviolet Hitchhiker (IEH-1), the first of five planned flights to measure and monitor long-term variations in the magnitude of absolute extreme ultraviolet (EUV) flux coming from the Sun, and to study EUV emissions from the plasma torus system around Jupiter originating from its moon Io.

Also flying aboard Endeavour will be the combined Capillary Pumped Loop-2/Gas Bridge Assembly (CAPL-2/GBA) payload. This experiment consists of the CAPL-2 Hitchhiker payload designed as an in-orbit microgravity demonstration of a cooling system planned for the Earth Observing System Program and the Thermal Energy Storage-2 payload, part of an effort to develop advanced energy generation techniques. Also a part of this payload are several Get Away Special (GAS) experiments which will investigate areas such as the interaction of spacecraft attitude and orbit control systems with spacecraft structures, fluid-filled beams as structural dampers in space and the effects of smoldering combustion in a long-term microgravity environment.

On the tenth flight day, two astronauts will leave Endeavour's crew cabin for about six hours to perform several tasks that will broaden NASA's experience base for building and maintaining the Space Station and for other future spacewalks. The astronauts will perform a number of tasks designed to evaluate and verify specific assembly and maintenance tasks for the Space Station. The spacewalk also will evaluate spacesuit design modifications to protect spacewalkers from the extremely cold space environment.

Another payload being flown with a connection to the development of the Space Station is the Electrolysis Performance Improvement Concept Study (EPICS). Supply of oxygen and hydrogen by electrolyzing water in space will play an important role in meeting NASA's needs and goals for future space missions. On-board generation of oxygen is expected to reduce the annual resupply requirement for the Space Station by approximately 12,000 pounds. The oxygen generation assembly which was initially baselined for the Space Station Freedom Program is the Static Feed Electrolyzer (SFE). The EPICS hardware being flown on STS-69 will demonstrate and validate the SFE electrochemical process in microgravity, as well as investigate performance improvements thought possible in a microgravity environment.

There are various payloads which have made several flights aboard the Space Shuttle which will be flying once again. The payloads are the National Institutes of Health- Cells-4 (NIH-C4) experiment that will continue examining bone loss during space flight; the Biological Research in Canister-6 (BRIC-6) that will continue the study of the processing of outside signals by mammalian cells and the gravity-sensing mechanism within mammalian cells, which scientists are still trying to identify.

Two other frequent flyers on the Shuttle are the commercial experiments (CMIX-4) whose objectives will include analysis of cell change in microgravity along with studies of neuro-muscular development disorders. Also flying is the Commercial Generic Bioprocessing Apparatus-7 (CGBA-7). CGBA is a secondary payload that serves as an incubator and data collection point for experiments in pharmaceuticals testing and biomedicine, bioprocessing and biotechnology, agriculture and the environment.

STS-69 will be the 9th flight of Space Shuttle Endeavour and the 71st flight of the Space Shuttle System.

(END OF GENERAL RELEASE; BACKGROUND INFORMATION FOLLOWS.)

MEDIA SERVICES INFORMATION

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

The schedule for television transmissions from the Orbiter and for mission briefings will be available during the mission at Kennedy Space Center, FL; Marshall Space Flight Center, Huntsville, AL; Dryden Flight Research Center, Edwards, CA; Johnson Space Center, Houston; NASA Headquarters, Washington, DC. The schedule will be updated to reflect changes dictated by mission operations.
Television schedules also may be obtained by calling COMSTOR 713/483-5817. COMSTOR is a computer data base service requiring the use of a telephone modem. A voice update of the television schedule is updated daily at noon Eastern time.

Status Reports

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

Briefings

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

Access by Internet
NASA press releases can be obtained automatically by sending an Internet electronic mail message to domo@hq.nasa.gov. In the body of the message (not the subject line) users should type the words "subscribe press- release" (no quotes). The system will reply with a confirmation via E-mail of each subscription. A second automatic message will include additional information on the service.
Informational materials also will be available from a data repository known as an anonymous FTP (File Transfer Protocol) server at ftp.pao.hq.nasa.gov under the directory /pub/pao. Users should log on with the user name "anonymous" (no quotes), then enter their E-mail address as the password. Within the /pub/pao directory there will be a "readme.txt" file explaining the directory structure.

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

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

Access by Compuserve

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

STS-69 QUICK LOOK

Launch Date/Site:	August 5, 1995/KSC Launch Pad 39B
Launch Time:	10:45 a.m. EDT
Launch Window:	2 hours, 30 minutes
Orbiter:	Endeavour (OV-105) - 9th flight
Orbit/Inclination:	200 nautical miles/28.45 degrees
Mission Duration:	10 days, 20 hours, 29 minutes
Landing Date:	August 16, 1995
Landing Time:	7:14 a.m. EDT
Primary Landing Site:	Kennedy Space Center, FL
Abort Landing Sites:	Return to Launch Site: - KSC Transoceanic Abort Landing: - Banjul, The Gambia Ben Guerir, Morocco Moron, Spain Abort Once Around - Edwards AFB, CA
Crew:	Dave Walker, Commander Ken Cockrell, Pilot Jim Voss, Payload Commander, Mission Specialist 1 Jim Newman, Mission Specialist 2 Mike Gernhardt, Mission Specialist 3
EVA Crewmembers:	Voss (EV 1), Gernhardt (EV 2)
Cargo Bay Payloads:	Wake Shield Facility SPARTAN-201 IEH-01 CAPL/GBA
Middeck Payloads:	BRIC CGBA CMIX EPICS STL/NIH-C

Developmental Test Objectives/Detailed Supplementary Objectives

DTO 301D:	Ascent Structural Capability Evaluation
DTO 305D:	Ascent Compartment Venting Evaluation
DTO 306D:	Descent Compartment Venting Evaluation
DTO 307D:	Entry Structural Capability
DTO 312:	ET TPS Performance
DTO 414:	APU Shutdown Test
DTO 415:	Water Spray Boiler Electrical Heater Capability
DTO 653:	Evaluation of the MK-1 Rowing Machine
DTO 656:	PGSC Single Event Upset Monitoring
DTO 667:	Portable In-Flight Landing Operations Trainer (PILOT)
DTO 671:	EVA Hardware for Future EVA Missions
DTO 672:	EMU Electronic Cuff Checklist
DTO 679:	KU-Band Communications Adapter Demonstration
DTO 700-8:	GPS Developmental Flight Test
DTO 700-10:	Orbiter Space Vision System Flight Video Taping
DTO 805:	Crosswind Landing Performance
DTO 831:	Manipulator Position Display as an Aid to RMS Operators
DTO 833:	EMU Thermal Comfort Evaluations
DTO 914:	Space Linear Acceleration Mass Measurement Device Evaluation
DTO 1210:	EVA Operations Procedure/Trainer
DSO 482:	Cardiac Rhythm Disturbances During EVA
DSO 483:	Back Pain Pattern in Microgravity
DSO 485:	Inter Mars TEPC
DSO 489:	EVA Dosimetry Evaluation
DSO 491:	Characterization of Microbial Transfer During Space Flight
DSO 492B:	In-Flight Evaluation of a Portable Clinical Blood Analyzer
DSO 494:	Influence of Microgravity and EVA on Pulmonary Oxygen Exchange
DSO 604:	Visual Vestibular Integration as a Function of Adaptation
DSO 605:	Postural Equilibrium Control During Landing/Egress
DSO 608:	Effects of Space Flight on Aerobic and Anaerobic Metabolism in Exercise
DSO 610:	In-Flight Assessment of Renal Stone Risk
DSO 624:	Pre and Postflight Measurement of Cardiorespiratory Responses to Submaximal Exercise
DSO 901:	Documentary Television
DSO 902:	Documentary Motion Picture Photography
DSO 903:	Documentary Still Photography

SPACE SHUTTLE ABORT MODES

Space Shuttle launch abort philosophy aims toward safe and intact recovery of the flight crew, Orbiter and its payload. Abort modes for STS-69 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 Edwards AFB, CA.

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

- Return-To-Launch-Site (RTLS) -- 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 the Kennedy Space Center until within gliding distance of the Shuttle Landing Facility.

MISSION SUMMARY TIMELINE

Flight Day 1
Launch/Ascent
OMS-2 Burn
IEH Activation
WSF Activation
RMS Checkout

Flight Day 2
IEH Operations
CMIX Operations
SPARTAN-201 Deploy

Flight Day 3
Deorbit Burn
IEH Operations
Rendezvous Burns
Exercise DTOs and DSOs

Flight Day 4
SPARTAN-201 Retrieval
WSF Communications Checkout

Flight Day 5
WSF Ram Cleaning and ADACS Checkout
WSF Deploy
WSF Science Monitoring

Flight Day 6
WSF Science Monitoring
Secondary Experiment Operations
Rendezvous Burns

Flight Day 7
WSF Plume Tests
WSF Retrieval

Flight Day 8
WSF CHAWS Operations
WSF Berthing
IEH Operations
Cabin Depress
Electronic Cuff Checklist Checkout

Flight Day 9
Off Duty Time
GLO Operations
EMU Checkout
Crew News Conference

Flight Day 10
EVA Prep
EVA (6 hours)

Flight Day 11
Flight Control System Checkout
Reaction Control System Hot Fire
GLO Operations
Cabin Stow

Flight Day 12
Deorbit Prep
Entry
KSC Landing

STS-69 ORBITAL EVENTS SUMMARY

Event	Mission Elapsed Time	Eastern Time/Date
Launch	0/00:00	10:45 AM, August 5
OMS-2	0/00:43	11:28 AM, August 5
SPARTAN Release	1/00:33	11:18 AM, August 6
SPARTAN Grapple	2/23:13	9:58 AM, August 8
OMS-3	3/02:59	1:44 PM, August 8
OMS-4	3/03:43	2:28 PM, August 8
WSF Release	3/18:33	5:16 AM, August 9
WSF Grapple	6/00:07	10:50 AM, August 11
OMS-5	7/00:08	10:53 AM, August 12
OMS-6	7/00:52	11:37 AM, August 12
EVA Begins	8/17:03	3:48 AM, August 14
EVA Ends	8/23:13	9:58 AM, August 14
Deorbit Burn	10/19:29	6:14 AM, August 16
Landing	10/20:29	7:14 AM, August 16

PAYLOAD AND VEHICLE WEIGHTS

	Pounds
Orbiter (Endeavour), empty and 3 SSMEs	174,249
Wake Shield Facility (WSF)	4,364
WSF Support Equipment	3,882
SPARTAN-201	2,842
SPARTAN-201 Support Equipment	2,405
BRIC	54
CGBA	121
CMIX	70
EPICS	102
STL	69
DTOs/DSOs	694
Shuttle System at SRB Ignition	4,519,985
Orbiter Weight at Landing	219,718

STS-69 CREW RESPONSIBILITIES

Task	Prime	Backup
Wake Shield Systems	Gernhardt	Voss
Wake Shield Science	Newman	Voss
WSF Deploy and Retrieve	Newman	Voss
SPARTAN Systems	Gernhardt	Voss
SPARTAN Deploy/Retrieve	Gernhardt	Newman
Rendezvous	Walker	Cockrell/Newman
IEH	Cockrell	Voss/Walker
BRIC	Gernhardt	Voss
CAPL/GBA	Newman	Voss
CGBA	Voss	Walker
CMIX	Gernhardt	Voss
EVA	Voss	Gernhardt
EVA Coordinator	Cockrell	
EVA RMS	Newman	
EPICS	Gernhardt	Newman
STL/NIH-C	Cockrell	Voss
Earth Observations	Cockrell	Newman

WAKE SHIELD FACILITY-2 (WSF-2)

The Wake Shield Facility (WSF) is a 12-foot diameter, stainless steel disk designed to generate an "ultra-vacuum" environment in space within which to grow thin films for next generation advanced electronics. This mission -- the second in a planned series of four -- represents the utilization of a unique attribute of space, the "ultra-vacuum." The STS-69 crew will deploy and retrieve WSF-2 during the mission. NASA's Office of Space Access and Technology, Wash. DC, is the sponsor of the WSF-2.

The principle objectives of the WSF-2 mission include: performance of WSF as a free-flyer far enough away from the Orbiter to achieve and characterize for the first time an uncontaminated "ultra-vacuum" in low-Earth orbit; and, demonstrate the feasibility of epitaxial growth of high quality compound semiconductor thin films and heterostructures required for future advanced electronic and optoelectronic devices as part of the four-flight WSF proof-of-concept program.

The first flight of the WSF-1 occurred aboard Discovery on STS-60 in February of 1994. Because of difficulties in attitude control, experiments were performed only while WSF-1 was attached to the Shuttle's robot arm. Although the results of WSF-1 did demonstrate wake formation and thin film growth, water vapor contamination from the Shuttle interfered with the achievement of "ultra vacuum" necessary for achieving the growth of semi-conductor materials superior to those that can be grown on Earth. Following this first flight, a WSF advisory committee reviewed flight anomalies and approved corrective actions. Subsequently, a NASA independent review board evaluated all systems and unanimously agreed that WSF-2 was ready for flight.

Results from the four planned WSF flights may have a significant impact on the microelectronics industry because the use of advanced semiconducting thin film materials in electronic components holds a very promising economic advantage. The commercial applications for high quality semiconductor devices are most critical in the areas of cellular telephones, high-speed transistors and processors, high-definition television, fiber optic communications and opto-electronics. The majority of electronic components used today are made of the semiconductor silicon, but there are many other materials that could achieve higher predicted performance than silicon. Atomic quality, sample size, and sample processing all suffer for compound semiconductors, and improving these parameters would result in high quality semiconductor materials which could lead to a new generation of electronic components.

Epitaxy, the growth of atomically ordered thin films in a vacuum environment, is one method of generating such advanced materials. A prime barrier to improving epitaxial films is the limit on the quality of the vacuum which can be generated in an industrial growth chamber. To improve the material, the vacuum in which it is grown must be improved. The vacuum of space can make this improvement possible.

Low-Earth Orbit (LEO) space can be used to grow compound semiconductor materials such as gallium arsenide, by creating a vacuum "wake" behind an object moving in orbit. The moderate natural vacuum in LEO has enough atoms present to contaminate a growing film. A vehicle in orbit, such as the WSF, can push those atoms out of the way, leaving few, if any, behind in its wake, thus the name. The unique ultra-vacuum produced in space by the WSF will be 1,000 to 10,000 times better than the best laboratory vacuum chambers on Earth. Using this ultra-vacuum in space, the WSF holds the promise of producing the next generation of semiconductor materials and the devices they will make possible.

The WSF was designed, built, and managed by the Space Vacuum Epitaxy Center (SVEC)--a NASA Center for the Commercial Development of Space based at the University of Houston, -- with its principle industry partner, Space Industries, Inc. (SII), League City. Twelve additional corporate partners support the WSF program, including: Advanced Modular Power Systems, Ann Arbor, MI; American Xtal Technology, Dublin, CA; AKZO Chemicals, Inc., Houston, TX; Honeywell Satellite Systems, Phoenix, AZ; Ionwerks, Houston, TX; International Stellar Technology, Inc., Houston, TX; Instruments, S.A., Inc., Edison, NJ; Lockheed Martin, Syracuse, NY; MKS Instruments, Andover, MA; and S. I. Diamond, Inc., Houston, TX. In addition, Baylor University, Case Western Reserve University, Lamar University, the University of Texas at Dallas, the University of Texas at Austin; the University of Toronto; NASA's Johnson Space Center, NASA's Marshall Space Flight Center, NASA's Lewis Research Center, and the U.S. Air Force Phillips Laboratories are members of the SVEC consortium.

Program Overview

The space ultra-vacuum concept was first identified by NASA more than 20 years ago, but there was no need identified at that time for its use. The recent interest of scientists and corporate researchers in epitaxial thin film growth has motivated the use of space to create the ultra-vacuum in which to grow better thin films.

Recognizing this scientific opportunity as a new economic opportunity in 1987, SVEC formed a consortium of interested industries, academic institutions and government laboratories to utilize LEO for thin film growth. In 1989, SVEC partnered with its industry members, led by SII, Inc., and with NASA's Johnson Space Center to build the WSF using an innovative commercial approach.

The SVEC commercial approach to space hardware development foregoes extensive paperwork, uses commercial off-the-shelf hardware where possible, and maintains design simplicity, while not compromising safety. It does, however, prudently accept some risk in mission success through not designing for the traditional 100% reliability goal of most aerospace programs. This unique approach has allowed the WSF to be produced at less than one sixth or $30 million -- the cost of a traditional aerospace hardware development program -- in a 10-year period.

Hardware Description

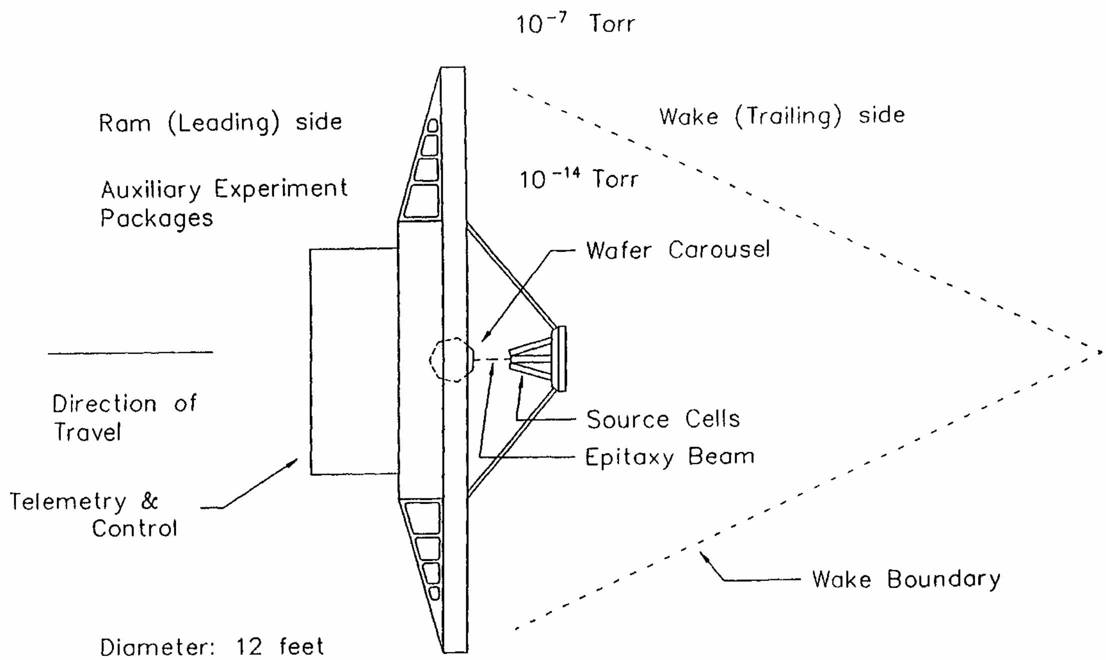
The WSF hardware consists of the Shuttle Cross Bay Carrier mounting equipment and the Free Flyer. The Carrier remains in the Shuttle and has a latch system which holds the Free Flyer to it. The Shuttle's robot arm will be used to remove the Free Flyer from the Carrier and deploy it into space. The WSF will follow behind the Shuttle at a station- keeping distance of 30 nautical miles.

The Free Flyer is a fully-equipped spacecraft on its own, with cold gas propulsion for separation from the Shuttle and a momentum bias attitude control system. Sixty kilowatt- hours of energy, stored in silver-zinc batteries, power the thin-film growth furnaces, substrate heaters, process controllers, and a sophisticated array of vacuum characterization devices, including mass spectrometers and total pressure gauges. Weighing approximately 8,100 pounds altogether, (the Free Flyer itself is 4,350 pounds), the WSF occupies one quarter of the Shuttle payload bay. Process control equipment and vacuum characterization equipment are located on the back (wake side) of the free flyer, while the controller electronics, attitude control system, batteries and support equipment are located on the front (ram side). The WSF radio frequency communications system routes telemetry and commands, including video, from the Cross Bay Carrier, through the Shuttle systems to both WSF ground personnel and the flight crew.

The WSF as a Versatile Space Platform

As a free-flying platform, the WSF's wake side -- the "ultra-clean side" -- is used on this mission primarily for ultra-pure thin-film growth. The ram side --the "dirty side" -- houses the avionics platform and also is used to accommodate other experiments and space technology applications. The ram side has more than 65 square feet of usable surface in the form of the outer shield, which will support other space payloads.

Since the WSF is mounted horizontally in the Shuttle payload bay, the open volume below the WSF is effectively used by mounting additional payload canisters on the Cross Bay Carrier. The Carrier's power and data capabilities are extended to the payload canisters, prompting the name "Smart Cans." Based on NASA's Goddard Space Flight Center's Get Away Special Canisters (GAS Cans), the Smart Cans also provide the opportunity for other payloads to fly with the WSF (however, they stay inside the Orbiter payload bay during the entire mission.) Candidates for these supplemental payload opportunities have been actively pursued by SVEC, resulting in nine additional experiments being undertaken on WSF-2 in a cooperative manner.



Wake Shield Facility

What is Epitaxial Thin Film Growth?

Epitaxial thin film growth is an approach to generating atomically ordered thin films of semiconductor oxides and metals with a reduced number of defects through the growth of material on a crystalline substrate in a vacuum. In epitaxy, a prepared surface, or substrate, is exposed in a vacuum to atomic or molecular beams of elements such as aluminum (Al), arsenic (As), gallium (Ga), or indium (In). The substrate acts as an atomic pattern, or template, upon which the atoms form crystalline thin films. The atoms grow in layers which follow the atomic structure pattern of the substrate. A thin film of new materials then grows on top of the substrate in an atom-by-atom, atomic-layer-by-atomic-layer manner to form a "wafer" with an ultra-high purity. This growth technique is defined as Molecular Beam Epitaxy, and has been used as a laboratory technique for studies in new thin film electronic materials for the past 20 years. It has been shown during this time that the vacuum environment within which the materials are grown is critical to the quality of the thin film.

WSF-2 can grow epitaxial thin films on seven different substrate wafers with material from seven different source furnaces, or cells. The principle objectives of thin film experiments are the growth of high purity films and high electron mobility structure in aluminum, gallium, arsenide type systems.

Cooperative Payloads: Free-Flyer Experiments

The **Global Positioning System** (GPS) is a dual mode experiment from the University of Texas at Austin using a GPS receiver to determine precision position and velocity of the WSF and employing GPS signal strength attenuation to determine atmospheric temperature profiles. Partially funded by a NASA Johnson Space Center regional university grant, the GPS experiment will operate during the free flight portion of the WSF mission recording position, velocity, signal strength and diagnostic information. The system will be activated by ground command from the JSC Payload Operations Control Center (POCC). Data will be collected onboard, stored in an unique solid state recording device developed for this mission by JSC, and analyzed post flight.

NASA engineers and scientists working jointly with SVEC will undertake the **ambitious Shuttle Plume Impingement Experiment** in support of Space Station development. The complex interaction between Shuttle jet firings and space structures is a critical concern to Space Station planners. The WSF Free Flyer, loaded with environmental diagnostic equipment, is the ideal target for this study -- a cost- effective means to multiply benefits to differing program goals. A complex and extensive series of Shuttle thruster firings at a variety of distances from the WSF have been developed to use the WSF's response as measure of the characteristics of the Shuttle's thruster plumes.

The Neutral Mass Spectrometer (NMS) was developed in a team effort by the University of Texas at Dallas and Lamar University, Beaumont, TX. This experiment will test a magnetic-sector field mass spectrometer designed to measure the ultra-vacuum created in the wake of the WSF. Located on the WSF outer shield, the NMS will be ground commanded for operations during the free flight portion of the WSF mission.

The **Cosmic Dust and Orbital Debris Experiment Monitor** (CoDEM) is an experiment from the Baylor University Space Science Laboratory. This experiment will collect and characterize the near WSF environment with in-situ measurements of dynamic and physical characteristics of particulate matter. The ensemble of detectors will measure particle time-of-flight, impact plate plasma, and particle impact momentum. This experiment incorporates high sensitivity, high reliability integrated detectors into a package capable of returning captured materials for laboratory examination.

This state-of-the-art detector will employ thin-film plasma, impact plate plasma, and particle impact momentum devices to measure hypervelocity impacts of cosmic dust or orbital debris. These measurements will permit determination of mass, density, and velocity. The experiment will attempt to capture dust grains using micropore foams and a substance called aerogel. CoDEM is a self-contained experiment which requires no interaction from the ground during on-orbit operations.

The **Earth Reference Attitude Determination System** (ERADS), from Honeywell Satellite Systems, uses a combination of Earth and Sun sensors in combination on the rim of the WSF. The sensor has an annular field of view which permits Earth limb and star field viewing. ERADS is activated and controlled from the ground, collecting data in an on-board data recorder. Data will be processed post flight. Real time interaction is limited to state of health and system activation/deactivation.

The University of Toronto Institute for Aerospace Studies has developed a **Materials Exposure Experiment** for collecting data on atomic oxygen interaction with various materials. This is a passive exposure experiment mounted on top of the WSF batteries facing into the velocity vector (ram direction). The experiment will expose over 150 samples of 26 different materials to the space environment. The objective is to gather data on how this affects these materials.

The **Hyper Velocity Impact Capture Experiment**, developed by NASA's Jet Propulsion Laboratory, is a passive debris collection/exposure experiment which has flown on previous Shuttle missions. The experiment has three collectors -- two on the WSF free flyer, and one remaining on the Cross Bay Carrier in the Shuttle payload bay. The objective is to measure space debris around the WSF and compare it to data collected on previous space flights. The two exposure plates on the free flyer are mounted on the outer shield, the large collector facing into the velocity vector and the smaller facing the opposite direction.

The Cross Bay Carrier collector is mounted on the port side of the carrier facing out of the Shuttle bay. The objective is to gather information about the flow of debris around the WSF. The capture medium will be aerogel.

Charging Hazards and Wake Studies (CHAWS), an experiment from the Air Force Phillips Laboratory located at Hanscom AFB, MA, expands the understanding of the interactions of the space environment with space systems and the hazards these interactions create for satellite systems. Goals are to: measure the ambient low energy positively charged particles, and study the magnitude and directionality of the current collected by a negatively charged object in the plasma wake. The experiment consists of two sensors and control electronics. The Langmuir probe is located on the wake side of the WSF, and the other sensor is located on the ram side at the nadir position near the edge of the outer shield.

The CHAWS experiment will collect its primary data while the WSF is attached to the Shuttle robot arm. Shuttle attitude and the robot arm position will be varied to expose the sensors and allow the “mapping” of plasma wake around the Shuttle. Real-time data and command is used to control the CHAWS during the operations. The payload will be controlled by Air Force personnel from the JSC POCC. CHAWS operations will be conducted during a six-hour period at the conclusion of the WSF free flight mission. This experiment is a re- flight of the experiment flown during WSF-1 on STS-60.

Cooperative Payloads: Cross Bay Carrier Experiments

The Iowa **Joint Experiment on Microgravity Solidification**, constructed by the Iowa Space Grant Consortium, is carried in a WSF SMART Can located on the Cross Bay Carrier. The overall objective of the experiment is to examine the effects of a microgravity environment on the solidification process of a tin-cadmium alloy imbedded with particulate matter. The experiment consists of six test cells, heaters and a control processor located in the “Can”. The on-board computer is a 486 processor with 3 megabytes of flash memory. The cells, 1 inch diameter by 4 inches long stainless steel tubes, will be heated to melt the samples, held at this temperature, and then passively cooled. The temperature of the cells will be monitored and recorded by the on-board computer processor. Samples will be analyzed post-flight.

During the WSF-2 mission, the experiment will be activated by the crew using the Shuttle standard switch panel. All experiment events are pre-programmed and the experiment will be autonomous.

The **Advanced Process Controller** (APC) is a joint Space Industries and Space Vacuum Epitaxy Center venture for development and space qualification of a PC type process controller. Future uses of the controller include the automated control of the commercial WSF. The process controller will be located in a “Can” and will be used to monitor temperatures, current and voltage as well as providing relay control functions. The APC will be activated by the flight crew using the standard switch panel. Ground commanding will originate from the POCC at JSC.

An engineering team at JSC has developed Long Range AutoTRAC, a video system for testing light-enhanced photogrammetric ranging techniques on-orbit. The video camera/light emitting diode (LED) combination instrument is located on the Wake Shield Cross Bay Carrier. The LEDs will illuminate four retroreflectors located on the ram side of the WSF, and the camera will view the returned light. Video images will be stored for post-flight analysis to determine range, bearing and attitude of the WSF.

Other Experiments Supported by WSF

The **MagField Experiment** undertaken by tenth grade students at Gregory Jarvis High School in Mohawk, New York, will determine the variation of the Earth's magnetic field from magnetometer and electron diffraction data obtained during the Wake Shield mission. An electron beam, used for in-situ diffraction measurement of the atomic structure of growing semiconductor thin films, is deflected by the Earth's magnetic field. The amount and direction of the deflection can be used to determine the magnitude and direction of the Earth's magnetic field as a function of the WSF's orbital position.

Data collected during the WSF mission will be given to the school for post-flight analysis. The high school students will work with Space Vacuum Epitaxy Center researchers in applying the WSF magnetic field data to the identification of variations of the Earth's magnetic field from that of an ideal magnetic dipole field.

Mission Scenario

On Flight Day 4, the WSF will be grappled by the Shuttle arm and removed from the Cross-Bay Carrier. The WSF will be positioned by the arm to be scoured by the highly reactive atomic oxygen found in LEO, and by the Sun's heat. The cleaning will last from one-and-a-half to three hours. Some systems tests will be run during this cleaning cycle, such as communications checks between the Carrier and the Free Flyer, checks of the Free Flyer batteries, and activation of the primary video camera on the wake side of the Free Flyer.

After the cleaning is done, the arm will move the WSF to the release position near the center of the payload bay. The Free Flyer will separate from the arm and move under its own nitrogen gas thrusters to about 30 nautical miles behind the Shuttle to isolate it from Shuttle contamination sources (such as water dumps, fuel cell purges and engine firings).

The WSF will stay 30 nautical miles behind the Shuttle while growing the thin films. During this time, it will be operated from the POCC at JSC. The SVEC team will monitor and control all aspects of WSF operations in close cooperation with the astronaut crew. Cooperative payloads will be operated from the Commercial Payload Command Center located at Space Industries a few miles from JSC in League City, TX. On Flight Day 6, the Shuttle will rendezvous with the Free Flyer. Every member of the STS-69 crew has a vital role to play during the WSF rendezvous and capture, and the integral plume experiment. During approach, David Walker and Kenneth Cockrell will fly Endeavor in a complex series of maneuvers designed to expose the WSF to carefully controlled thruster exhaust plumes. James Newman and Michael Gernhardt will coordinate the plume experiment initiation and data acquisition, and James Voss will track the WSF position by video. After the astronauts recapture the WSF, it will stay on the Shuttle arm above the payload bay during the astronaut sleep period for extended WSF environmental measurements.

On Flight Day 7, the CHAWS experiment will be performed. The astronauts will position the WSF to the point above the overhead windows and maneuver it to gather plasma flow data around the WSF. The Auroral Photography Experiment B camera will be used in support of the plasma flow studies to view the Shuttle glow phenomenon on the CHAWS plasma probe from the Shuttle's aft flight deck windows. Plasma flow data will be acquired for two full orbits after which the WSF will be re-stowed for return to Earth.

Future Plans for the WSF Program

The WSF program consists of four flights at roughly one year intervals. During these four flights, the WSF program will characterize the uncharted neutral and plasma wake formed by a vehicle in LEO; grow thin films in the unique wake ultra-vacuum; and demonstrate the ability to grow commercial quantities of epitaxial thin films in space, establishing the "proof-of-concept" required for industry to fully embrace the space epitaxial growth technology. To accomplish these goals, the WSF program is designed to evolve, with the WSF-3 flight in 1996, increased capability in number and types of thin film grown, and in command and control of the growth process through ground operations from a commercial payload control center. WSF-3 also will see the addition of solar panels, additional on-board computing capabilities, and robotic substrate sample manipulation for extended orbital operations. WSF-4 in 1998 is expected to have the capability of processing up to 300 epitaxial thin film wafers.

Beyond the first “proof-of-concept” flights, full commercial use of the WSF is projected. This “Mark II” phase envisions -- a WSF Free Flyer orbiting for a five-year manufacturing cycle. The 4,350-pound weight of the Free Flyer makes it economically unfeasible to launch and retrieve for every batch of wafers grown. Since each 300 wafer batch only weighs about ten pounds, it is clearly more suitable to launch only the raw materials and bring back only the finished wafers. Therefore, the WSF Mark II would be launched into orbit and then periodically serviced from the Space Station.

Conclusion

Accomplishing the objectives of the four flight test program is expected to prove the theory that electronic materials grown in space can be of higher quality than those grown on Earth, can be processed in space, and can be produced in large areas. The electronics industry’s need for high-speed optical and high-frequency electronic devices will continue to drive advanced materials development and improvement. The ever-increasing use of electronic materials worldwide and the ability to grow them in thin film form in space is expected to give commercial viability to the use of the space ultra-vacuum to produce advanced electronic materials.

NASA SPECIAL PAYLOADS DIVISION ON STS-69

STS-69 marks a major milestone for payloads from the Goddard Space Flight Center. All three of the payloads are part of NASA's effort to produce faster, better, and cheaper access to space and all three of the payloads come from the Special Payloads Division (SPD) at Goddard. Not only are both of the Shuttle projects under SPD represented, but all of the Shuttle programs administrated by the SPD have at least one experiment flying on STS-69.

The SPARTAN Project is flying the third SPARTAN 201 (SP201-03) mission in a series of four, which is a primary payload. The White Light Coronograph (WLC) instrument on SP201 is a Goddard Laboratory for Astronomy and Solar Physics Division instrument. The other two bridges, International Extreme Ultraviolet Hitchhiker (IEH-1) and Capillary Pumped Loop-2 (CAPL-2)/Get Away Special Bridge Assembly (GBA-6) are from the Shuttle Small Payloads Project (SSPP). IEH-1 has three Hitchhiker Program experiments and a Hitchhiker-Jr Program experiment. CAPL-2/GBA(6) has one Hitchhiker experiment, one Complex Autonomous Payload using the Get Away Special (GAS) carrier, and four GAS payloads.

SPARTAN 201-03

The SPARTAN 201-03 mission is a scientific research effort aimed at the investigation of the interaction between the Sun and its outflowing wind of charged particles. SPARTAN's goal is to study the outer atmosphere of the Sun and its transition into the solar wind that constantly flows past the Earth. The mission involves the deployment and operation of the free-flying SPARTAN spacecraft from Space Shuttle Endeavour.

This mission -- the third for SPARTAN -- is intended to coincide with the passage of the Ulysses spacecraft over the Sun's north polar region. As the Ulysses spacecraft passes high over the north pole of the Sun, its instruments are sampling the physical properties of electrons, protons, and ions in the solar wind flowing past the spacecraft. These properties include variations of temperature, density, ionic composition, and magnetic and velocity fields. At the same time, intensive collaborative observations of the source of the solar wind at the Sun are planned, including SPARTAN 201-03 and a variety of other ground and space-based experiments.

SPARTAN 201-03 Science and Instruments

Science Objectives

The primary objective of the SPARTAN 201-03 mission is to understand the physical circumstances of the corona at the Sun during the time of the Ulysses north polar passage. It had been suspected for about 20 years that the polar regions of the Sun were sources for high speed solar wind streams. This hypothesis was finally confirmed by measurements made by the Ulysses spacecraft during the south polar passage in September 1994.

The SPARTAN solar viewing instruments will be used to define conditions at the base of the heliosphere where the solar wind has its origins. The great mysteries yet to be solved are what process accelerates the solar wind and, still more basic, why the corona is so much hotter than the underlying layers of the Sun.

Instruments

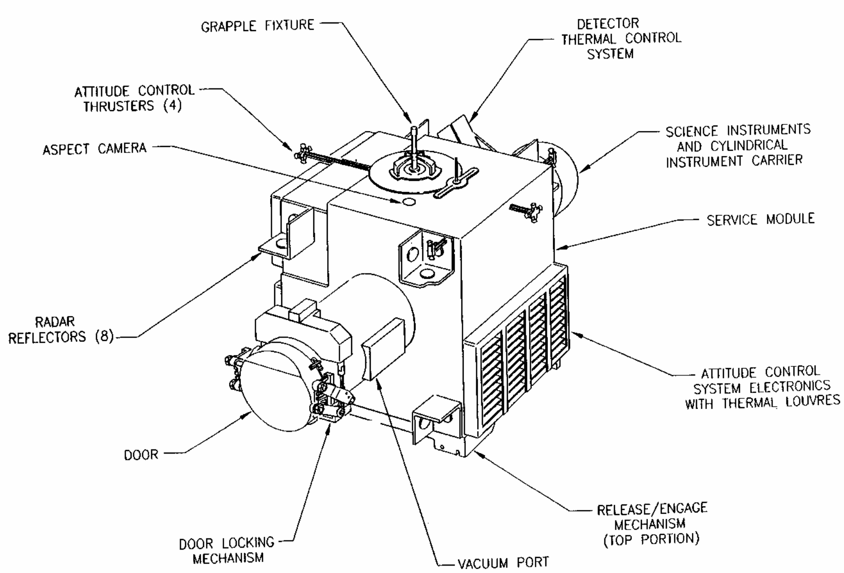
The two scientific instruments on SPARTAN 201-03 are the Ultraviolet Coronal Spectrometer (UVCS) and the White Light Coronagraph (WLC).
The UVCS is used to measure characteristics of the light emitted by neutral hydrogen atoms in the solar corona. It also measures the brightness of light emitted by hot, highly-charged atomic ions. These measurements are used to determine line-of-sight velocities, kinetic temperatures, densities, and bulk outflow velocities for some of the major constituents in the corona and solar wind. This device was developed by the Smithsonian Astrophysical Observatory, Cambridge, MA.

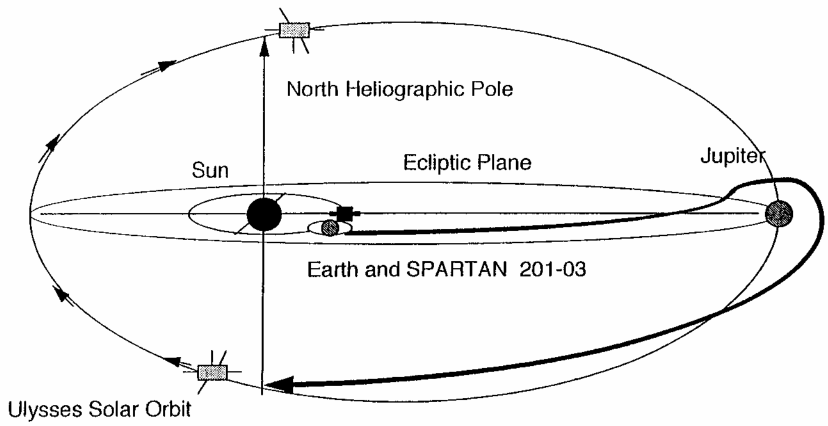
The WLC is a specialized telescope which produces an artificial eclipse of the Sun so that the constantly-changing shape and form of the solar corona can be imaged. The experiment is operated by the Goddard Space Flight Center and was developed by the High Altitude Observatory, Boulder, CO.

The UVCS will return spectroscopic data for ionized hydrogen and five-times ionized oxygen located in coronal regions from 1.35 to 4 solar radii. The light used by UVCS is in the extreme ultraviolet region of the spectrum. Radiation from these ions is unobservable from the surface of the Earth because of atmospheric absorption.

The WLC instrument images the white light (electron- scattered) component of the corona to provide information on the detailed coronal structure. Space-borne instruments of this type are free from the glare caused by light-scattering within the Earth's atmosphere. They allow the corona to be imaged at distances high above the Sun's surface. Together, these two instruments will be used to investigate properties of the solar corona at the base of the solar wind. These include:

- The distribution of temperature and density distributions for both electrons (WLC) and protons and heavy ions (UVCS).
- Detection of bulk flows in the lower corona and inference of systematic velocity fields in the corona.
- Detection of heating of the lower corona by the deposition of energy carried by hydromagnetic waves (WLC and UVCS).





Earth-Sun Relationship During Joint SPARTAN-Ulysses Operations

Science Background

Why Investigate the Corona and Solar Wind?

The modern world is becoming increasingly dependent upon advanced communication, navigation, and other technologies. These technologies have occasionally fallen victim to disruptions in operation caused by changes in "space weather" due to solar variations. Earlier this year NASA's Wind spacecraft determined that space weather effects were the primary reason that two spacecraft -- Anik E-1 and GOES-8 -- experienced equipment problems last year. Therefore, knowledge of the influences of the Sun upon the Earth is not only important, but ultimately required for optimal design and operation of some of these key systems.

The Sun is a magnetic variable star whose energy -- including heat, light, X-rays, gamma-rays and the solar wind -- dominates and powers the solar system. The thin, hot upper atmosphere of the Sun, called the solar corona, achieves enormous temperatures -- about two million degrees -- and is the interface between the Sun and the solar wind. The solar wind is a continual torrent of electrically charges particles blown away from the Sun in all directions.

Gusts in the solar wind flowing past the Earth's magnetic field are responsible for disruptions felt on Earth associated with space weather. The interplay of forces is responsible for dramatic global effects. One spectacular example of the effects of this interplay in the Earth's polar atmospheres are aurora, called the Northern and Southern lights. Other more indirect effects of the solar wind may be highly disruptive, such as electric power distribution system failures, radio communication disruptions, aerial magnetic prospecting or surveys, and diminished performance and reliability of spacecraft in Earth orbit.

Additional background information and graphics on SPARTAN 201, Ulysses, and the Sun may be obtained from the World-Wide Web directly through the SPARTAN 201-03 Home Page at: http://umbra.gsfc.nasa.gov/spartan or via links through the STS-69 Mission Home Page at: http://shuttle.nasa.gov

Key Spacecraft Characteristics

Mass:	2,845 lbs. with instruments
Power:	28 Volt DC batteries, 18 kwh capacity
Command and Data System:	Pulse Code Modulation (PCM) system with 10 gigabyte tape recorder for science and engineering data storage onboard
Attitude Control System:	Three axis stabilized cold gas (GN2) pointing system, +/- 30 arc-sec accuracy using Sun sensors
Construction:	Reusable bolted aluminum service module and instrument carrier
Communications:	In-bay communication through Shuttle laptop computer also known as the Payload General Support Computer, used for final solar target input. No communication while in free-flight
Science Mission Duration:	45 hours of free-flight
Advanced Instrumentation Systems:	(1) UVCS: first spectral diagnostics of coronal proton temperature, and coronal bulk flows; (2) WLC: first externally occulted orbital coronagraph with a two-dimensional solid-state detector for precision photometry.

Mission Operations

After the SPARTAN is deployed by the Shuttle, the spacecraft operates on its own for 43 hours, achieving a maximum distance of 70 to 100 nautical miles from the Shuttle at mid-mission.

After its independent operation, SPARTAN is placed into a safe-hold condition, and is recovered and placed into the Shuttle cargo bay. The internal tape recorder is removed from the spacecraft after landing and data are recovered during tape playback.

Background

The SPARTAN program is designed to provide easy and relatively inexpensive access to Earth orbit via the Space Shuttle for science experiments. SPARTAN’s design consists of a basic carrier, which, with the addition of a science experiment, becomes a complete spacecraft designed to meet specific science objectives on each mission. SPARTAN missions include stellar, solar, Earth fine-pointing, and microgravity science and technology experiments requiring space exposure away from the Space Shuttle.

The SPARTAN program was conceived in the mid-1970s and developed by the Special Payloads Division, Goddard Space Flight Center, and the U.S. Naval Research Laboratory, Washington, DC, to extend the capabilities of sounding rocket-class science experiments by making use of the Space Shuttle.
In June 1985, a SPARTAN mission successfully carried an X-Ray telescope aboard STS-51G. Another carrier, SPARTAN Halley, was on board Shuttle Mission STS-51L. In April 1993 and September 1994, SPARTAN 201 was flown aboard the Space Shuttle Discovery on missions STS-56 and STS-64. The SPARTAN 204 carrier system was carried aboard STS-63 in February 1995.

The SPARTAN project is managed by NASA’s Goddard Space Flight Center for the Office of Space Science, Washington, DC. Goddard provides the SPARTAN carrier and manages its integration with the Shuttle.

SPARTAN Team

SPARTAN 201-03 Project Manager: Craig Tooley, Goddard Space Flight Center Greenbelt, MD

UVCS Principal Investigator: Dr. John Kohl, Smithsonian, Astrophysical Observatory, Cambridge, MA

WLC Principal Investigator: Dr. Richard Fisher, GSFC

Space Physics Division Director: Dr. George Withbroe, NASA Headquarters, Washington, DC

SPARTAN Program Manager: Paul DeMinco, NASA Headquarters

Special Payloads Division Director: Robert Weaver, GSFC

Discipline Scientist for Solar Physics: Dr. William Wagner, NASA Headquarters

STS-69 Mission Scientist: Dr. Richard Fisher, GSFC

INTERNATIONAL EXTREME ULTRAVIOLET HITCHHIKER (IEH-1)

IEH-1 is the first of five planned flights to measure and monitor long-term variations in the magnitude of absolute extreme ultraviolet (EUV) flux coming from the Sun, and to study EUV emissions from the plasma torus system around Jupiter originating from its moon Io.

These observations are accomplished by the two complementary experiments that comprise IEH, the Solar Extreme Ultraviolet Hitchhiker (SEH) and the Ultraviolet Spectrograph Telescope for Astronomical Research (UVSTAR).

SEH and UVSTAR are international cooperative investigations. International partners in IEH-1 from the Italian Space Agency will study the EUV emission of hot stellar objects. The NASA portion of the science is sponsored by the Solar System Exploration Division, NASA Headquarters.

The EUV spectrum contains very short wavelength light that does not penetrate the Earth's atmosphere. Because these wavelengths are blocked by the atmosphere, scientists must use instruments above the atmosphere to study this portion of the solar flux. Useful models of the Earth's atmosphere (or any other planetary atmosphere) require accurate knowledge of the sun's absolute EUV irradiance. It is widely recognized in the scientific community that more accurate long-term solar measurements of this type are urgently needed, given that the solar spectrum changes from day to day, from one solar rotation to the next, and it changes even more dramatically over the 11-year solar cycle.

Solar Extreme Ultraviolet Hitchhiker (SEH)

SEH is a set of instruments designed and built to provide research scientists with a tool to accurately measure solar flux (the amount of light passing through a given area in a given time) in the Extreme Ultraviolet (EUV) region of the solar spectrum.

Using an EUV solar spectrometer, a device that measures the wavelengths of non-visible light, the SEH instrument will take a photograph of the EUV solar spectrum between 250 and 1700 angstroms. (The shortest wavelength of light which we can see with our eyes is deep blue and has a wavelength of 4,000 angstroms. The longest is red with a wavelength of 7,000 angstroms. The light this instrument will view on STS- 69 is a very deep blue) SEH also takes measurements with gas cell experiments, using helium and neon gas. These gas cells provide extremely accurate brightness-type measurements of the solar EUV, much like a light meter on a camera.

Relatively little is known about this important EUV energy source, even though there have been previous missions conducted to measure the solar EUV radiation. This is because absolute measurements in the EUV are difficult, and EUV- related technology is still maturing.

This difficulty is well known, and most past missions have produced data with rather large uncertainties, due primarily to instrument calibration uncertainties and time- dependent instrument sensitivity changes which are difficult to separate clearly from the variability of solar EUV emissions. The stability of the SEH instrument removes these difficulties.

The SEH set of instrumentation was most recently flown successfully on a sounding rocket mission on September 4, 1990. The combination of spectral and brightness data reveals not only what wavelengths are in the solar EUV spectrum, but also provides an exact measurement of the absolute flux in that region, providing the most reliable absolute solar EUV data available.

The SEH experiment was developed and built at the University of Southern California, with Dr. Darrell Judge as the principal investigator and Don McMullin as the experiment manager.

Consortium for Materials Development in Space Complex Autonomous Payload (CONCAP IV-03)

CONCAP IV-03 is the third flight of an experiment that studies the growth of organic nonlinear optical (NLO) crystals and thin films. The materials being used are of great interest because they can be used in the photonics industry. Photonics is the use of laser light instead of electrons through wires to send bits of information. The advantage of photonics is the elimination of mechanical components, switches, and wear items, and the increased speed of information transferal that lasers offer.

NLO materials are the key to many optical applications now and in the future, with optical computing being a prime example. Many studies have suggested that the photonics industry ultimately will grow to the scale of the current electronics industry. Just as material improvements in silicon were essential to electronics, so too are improved optical materials required for advances in photonics. NLO materials play the same role in photonics and optoelectronics that semiconductors do in the electronics industry. The issue in this project is whether crystals grown in microgravity can speed the evolution of photonics.

A total of two crystals and 45 thin films will be grown. It is anticipated that the lack of gravity will achieve two goals: it will avoid convection, leading to crystals with more uniform composition; and it will avoid the deformation of the crystals under their own weight “sagging” at the relatively high growth temperatures where they are extremely soft.

Nonlinear optical crystals have two important properties: frequency doubling and the pockets effect. When a laser beam passes through the crystal it comes out with twice the frequency of the original beam, a phenomenon known as “frequency doubling.” Frequency doubling is important because it doubles the range of frequencies available for laser applications. Currently, lasers only operate at a limited number of frequencies with some very important frequencies missing for scientific and commercial applications. When an electric field is applied to some NLO materials, the index of refraction of the material changes, a phenomenon known as the “pockets effect.” When the index of refraction changes, so does the path of light traveling through the crystal. The pockets effect allows a crystal to act as a high speed switch.

CONCAP IV-03 is contained in a Hitchhiker canister and uses the Hitchhiker-Jr (HH-J) carrier avionics system. This experiment is the first to use HH-J which utilizes the Payload and General Support Computer located in the aft flight deck and operated by a crewmember.

CONCAP IV-03 is managed by the Consortium for Materials Development in Space, at the University of Alabama at Huntsville. The experiment manager is Bill Carswell.

Shuttle GLO Experiment (GLO-3)

This experiment originated as the “Shuttle Glow” experiment sponsored by the USAF/Phillips Laboratory. It also is 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 gasses 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.

According to Dr. David J. Knecht, Phillips Laboratory program manager for GLO, the experiment consists of imagers and spectrographs, which are bore-sighted 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 of 115-1100 nanometers. The sensor comprises 9 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. Active participants who have ground-based instrumentation try to make observations throughout the campaign. The data is correlated and deposited in a data bank at the National Center for Atmospheric Research, Boulder, Colorado, for use by the community. The coordination of this data is important to relate local observation to the global picture provided by the GLO observations from the Shuttle.

Dr. Edmond Murad from the Phillips Laboratory and Dr. A. Lyle Broadfoot from the University of Arizona are co- principal investigators on GLO.

Ultraviolet Spectrograph Telescope for Astronomical Research (UVSTAR).

Response in the solar system to the solar input measured by SEH will be observed by a complementary set of instruments called UVSTAR. On this Shuttle mission, the UVSTAR instrumentation will measure EUV and Far Ultraviolet (FUV) emissions in the Jovian system, and the SEH will provide the solar flux data needed for proper context.

UVSTAR is a pair of telescopes with imaging spectrographs that are sensitive to EUV and FUV wavelengths, from 500-850 angstroms and 800-1250 angstroms respectively. From the Space Shuttle, UVSTAR will form spectrally resolved images of stars and extended emission regions such as the Io plasma torus. Observing time will be shared to achieve objectives in both planetary science and stellar astronomy.

UVSTAR offers an important advantage for Io torus research in its capability to form simultaneous images of the torus in each of its brightest emission lines. The spectral dispersion is great enough to separate images of most of the important emissions.

The EUV spectrum of the plasma torus is rich in information about the ion composition, density, and electron temperature of the plasma. Studies of the spectrum and shape of the torus will help answer fundamental scientific questions about the source of the energy and how material becomes a part of the torus.

Although ground-based studies of torus emissions at visual wavelengths have added much to our knowledge of this plasma, measurements in the EUV offer a more direct means of studying certain processes in the torus. Recent EUV measurements by the Hopkins Ultraviolet Telescope on the Astro-2 Shuttle mission and the Extreme Ultraviolet Explorer spacecraft have emphasized the importance of this wavelength range.

UVSTAR also will complement and extend observations planned by the Galileo spacecraft, which arrives in orbit around Jupiter on December 7. Galileo's orbital geometry limits its opportunities for viewing the plasma torus with its UV instruments, especially with the EUV spectrograph.

UVSTAR will provide observations of the Jovian system at greatly improved spectral resolution. The imaging spectrographs will measure the intensity of several important emission lines of ionized sulfur and ionized oxygen as a function of position and time in the torus, measure molecular and atomic hydrogen from Jupiter's dayglow and aurora, and possibly help to clarify the coupling between the torus and the aurora.

UVSTAR includes capabilities for independent target acquisition and tracking. Rough pointing will be provided by orienting the Shuttle. The finder telescope will locate the target and move the optical axis to it. Pointing control will then be transferred to the tracker telescope. A computer- controlled digital feedback system will hold the UVSTAR on target by canceling the Shuttle's attitude control motions.

UVSTAR was prepared for flight jointly by principal investigators Dr. A. Lyle Broadfoot of the Lunar and Planetary Laboratory, University of Arizona and Dr. Roberto Stalio of the Center for Advanced Research in Space Optics, University of Trieste, Italy. Dr. Broadfoot is the lead principal investigator for the Io plasma torus observations. Dr. Stalio is the lead principal investigator for the astronomical observations.

CAPILLARY PUMPED LOOP/
GET AWAY SPECIAL BRIDGE ASSEMBLY (CAPL-02/GBA)

The combined CAPL-2/GBA (6) payload consists of the CAPL-2 Hitchhiker payload, the Thermal Energy Storage-2 (TES- 2) payload, and five GAS payloads on a single cross-bay structure called the GBA.

The Shuttle Space Payloads Project (SSPP) Office has responsibility for the mission management, safety, payload integration, and mission operations of the payload. Chris Dunker, from SSPP, is the mission manager.

Capillary Pumped Loop (CAPL-2)

The CAPL-2 payload is an in-orbit microgravity demonstration of the full-scale capillary pumped loop system planned for the Earth Observing System (EOS) Program. The CAPL-2 payload is a reflight of the CAPL-1 Hitchhiker payload flown on STS-60 in February 1994, with modifications to enhance the startup of its capillary system. The CAPL-2 flight will verify the heat transport requirements of the thermal control system under design for the EOS.

This experiment uses an evaporator plate with a capillary pump that vaporizes a liquid ammonia working fluid by the use of heaters. The vapor ammonia then travel through a three-meter-long line to heat exchangers, where the vapor is condensed to a liquid and returned to the evaporator plate via a three-meter-long liquid line. Heat rejection is accomplished via heat pipes that carry the heat from the exchangers to a radiator. A unique feature of the CAPL-2 is that all of the pumping is done by capillary forces, with no mechanical moving parts. The CAPL-2 utilizes separate electronics control modules for telemetry, command, and power. The CAPL-2 electronics are, in turn, connected to the Hitchhiker avionics as a standard, easy-to-use Shuttle carrier system. During the mission, a control center at Goddard will issue commands to the CAPL-2 experiment, monitor its performance and conduct real-time mission analysis on the CAPL-2 system.

The Capillary Pumped Loop is sponsored by NASA’s Mission to Planet Earth and developed by the Goddard Space Flight Center Thermal Engineering Branch with Jentung Ku as the principal investigator. Dan Butler is the experiment manager.

Thermal Energy Storage (TES)

The Thermal Energy Storage (TES-2) experiment also is part of the CAPL-2/GBA-6. The TES-2 payload is designed to provide data for understanding the long-duration behavior of thermal energy storage fluoride salts that undergo repeated melting and freezing in microgravity. The TES-2 payload is designed to study the microgravity behavior of voids in Lithium Fluoride-Calcium Fluoride eutectic, a thermal energy storage salt. Data from this experiment will validate a computer code called TESSIM, useful for the analysis of heat receivers in advanced solar dynamic power system designs.

Solar dynamic power systems provide power by converting solar energy to electrical power. During solar conditions some of the Sun’s energy is also used to melt a thermal energy storage salt which resides in a heat receiver. In shade, or eclipse conditions, the thermal energy salt freezes giving up its thermal energy such that electrical power may be continually provided.

TES-2 occupies a standard five cubic-foot Get Away Special canister and is expected to develop internal temperatures in excess of 700 degrees Celsius in order to melt the fluoride salts. When the thermal energy salt is melted, it expands approximately 30 percent in volume. As the thermal salt cools, it solidifies and shrinks, thus causing voids or pockets to form in the salt. This void formation affects both the heat absorption rate of the salt, and the design of the heat receiver containers holding the salt.

Repeated melt/freeze cycles will characterize the void formation and movement of the void in the salt. Understanding and predicting the melt/freeze behavior of contained thermal energy storage salt in the on-orbit microgravity environment will lead to an improved design for solar dynamic system heat receivers.

TES-2 is the second of four flight experiments. It is flying as a Complex Autonomous Payload (CAP) managed by the Shuttle Small Payloads Project at Goddard Space Flight Center, Greenbelt, MD.

The TES experiment conception, design and fabrication took place at NASA's Lewis Research Center, Cleveland, OH. Carol Tolbert is the TES-2 principal investigator and Frank Robinson Jr. is the TES-2 project manager.

GET AWAY SPECIAL (GAS) PAYLOADS

Four Get Away Special (GAS) payloads are planned for STS-69. Each will be contained in a standard five-cubic-foot canister. The four payloads are as follows:

G-515
European Space Agency, Noordwijk, The Netherlands

The **Control Flexibility Interaction Experiment** will study active damping control loops using a flexible plate and two piezo (pressure) actuators for better understanding of the interaction of spacecraft attitude and orbit control systems with spacecraft structures.

This experiment will verify the feasibility of an active damping system, autonomous in operation, as part of an overall spacecraft control system. The experiment will show through a scaled simulation a cantilevered, flexible plate being perturbed and then having its motion detected and damped automatically.

The experiment duration will be around two hours and will include several runs of the perturbation - control loop. Expected disturbances induced by Space Shuttle maneuvers are welcome to proof of the concept of active damping.

Since 1990, the In-Orbit Technology Demonstration Program of the European Space Agency has flown four Get Away Special payloads and one Hitchhiker payload on board a U.S. Space Shuttle.

G-645
Millcreek Township School District, Erie, PA
McDowell High School, LORD Corp.

G-645 will investigate the performance of Electroheological (ER) fluid-filled beams as structural dampers in space. The experiment consists of two instrumented aluminum beams filled with ER fluid. The beams are moved from rest into a deflected position by an actuator; they are then held in this position by electro-magnets. A 5000-volt current is applied to the beams, activating the ER fluid. On a command from the computer, the beams are released, and the frequency and decay rate are measured and recorded on a computer chip. The cycle is repeated without the 5000-volt application, and the full test is repeated six times each hour during the first three days of the flight.

ER fluid is such that when it is subjected to an electric field, its flow characteristics are changed. The fluid becomes more viscous and exhibits more resistance to shear stress which increases the damping of the fluid.
The objective of this payload is to conduct a structural damping evaluation of ER fluid-filled beams in a space environment. By subjecting the ER fluid-filled beams to launch, orbit, and re-entry conditions, the vibratory performance of these beams will be monitored and the effect of microgravity determined.

G-702
NASA Lewis Research Center, Cleveland, OH

The Microgravity Smoldering Combustion (MSC) experiment, will study the effects of smoldering combustion in a long- term microgravity environment. This experiment will focus on one-dimensional smoldering of polyurethane foam.

Smoldering is a non-flaming form of combustion that takes place in the interior of porous combustible materials. Common examples of smoldering are non-flaming embers, charcoal briquettes, and cigarettes. The objective of the study is to provide a better understanding of the controlling mechanisms of smoldering, both in microgravity and Earth gravity. As with other forms of combustion, gravity affects the availability of air and transport of heat, and therefore the rate of combustion. The results of the microgravity experiments will be compared with identical ones carried out in Earth's gravity. They also will be used to verify present theories of smolder combustion. The results of the study will provide new insights into the process of smoldering combustion.

Professor Carlos Fernandez-Pello of the University of California, Berkeley, is the principal investigator for the MSC experiment. Dr. David Urban of NASA's Lewis Research Center is project scientist, and John M. Koudelka of Lewis is project manager.

G-726
NASA Langley Research Center, Hampton, VA

The Joint Damping Experiment (JDX) is a structural dynamics experiment designed to study the non-linear, gravity dependent behavior of a pin-jointed truss. A precise knowledge of the dynamics and damping of space structures is vital to the robust design of future NASA missions involving precision structures. Many proposed designs for large space structures use light-weight trusses composed of high-stiffness members which exhibit very little damping. Deployable truss structures using pinned joints typically have significantly higher damping than erectable trusses using "tight" mechanical joints. However, joint damping is difficult to predict and highly dependent on preload across the joint interface.

JDX will allow comparison of damping in microgravity and 1-G environments. Flight testing has previously been conducted on an aircraft which provides a short duration microgravity environment.

The JDX test article consists of three cubic (8x8 inches) bays of a truss structure mounted within a GAS canister. One end of the structure is cantilevered to the bottom of the GAS canister. A mass is attached to the free end to lower the fundamental resonant frequencies of the structure. A controller/data acquisition system, an excitation assembly consisting of linear actuators, linkages, and electromagnets, plus a set of sealed batteries, also are housed.

JDX is designed to be fully autonomous. On ascent, a baroswitch applies power to the controller. During the first astronaut sleep period (when vehicle accelerations are minimal), the controller conducts a series of tests. During each of the 30 planned tests, one of three vibration modes of the truss is excited and the resulting vibration decay is recorded.

The JDX is conducted by the Department of Mechanical and Aerospace Engineering, Utah State University. JDX is funded by the NASA Office of Space Access and Technology through the In-Space Technology Experiments Program. Technical oversight and project administration is provided by NASA's Langley Research Center. JDX is designed to be a relatively simple and inexpensive space flight experiment and was competitively selected by NASA for its innovative approach to the study of structural dynamics in space. JDX and similar projects provide the university community with a unique opportunity to perform basic engineering science experiments in the space environment and to contribute to the nation's space expertise.

EXTRAVEHICULAR ACTIVITY DEVELOPMENT FLIGHT TEST-2

Two astronauts will leave Endeavour’s crew cabin for about six hours on the 10th day of the mission to perform several tasks that will broaden the capabilities and experience base for building and maintaining the International Space Station and for other future spacewalks.

The extravehicular activity, conducted by Mission Specialists Jim Voss and Michael Gernhardt, supports four different Detailed Test Objectives (DTOs).

DTO 833 is designed to evaluate spacesuit design modifications to protect spacewalkers from the extremely cold space environment and their ability to perform in such conditions. At the start of the EVA, one of the crewmembers will install two thermal cubes in the payload bay to collect temperature data on the space environment. One cube will be mounted on the end of the Shuttle’ s robot arm, and the other cube will be mounted at the task board worksite.

As another part of the test, engineers will collect temperature data within the spacesuit throughout the entire spacewalk. Temperature data also will be collected on modified crew garments which are designed to bypass the present Liquid Cooling Ventilation Garment.

DTO 671 consists of a number of tasks designed to evaluate and verify specific assembly and maintenance tasks for the Space Station. Each of the two EVA astronauts will spend about an hour performing a variety of tasks at a board mounted on the starboard side of the payload bay. The tasks include working with handrails, fasteners and connectors while the spacewalker is both free-floating and positioned in a fixed foot restraint. The amount of time and effort required for specific tasks also will be assessed during this time.

Throughout the EVA, any specific instructions the crew member may need will be displayed on an Electronic Cuff Checklist, which represents DTO 672. The checklist, which has been tested on two previous missions, is being flown to demonstrate its on-orbit use and to gain the experience necessary to move toward operational use.

Comments from the crewmembers on all of the tests will be evaluated as part of DTO 1210, which will help ground crews improve EVA operations.

For the spacewalk, Voss will be designated as EV1 and will have red stripes around the legs of his spacesuit, while Gernhardt will be EV2. Pilot Ken Cockrell will assist the spacewalkers from inside the crew cabin.

The spacewalk is the 30th EVA of the Shuttle program.

NATIONAL INSTITUTES OF HEALTH-CELLS 4

Effect Of Space Flight On Bone Cell Formation And Loss During Space Flight
Principal Investigator:
Dr. Russell T. Turner
Mayo Clinic
Rochester, MN

Weightlessness results in bone loss. The bone loss is similar to that which occurs in people who undergo prolonged bed rest or, in some cases, lose the use of one of their limbs due to injury or disease. The exact cause of the bone loss is not yet clear but is at least partially due to decreased activity of osteoblasts, the cells which produce the matrix which mineralizes to become bone. Weightlessness results in decreased bone formation in rodents, as well as humans. Studies performed on rats implicate a protein which is produced by bone cells and is important in the communication between cells. The gene for that protein was found to be expressed in bone at reduced level immediately following space flight but that level was dramatically increased (within 24 hours) when normal activity was reestablished after landing.

This experiment will determine if gene expression is reduced in cultured bone cells following space flight and how quickly the levels return to normal after flight. Results from this experiment will help determine the usefulness of cultured bone cells in understanding how gravity functions to maintain bone cell activity.

Osteoblasts And Bone Formation In Microgravity
Principal Investigator:
Dr. Robert Majeska
Mount Sinai School of Medicine
New York, NY

Bone loss during space flight is well documented, but remains not yet fully understood. Among the unanswered issues are the direct effects which microgravity exerts on bone cells, and the mechanisms by which these cells recognize changes in gravity. This study will focus on bone cells of the osteoblast family, which synthesize bone matrix and also may participate in its breakdown (resorption) by regulating the formation and activity of bone-resorbing cells. The experiment will test the hypothesis that microgravity can produce direct effects on osteoblastic cells similar to those of regulatory hormones. In addition, the study will examine whether microgravity alters the interaction of osteoblastic cells with their matrix, resulting in changes in shape or cellular organization known to affect cell function.

In this study, cells will be cultured in the middeck compartment of the Shuttle in the Space Tissue Loss culture device. Parallel control cultures will be maintained on Earth under identical conditions. During the flight, batches of both control and experimental cells will be fixed for analysis and samples of culture medium will be collected for biochemical changes. Following the flight, the cells will be analyzed to identify changes in shape and function. Samples of medium culture will be analyzed to identify the presence of bone matrix proteins and matrix-degrading enzymes which may participate in early stages of bone change.

The NIH-C4 payload is sponsored by NASA’s Office of Life and Microgravity Sciences and Applications and the National Institute of Arthritis and Musculoskeletal Diseases.

COMMERCIAL GENERIC BIOPROCESSING APPARATUS (CGBA- 7)

General

STS-69 will mark the seventh flight of BioServe's Commercial Generic Bioprocessing Apparatus (CGBA-7). BioServe is a NASA Center for the Commercial Development of Space based at the University of Colorado in Boulder, CO, and at Kansas State University in Manhattan, KS. The CGBA is a middeck-locker secondary payload that serves as a housing, incubator and data collection point for BioServe's Fluids Processing Apparatuses (FPAs). FPAs are multi-purpose devices that are essentially multi-chambered syringes that, upon activation, permit fluids to be mixed. After a specified period of time, the FPAs can be activated again to "fix," or stop, an experiment prior to return to Earth. CGBA-7 will support experiments in pharmaceuticals testing and biomedicine, bioprocessing and biotechnology, agriculture and the environment.

One of the strengths of the CGBA/FPA payload is that it is capable of addressing a wide variety of experimenter needs. The CGBA/FPA also has proven to be an exceptionally reliable payload: quality sample/data return rates from previous flights have exceeded 99%. Highlights of the experiments to be flown in the CGBA during the STS-69 mission include:

Bacteriorhodopsin Polymerization

(Manufacture of Uniform Three-Dimensional Polymer Matrices Containing Bacteriorhodopsin for use in Memory Architectures)

Principal Investigators: Dr. Robert Birge, Deshann Govender, Center for Molecular Electronics, University of Syracuse, NY

Bacteriorhodopsin is a protein that has promise as a data storage medium. It is hoped that access to microgravity will permit the formation of more homogenous bacteriorhodopsin polymers. During the STS-69 mission, BioServe will assist Dr. Birge of the Center for Molecular Electronics (a consortium of university and industry with interests in protein-based mass memories) in his efforts to optimize the formation of the bacteriorhodopsin matrix needed to develop the protein matrix materials needed for improved three-dimensional optical memory storage devices. Bacteriorhodopsin-based memories offer the promise of exceptionally high data storage densities for future computer applications.

Water Purification

(Disinfection of Pseudomons aeruginosa with Low Levels of Polyiodide, Silver, Copper, and Silver/Copper Resins)

Principal Investigator: Dr. George Marchin, Kansas State University.

Kansas State University's Dr. George Marchin, working with BioServe Affiliate WTC-Ecomaster (Minnesota), will determine if a combination of silver and copper resin materials will be effective in disinfecting Pseudomons bacterial contamination with applications to the microbial check valve used on the Shuttle. In addition to water purification applications in space, products developed by Dr. Marchin have already found wide use in industry for a variety of water purification applications.

Bone Cell Growth in Space

(Development, Growth and Activation of Bone Marrow Macrophages, Phase II)

Principal Investigators: Dr. Keith Chapes, Dr. A. Forsman, Dr. A. Beharka, Kansas State University

This second flight of bone marrow macrophages supports BioServe-affiliate Chiron's (Emeryville, CA) interests in two ways. First, Dr. Chapes and his colleagues seek to test whether the transcription of receptor proteins or cytokines are altered by space flight. A second goal is to determine if culturing the macrophages in an agar culture system alters cell behavior during space flight as compared to ground controls. The information gathered during this flight may contribute to Chiron's growing understanding of immune suppression. This information has application to terrestrial efforts to understand and mitigate immune-related diseases and disorders. For space flight applications, this work may result in therapies or methods that could eventually be used to reduce the risk of infection by astronauts during exposure to space flight. This ability will become progressively more important as astronauts spend more time in space.

Stabilization and Activation of Cells in Space

(CeReS-Mediated Cell Stabilization and Reversal)

Principal Investigators: Dr. Terry C. Johnson, Dr. H. Fattaey, Kansas State University

Working in collaboration with Dr. Floyd Taub of Syncrocell (Silver Spring, MD), Drs. Johnson and Fattaey have been working with a unique sialoglycopeptide that has the property of stopping the activities of cells in such a way that they can subsequently be "re-activated." The applications for space-based biological research are important: a colony of cells can be "stabilized" prior to launch, "activated" in orbit and, finally," stabilized" again prior to their return to Earth. This both accommodates launch holds and permits the cells to conduct all of their desired activities in microgravity without the confounding effects of a gravity field. The terrestrial applications for biotechnology applications and a variety of unique disease treatments may be even more significant, however. For example, it may be that desired groups of diseased or cancerous cells can be "stabilized" and subsequently "re- activated" such that drugs can be delivered to the cells when they are most receptive to them. This has the promise of increasing the effectiveness of existing drugs and therapies considerably.

Growth of Biological Crystals in Space

(Crystallization of Oligonucleotides and Proteins in Space)
Principal Investigators: Dr. Paul Todd, Dr. Michael Sportiello, University of Colorado

Working with researchers from NeXstar (Boulder, CO), Drs. Todd and Sportiello will seek to accomplish two objectives. First, they will attempt to grow large, high- quality crystals of ribonucleic acid in order to determine the three-dimensional structure. Also during the flight of a new, proprietary crystallization methodologies will be investigated which hold the promise of permitting the formation of crystals of higher quality. After the crystals are returned to Earth, they will be subjected to a variety of analysis techniques. With an understanding of the structure of the crystals in hand, researchers will then possess invaluable information that can be used for the design of new drugs.

Dr. George Morgenthaler is the Director of the BioServe CCDS. Dr. Louis Stodieck is responsible for mission management for CGBA-07.

BIOLOGICAL RESEARCH IN CANISTER - 06

Principal Investigator:
Dr. Ingrid Block
German Aerospace Research Establishment

The processing of outside signals by mammalian cells is a complex pathway, and gravity is one signal which is received by these cells. The gravity-sensing mechanism within mammalian cells has not been identified. To study this intracellular signal transmission, the Biological Research in Canister-06 (BRIC-06) payload will fly a unicellular eucaryote cell culture of slime mold (Physarum polycephalum) as a model system. The investigator will examine the cultures for specific chemical concentrations which are signs of the signal transduction process. Dr. Block has flown three previous space flight experiments and has answers to some pieces of the transduction pathway puzzle. The BRIC-06 flight will add another piece to the puzzle of how gravity is sensed within mammalian cells.

The slime mold will be housed inside 36 petri dishes which are stacked inside three aluminum canisters in the Shuttle's middeck area. On flight day-two, crew members will place one set of samples in the gaseous nitrogen freezer which will instantly fix the samples at their current state. This procedure will be repeated on flight day-three for a second set of samples. The third set of samples will remain at ambient temperature throughout the mission. Upon landing, all the samples will be removed from the Shuttle and returned to the landing site laboratory. Ambient samples then will be frozen and shipped, along with the inflight-frozen samples, to Dr. Block's laboratory in Germany.

The Biological Research in Canister payload is the sixth in a series of payloads which studies the effects of microgravity on plants, small animals, and cell cultures. The experiment is sponsored by NASA's Office of Life and Microgravity Sciences and Applications, Wash, DC.

ELECTROLYSIS PERFORMANCE IMPROVEMENT ONCEPT STUDY (EPICS)

Background

Supply of oxygen and hydrogen by electrolyzing water in space will play an important role in meeting NASA's needs and goals for future space missions.

On-board generation of oxygen is expected to reduce the annual resupply weight for the Space Station by approximately 12,000 pounds with an associated reduction in logistics costs. The oxygen generation assembly which was initially baselined for the Space Station Freedom program is the Static Feed Electrolyzer (SFE) manufactured by Life Systems, Inc. The EPICS flight experiment will demonstrate and validate the SFE electrochemical process in microgravity, as well as investigate performance improvements projected possible in a microgravity environment.

The space environment is needed for this experiment because the SFE process has not been operated in microgravity, data on gas and liquid transport in microgravity is very limited, and one-G test results are compromised by buoyancy and by gravity-affected fluid configuration within the electrolysis cells. A lower cell voltage operation may result from microgravity effects on the distribution of liquid electrolyte, the gas/liquid interfaces with the cell, and the capillary forces on fluids within the pores of the electrodes and the electrolyte matrix.

Mission Description

The EPICS experiment will examine the effects of microgravity on electrolyte distribution in the SFE electrolyte retention matrix. This will be accomplished by determining performance characteristics of electrode/matrix assemblies having different matrix thicknesses and electrode pore sizes, and operating at varying current densities. In one-G SFE operation, gravity produces an electrolyte distribution gradient and an electrolyte density gradient in the cell core. Such gradients result from the relative effects of gravity and capillary forces acting on the electrolyte solution within the cell core matrix. If a more uniform electrolyte distribution were to occur in microgravity, then a more efficient electrolysis process could result. Comparison of flight and ground test data collected under the same operating conditions will enable designers to determine if, and by how much, efficiency is enhanced in microgravity. This understanding can then be applied to the development of improved SFE designs.

The experimental hardware consists of two primary hardware assemblies:

a. Mechanical/Electrochemical Assembly (M/EA)
b. b. Control/Monitor Instrumentation (C/MI)

The M/EA contains the physical capability for conducting the EPICS experiment. It is composed of three separate, self-contained, Integrated Electrolysis Units (IEUs), ancillary components, and the enclosure. Each IEU is made up of an integrated electrolysis cell, a thermal control plate, an O_2 accumulator, and a H_2 accumulator.

The C/MI controls the operation of the experiment, provides for monitoring and control of critical parameters, and stores experimental data.

The experiment is designed to be self-contained, requiring only electrical energy and cabin air for cooling. The experiment is designed to be compatible with the weight, power, and heat rejection capability of two standard middeck locker spaces. The weight is approximately 93 lbs., and the required power is approximately 230 watts. The heat rejected to the cabin is essentially the power consumed.
The flight of the EPICS is sponsored by the NASA's Office of Space Access and Technology as part of the In-Space Technology Experiments Program. The EPICS payload is being developed by Life Systems, Inc., Cleveland, OH, and is managed by NASA's Johnson Space Center, Houston, TX.

COMMERCIAL MDA ITA EXPERIMENTS (CMIX-4)

CMIX-4 is the fourth in a five-flight program to support commercially driven biomedical research involving NASA, the University of Alabama/Huntsville (UAH) Consortium for Materials Development in Space, and Instrumentation Technology Associates, Inc. (ITA), a small business located in Exton, PA.

The Consortium's research goals for this mission include an analysis of microgravity and its effects on cell change, as prior flight experiments indicate that microgravity slows cell growth. This alteration of cell growth in microgravity may provide important insight into cell changes on Earth and may lead to therapeutic measures to counter cell growth inhibition, loss of bone mass and impaired immune function.

Research also will focus on neuro-muscular development disorders which are of interest to the industrial pharmaceutical and biotechnical research communities.

A third set of experiments will be associated with plant cell growth. Pharmaceutical products from plants have been used for treatment of various types of cancer. Plant products include vinblastine and taxol. Cultured cells from soy bean plants will be flown during this mission to assess the effect of microgravity on growth, development and production of secondary metabolites. These cells, grown in ground-based tests, produce a product with anti-colon cancer activity. Preliminary research indicates that microgravity may foster higher production of this product. Other research experiments will be conducted using the flight hardware provided by ITA.

ITA's portion of the mission concentrates on three research activities: the growth of over a dozen types of protein crystals with emphasis on urokinase protein crystals; microencapsulation of drugs; and the ITA student space education program.

The urokinase experiment is designed to grow protein crystals of urokinase for research linked to breast cancer inhibitors. If the structure of the urokinase protein crystal can be established, an inhibitor drug can be developed to combat breast cancer metastasis. To date, no ground-based research effort has provided urokinase crystals of sufficient size to effectively analyze. It is anticipated that the microgravity environment will enable urokinase protein crystals to be developed with sufficient size and uniformity of structure to be analyzed.

ITA also is working with its partners to explore microencapsulation of drugs (a drug delivery system) to better target the intervention area of tumors without affecting surrounding healthy tissues. These research efforts have considerable potential for the pharmaceutical industry and medical provider community.

A third major effort is ITA's student space experiment outreach program which donates a percentage of the CMIX payload flight hardware and technical support to selected university and high school projects as a means of fostering an interest in the field of space technology. ITA also will have other experiments including an assessment of properties of collagen fibrils grown in space.

This ambitious experiment activity is accomplished through an innovative exchange agreement between NASA and UAH, with a corresponding agreement between UAH and ITA. In exchange for the flight opportunities, ITA provides 50 percent of its privately developed Materials Dispersion Apparatus (MDA) flight hardware capacity to the UAH researchers. ITA markets half of its hardware commercially and provides a turn-key space processing, hardware and payload integration service to domestic and international users, including private sector companies, universities and research institutions. In addition, ITA conducts its own corporate biomedical research projects. This mission will also use Liquid Mixing Apparatus developed by ITA, and BioProcessing Modules provided by UAH. Some of these units will be contained within the Commercial Refrigerator Incubator Module. Others will be located in a separate storage pouch. This configuration of material and fluid mixing flight equipment enables hundreds of separate experiment samples to be flown within a single middeck locker.

A number of researchers will take part in this mission for UAH experiments, including Dr. Millie Hughes-Fulford, University of California at San Francisco; Dr. Mary Ann Priniapato, U.S. Food and Drug Administration; Dr. Edward Piepmeier, University of South Carolina; Dr. Raphael Gruener, University of Arizona; and Dr. Peter Kaufman, University of Michigan. These researchers are collaborating with Dr. Marian Lewis of UAH. ITA research projects and commercial users include two U.S. cancer centers, four U.S. corporations, a JSC researcher, four U.S. universities/research institutions, several international university research organizations including Canada and Germany (INTOSPACE) and one high school.

STS-69 CREWMEMBERS

STS069-S-002 -- These five NASA astronauts have been named as crew members for the STS-69 mission, scheduled onboard the Space Shuttle Endeavour in late July of 1995. David M. Walker (right front) is mission commander; with Kenneth D. Cockrell (left front) scheduled to serve as pilot. On the back row are (left to right) Michael L. Gernhardt and James H. Newman, both mission specialists; and James S. Voss, payload commander.

PHOTO CREDIT: NASA or National Aeronautics and Space Administration.

BIOGRAPHICAL DATA

DAVID M. WALKER , a three-time shuttle veteran will command Endeavour's ninth mission. A captain in the United States Navy, Walker, 51, was born in Columbus, GA, but considers Eustis, FL., to be his hometown. He received a bachelor's degree from the U.S. Naval Academy in 1966. After graduating from Annapolis, Walker received flight training from the Naval Aviation Training Command at bases in Florida, Mississippi and Texas. He was designated a naval aviator in December 1967 and proceeded to Naval Air Station Miramar, CA, for assignment to F-4 Phantoms aboard the carriers USS Enterprise and USS America. From December 1970 to 1971, he attended the USAF Aerospace Research Pilot School at Edwards Air Force Base, CA.

Selected as an astronaut in January 1978, Walker has logged a total of 464 hours in space. His first flight was as pilot of STS-51A in 1984. During that mission, crew members deployed Canada's Anik D-2 satellite and Hughes' LEASAT-1 satellite, and carried the first space salvage mission by retrieving the Palapa B-2 and Westar VI satellites for return to Earth.

Walker's second mission was STS-30 in May 1989. The highlight of the four-day mission was the deployment of the Magellan probe. Most recently, he commanded STS-53 in November/December 1992. The crew of five deployed a classified Department of Defense payload and then performed several Military-Man-In-Space and NASA experiments.

KENNETH D. COCKRELL, a native of Austin, TX, will serve as the STS-69 pilot. Cockrell, 45, received a bachelor's degree in mechanical engineering from the University of Texas in 1972, and a master's degree in aeronautical systems from the University of West Florida in 1974.

Cockrell received his commission through the Naval Aviation Reserve Officer Candidate Program at Naval Air Station at Pensacola, FL, in December 1972. He was designated a naval aviator in August 1974. Cockrell resigned his commission in 1987 to join the Johnson Space Center as an aerospace engineer and research pilot at Ellington Field, Houston, serving as an instructor pilot and functional check pilot in NASA T-38 aircraft.

Selected as an astronaut candidate in January 1990, Cockrell has had a variety of technical assignments including serving in the Astronaut Office's Operations Development Branch; working on landing, roll-out, tires and brake issues; and serving as CAPCOM in the Mission Control Center for ascent and entry.

Cockrell's first space flight in April 1993 was STS-56, the ATLAS-2 mission. During the nine-day flight, the crew conducted atmospheric and solar studies in order to better understand the effect of solar activity on the Earth's climate and environment.

JAMES S. VOSS, an Army Lieutenant Colonel will be Mission Specialist-1 and Payload Commander for the flight.

Voss, 46, was born in Cordova, AL, but considers Opelika, AL, to be his hometown. He has a bachelor's degree in aerospace engineering from Auburn University in 1972 and a master's degree in aerospace engineering sciences from the University of Colorado in 1974.

Upon graduation from Auburn and commissioning as a 2nd Lieutenant, Voss went directly to the University of Colorado to obtain his master's degree under the Army Graduate Fellowship Program. After attending the U.S. Naval Test Pilot School at the Armed Forces Staff College, Voss was assigned to the U.S. Army Aviation Engineering Flight Activity as a Flight Test Engineer/Research and Development Coordinator. He was involved in several major flight test projects before being detailed to the Johnson Space Center.
Voss began working at Johnson in 1984 as a Vehicle Integration Test Engineer. He participated in the STS 51-L accident investigation and supported the resulting reviews dedicated to returning the Space Shuttle safely to flight. He was selected as an astronaut in 1987, and is now a veteran of two Shuttle flights. His first mission, STS-44 in November 1991, included the deployment of a Defense Support Program satellite with an Inertial Upper Stage booster. His second mission was STS-52 in December 1992 during which a classified Department of Defense payload was deployed. He has logged more than 340 hours in space.

JIM NEWMAN, Ph.D., 38, will serve as Mission Specialist 2. Born in the Trust Territory of the Pacific Islands, Newman considers San Diego, CA, to be his hometown. He graduated cum laude with a bachelor’s degree in physics from Dartmouth College in 1978. He received a master’s and a doctorate in physics from Rice University in 1982 and 1984, respectively. After graduating from Rice, Newman did an additional year of post-doctoral work at Rice before being appointed as an adjunct assistant professor in the Department of Space Physics and Astronomy at the university. That same year, he came to work at Johnson where he conducted flight crew and flight control team training for all mission phases in the areas of Orbiter propulsion, guidance and control. He was working as a simulation supervisor when selected for the astronaut program in 1990.

STS-69 will be Newman’s second flight. His first mission was STS-51 in September 1993. During the 10-day flight, crew members deployed the advanced Communications Technology Satellite and the Orbiting and Retrievable Far and Extreme Ultraviolet Spectrometer on the Shuttle Pallet (SPAS) Satellite. Newman was responsible for SPAS operations and conducted a seven-hour spacewalk. He has logged 236 hours in space.

MICHAEL L. GERNHARDT, Ph.D., 39, will serve as Mission Specialist 3 for the STS-69 crew. Born in Mansfield, OH, Gernhardt received a bachelor’s degree in physics from Vanderbilt University in 1978, and master’s and doctorate degrees in bioengineering from the University of Pennsylvania in 1983 and 1991, respectively.

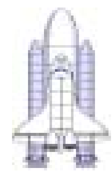
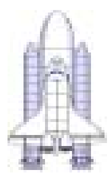
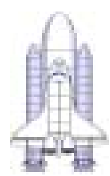
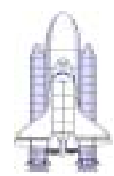
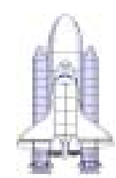
From 1977 to 1984, Gernhardt worked as a professional deep sea diver and project engineer on a variety of subsea oil field construction and repair projects around the world. He has logged more than 700 deep sea dives and has experience in air, mixed gas, bounce bell and saturation diving.

In 1988, he founded Oceaneering Space Systems, a wholly- owned subsidiary of Oceaneering International. Until his selection by NASA in 1992, he worked on the development of new astronaut and robot-compatible tools for performing maintenance on the Space Station. He also worked on the development of new portable life support systems and decompression procedures for extravehicular activities.

Since coming to NASA, Gernhardt has been detailed to the Shuttle Avionics Laboratory, supported training for the Hubble Space Telescope servicing mission and has worked on a variety of Space Station EVA developments. STS-69 will be his first space flight.

SHUTTLE FLIGHTS AS OF AUGUST 1995

70 TOTAL FLIGHTS OF THE SHUTTLE SYSTEM -- 45 SINCE RETURN TO FLIGHT

		STS-70 07/13/95 - 07/22/95		
		STS-63 02/03/95 - 02/11/95		
		STS-64 09/09/94 - 09/20/94		
		STS-60 02/03/94 - -2/11/94		
STS-65 07/08/94 0 07/23/94		STS-51 09/12/93 - 09/22/93		
STS-62 03/04/94 - 03/18/94		STS-56 04/08/83 - 04/17/93		
STS-58 10/18/93 - 11/01/93		STS-53 12/02/92 - 12/09/92		
STS-55 04/26/93 - 05/06/93		STS-42 01/22/92 - 01/30/92	STS-71 06/27/95 - 07/07/95	
STS-52 10/22/92 - 11/01/92		STS-48 09/12/91 - 09/18/91	STS-66 11/03/94 - 11/14/94	
STS-50 06/25/92 - 07/09/92		STS-39 04/28/91 - 05/06/91	STS-46 07/31/92 - 08/08/92	
STS-40 06/05/91 - 06/14/91		STS-41 10/06/90 - 10/10/90	STS-45 03/24/92 - 04/02/92	
STS-35 12/02/90 - 12/10/90	STS-51L 01/28/86	STS-31 04/24/90 - 04/29/90	STS-44 11/24/91 - 12/01/91	
STS-32 01/09/90 - 01/20/90	STS-61A 10/30/85 - 11/06/85	STS-33 11/22/89 - 11/27/89	STS-43 08/02/91 - 08/11/91	
STS-28 08/08/89 - 08/13/89	STS-51F 07/29/85 - 08/06/85	STS-29 03/13/89 - 03/18/89	STS-37 04/05/91 - 04/11/91	STS-67 03/02/95 - 03/18/95
STS-61C 01/12/86 - 01/18/86	STS-51B 04/29/85 - 05/06/85	STS-26 09/29/88 - 10/03/88	STS-38 11/15/90 - 11/20/90	STS-68 09/30/94 - 10/11/94
STS-9 11/28/83 - 12/08/83	STS-41G 10/05/84 - 10/13/84	STS-51-I 08/27/85 - 09/03/85	STS-36 02/28/90 - 03/04/90	STS-59 04/09/94 - 04/20/94
STS-5 11/11/82 - 11/16/82	STS-41C 04/06/84 - 04/13/84	STS-51G 06/17/85 - 06/24/85	STS-34 10/18/89 - 10/23/89	STS-61 12/02/93 - 12/13/93
STS-4 06/27/82 - 07/04/82	STS-41B 02/03/84 - 02/11/84	STS-51D 04/12/85 - 04/19/85	STS-30 05/04/89 - 05/08/89	STS-57 06/21/93 - 07/01/93
STS-3 03/22/82 - 03/30/82	STS-8 08/30/83 - 09/05/83	STS-51C 01/24/85 - 01/27/85	STS-27 12/02/88 - 12/06/88	STS-54 01/13/93 - 01/19/93
STS-2 11/12/81 - 11/14/81	STS-7 06/18/83 - 06/24/83	STS-51A 11/08/84 - 11/16/84	STS-61B 11/26/85 - 12/03/85	STS-47 09/12/92 - 09/20/92
STS-1 04/12/81 - 04/14/81	STS-6 04/04/83 - 04/09/83	STS-41D 08/30/84 - 09/05/84	STS-51J 10/03/85 - 10/07/85	STS-49 05/07/92 - 05/16/92
OV-102 **Columbia** **(17 flights)**	**OV-099** **Challenger** **(10 flights)**	**OV-103** **Discovery** **(21 flights)**	**OV-104** **Atlantis** **(14 flights)**	**OV-105** **Endeavour** **(8 flights)**