NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

SPACE SHUTTLE MISSION STS-55

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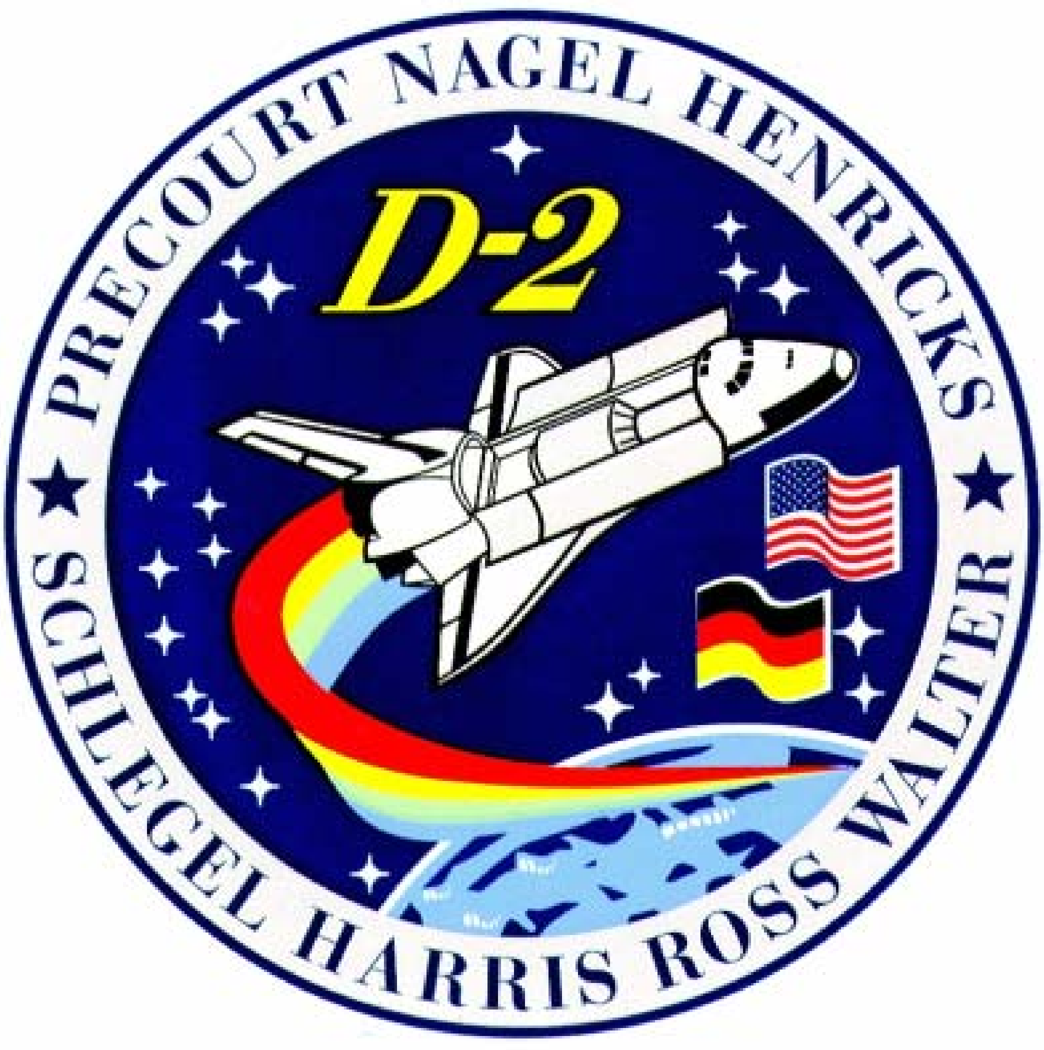

SECOND GERMAN SPACELAB MISSION/SPACELAB D-2

STS-55 INSIGNIA

STS055-S-001 -- *Designed by the flight crewmembers, the insignia for the STS-55 mission displays the space shuttle orbiter Columbia over an Earth-sky background. This mission is the second dedicated German (Deutsche) Spacelab flight and has accordingly been designated D-2. Depicted beneath the orbiter are the American and German flags flying together, representing the partnership of this laboratory mission. The two blue stars in the border bearing the crewmembers' names signify each of the alternate payload specialists, Gerhard Thiele and Renate Brummer. The stars in the sky stand for each of the children of the crewmembers in symbolic representation of the space program's legacy to future generations. The rainbow symbolizes the hope for a brighter tomorrow because of the knowledge and technologies gained from this mission's multi-faceted experiments.*

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

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RELEASE: 93-20 **February 1993**

SECOND GERMAN SPACELAB MISSION IS SPACE SHUTTLE'S 54TH FLIGHT

The 54th flight of the Space Shuttle will be devoted primarily to Germany for conducting a wide range of experiments in the microgravity environment of space flight.

Columbia, the flagship of the Shuttle fleet, will make its 14th voyage into Earth orbit carrying a crew of seven, including two German payload specialists. STS-55's primary payload is Spacelab D2, for the second Shuttle mission dedicated to Germany. Spacelab D1 was flown in 1985. Spacelab is a self-contained, space-based research laboratory carried inside the Shuttle's 60- foot-long cargo bay.

The seven member crew is a mix of veterans and first-time space travelers. Commander Steve Nagel and mission specialist Jerry Ross will both be making their 4th trip into orbit. STS-55 will mark Pilot Tom Henricks' second flight. Mission specialist Charles Precourt and Bernard Harris will be making their first space flights, as will the two German payload specialists Ulrich Walter and Hans Schlegel.

Mission management resides in the German Aerospace Research Establishment (DLR), the scientific program responsibility in the German Space Agency (DARA). Payload control and operation during the mission are handled by DLR's Space Operation Control Center (GSOC) at Oberpfaffenhofen near Munich, Germany.

Columbia is scheduled to be launched from the Kennedy Space Center (KSC), Fla., in late February. The mission is planned for 9 days with a landing at KSC.

Some 90 experiments are planned during the mission. The 7- member crew will be divided into two teams, red and blue, so that science operations can be carried out around the clock.

Most of the experiments have been provided by the German Space Agency and the European Space Agency (ESA). Japan has provided a number of experiments, and NASA is furnishing 3 experiments for this mission.

In addition to developing the concept of Spacelab itself, ESA will fly a total of 21 experiments. and participate in 11 experiments. Five are contained in the Advanced Fluid Physics Module and 19 are placed in the unique equipment facility, called Anthrorack, for human physiological research in microgravity. Six other experiments are in the field of materials synthesis and two flight experiments are for the future Columbus Attached Pressurized Module, which will form part of the international Space Station Freedom.

NASA also is flying its "ham" radio experiment, SAREX, which will enable Nagel and Ross to talk to schools and amateur radio enthusiasts on the ground. Both German payload specialists are licensed ham radio operators as well and will be operating their own ham system called SAFEX.

One payload that had been manifested on STS-55, BREMSAT, was removed prior to launch and will be reflown later this year. The payload was to have been deployed into space from a getaway special canister (GAS) to detect micrometeorites in near-Earth orbit and to measure cosmic dust. NASA mangers delayed the flight of the BREMSAT because problems with another GAS-deployed payload flown on STS-53 have not been satisfactorily resolved.

Most of the Spacelab D2 experiments will explore the behavior of humans, other living organisms and materials when the force of gravity is essentially removed.

"Our scientific methods, like our everyday behavior, are governed by a natural condition - the effect of gravity," said DLR's Spacelab D2 Project Manager Dr. Hauke Dodeck. "Objects fall down, lighter materials float or are carried upwards, heavier ones sink to the bottom.

"What happens to these processes when there is no gravitational force, in other words: no sedimentation, no thermal convection, no hydrostatic pressure? What new mixtures, structures and forms are possible?" he posed. "Concrete answers to such questions can be given only by space research."

D2 experiments will be carried out in 6 major scientific disciplines: materials sciences, biological sciences, technology, Earth observations, atmospheric physics and astronomy. Most of the experiments are contained in racks, about the size of a side- by-side refrigerator, inside the Spacelab module. A special fixture, called the Unique Support Structure, has been placed in Columbia's cargo bay. Astronomy, Earth-observing instruments and materials which require direct exposure to space are mounted to this structure.

In the materials sciences field, among the experiments to be performed are those involved in growing semiconductor materials. For this mission, the material will be gallium arsenide - a semiconductor of great importance for electronic applications. The objective is to produce crystals of high quality and large size. It is expected that the results will contribute to the improvement of terrestrial crystal growth methods.

The Material Sciences Laboratory will be the site for experiments on alloys and for experiments which use the microgravity environment to produce single-crystal bodies of a shape similar to a turbine blade.

"If the tests produce the hoped-for results," said Dodeck, "turbine blades can be developed which are strongly resistant to heat and stress, thereby improving the performance and lifetime of aircraft engines."

An experimental facility called the Holographical Optical Laboratory (HOLOP) will use holography to gain insight into processes of heat and mass transfer and of cooling in transparent materials which are of great interest for research into metallurgy and casting.

"HOLOP will transmit video pictures of experiments to the ground while they are being performed," Dodeck explained. "Scientists on Earth can not only watch what happens, but also may intervene in the test sequence, thus demonstrating a concept called telescience." The telescience experiment will be carried out from DLR's Microgravity Life Support Center (MUSC) at Cologne- Porz.

Other experiments will focus on protein crystal growth and biology. One experiment will use electrical impulses in an attempt to fuse cells to create hybrids. The results will advance both basic and applied research.

An experiment called the Statolith Experiment will study the development of balance-sensing organs in tadpoles of the South American clawed frog and larvae of a type of colored perch. An understanding of how those sensors develop, when not influenced by gravity, could lead to new insights into the causes of space sickness.

"D2 will use the human body as a test subject," said Dodeck. "A special medical research facility on this flight, called Anthrorack, is the most advanced of its type which has flown in space."

Some 20 different experiments will be performed in the facility, ranging from investigations on body organs and their controlling mechanisms, control of heart and blood circulation, to the functions of the lungs. In addition, a multitude of physiological processes will be observed.

A robotic technology experiment, called ROTEX, will gather basic experience on how a robot can operate in microgravity. A robot arm with 6 joints will perform a variety of tasks, including building a small tower of cubes and retrieving a small object floating in space. The robot can be operated from onboard or by scientists on the ground. Both modes will be tested.

Investigations on the effects of radiation upon organisms also will be studied. Astronauts will wear radiation detectors. Other detectors will be placed near biological experiments as control indicators. The results will contribute to the assessment of the biological effects of specific cosmic radiation, which will help reduce the health risks for future missions.

Part of the ongoing preparations for the assembly and operation of Space Station Freedom, over 200 samples of different materials will be placed on the support structure in the payload bay to gather data on interaction with atomic oxygen. The goal is to examine how different materials - polymers, compounds and organic films - stand up to atomic oxygen which is of keen interest to builders of the orbiting outpost which will be in space at least 3 decades.

Another instrument mounted outside, called MOMS, will obtain data to enable topographical maps to be produced by automatic data evaluation processes for the first time. A spherical mirror camera, GAUSS, which also is fixed to the payload bay structure, will take pictures in six spectral bands of all parts of the Milky Way, thereby extending the knowledge of the galaxy.

(END OF GENERAL RELEASE; BACKGROUND INFORMATION FOLLOWS.)

STS-55 MEDIA SERVICES INFORMATION

NASA Select Television Transmissions

NASA Select television is available on Satcom F-2R, Transponder 13, located at 72 degrees west longitude; frequency 3960.0 MHz, audio 6.8 MHz.

The schedule for television transmissions from the Shuttle orbiter and for the mission briefings will be available during the mission at Kennedy Space Center, Fla.; Marshall Space Flight Center, Huntsville; Ames-Dryden Flight Research Facility, Edwards, Calif.; Johnson Space Center, Houston, and NASA Headquarters, Washington, D.C. The television schedule will be updated to reflect changes dictated by mission operations.

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

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 science team will occur at least once per day. The updated NASA Select television schedule will indicate when mission briefings are planned.

D2 NEWSROOM OPERATIONS

A D2 mission news center will be established at DLR's Operations Control Center/German Space Operations Center (GSOC) at Oberpfaffenhofen, where mission science operations will be controlled. Media work space and facilities will be available on a limited basis and will be allocated on a daily first-come, first-served basis.

News media planning to cover the mission from the D2 news center should contact DLR's Public Affairs Office, Linder Hohe, 5000 Koln-Porz, by writing or sending a request via fax at (02203) 601-3249.

Operating Hours

The D2 news center will be open from 9 a.m. until 6 p.m. local time. Media which plan mission related reports early in the morning will have access to the news center and will be provided with pertinent information. Media will have access to mission timing and tracking displays.

Staffing

The D2 news center will be staffed by DLR public affairs officers, by public affairs officers representing the German Space Agency, the European Space agency, the German space industry, NASA and other experts. An interview desk in the news center will arrange and schedule interviews with mission participants.

Briefings, Status Reports And Press Releases

D2 status briefings will originate from the D2 news center at 12:30 p.m. local time, daily throughout the mission. Status reports and press releases in German will be issued once daily at 1 p.m. local time. English translations will be provided soon after release.

Mission Television

Coverage emanating from GSOC will include television from Spacelab and Space Shuttle and its payload bay and from the Payload Control Rooms in Oberpfaffenhofen and special programming. Special programming includes video highlights as well as comments and interviews by mission participants.

The "All-TV" program will originate from GSOC and will be distributed by Deutsche Bundespost/Telekom. "All-TV" is available on DFS Kopernikus 2, Transponder A2, located at 28.5 degrees, best downlink frequency 11.525 GHz. The transmission is scheduled from 11 a.m. to 5 p.m.

STS-55 QUICK LOOK

Launch Date/Site:	Feb. 25, 1993/Kennedy Space Center, FL, Pad 39A
Launch Time:	10:20 a.m. EST
Orbiter:	Columbia (OV-102) - 14th Flight
Orbit/Inclination:	160 nautical miles/28.45 degrees
Mission Duration:	8 days, 22 hours, 2 minutes
Landing Time/Date:	8:25 a.m. EST/March 6, 1993
Primary Landing Site:	Kennedy Space Center, Fla.
Abort Landing Sites:	Return to Launch Site - Kennedy Space Center, FL Transatlantic Abort - Banjul, The Gambia Ben Guerir, Morocco Moron, Spain Abort Once Around - Edwards AFB, CA Kennedy Space Center, FL White Sands, NM
Crew:	Steve Nagel, Commander (CDR) Tom Henricks, Pilot (PLT) Jerry Ross, Mission Specialist 1 (MS1) Charles Precourt, Mission Specialist 2 (MS2) Bernard Harris Jr., Mission Specialist 3 (MS3) Ulrich Walter, Payload Specialist 1 (PS1) Hans W. Schlegel, Payload Specialist 2 (PS2) Blue Team: Nagel, Henricks, Ross, Walter Red Team: Precourt, Harris, Schlegel
Cargo Bay Payloads:	Spacelab D2 Reaction Kinetic in Glass Melts GAS
In-Cabin Payloads:	Shuttle Amateur Radio Experiment-II

STS-55 ORBITAL EVENTS SUMMARY

Event	Elapsed Time	Velocity Change	Orbit (n. mi.)
Launch	00/00:00:00	N/A	N/A
OMS-2	00/00:42:00	220.9 fps	160 x 162
Deorbit	08/21:05:00	TBD	N/A
Landing	08/22:05:00	N/A	N/A

STS-55 VEHICLE AND PAYLOAD WEIGHTS

	Pounds
Orbiter (Columbia) empty and 3 SSMEs	181,034
Spacelab D-2	25,025
RKGM	200
RKGM GAS Support Equipment	190
SAREX-II	24
Total Vehicle at SRB Ignition	4,518,724
Orbiter Landing Weight	227,494

STS-55 SUMMARY TIMELINE

Flight Day 1
Launch
OMS-2
Spacelab-D2 activation

Flight Day 2
Spacelab-D2 operations
SAREX-II set-up

Flight Day 3
Checkout
Spacelab-D2 operations

Flight Day 4
Spacelab-D2 operations

Flight Day 5
Spacelab-D2 operations

Flight Day 6
Spacelab-D2 operations

Flight Day 7
Spacelab-D2 operations

Flight Day 8
Spacelab-D2 operations
Reaction Control System
hot-fire
Control Systems

Medical DSOs

Flight Day 10
SAREX deactivation
Spacelab-D2
deactivation
Cabin stow
Deorbit burn
Entry
Landing

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 include:

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

- Abort-Once-Around (AOA) -- Earlier main engine shutdown with the capability to allow one orbit around before landing at either Edwards Air Force Base, Calif., White Sands Space Harbor, N.M., or the Shuttle Landing Facility at the Kennedy Space Center, Fla.

- Trans-Atlantic 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, without enough energy to reach Banjul, would result in a pitch around and thrust back toward KSC until within gliding distance of the Shuttle Landing Facility.

STS-55 contingency landing sites are Edwards Air Force Base, the Kennedy Space Center, White Sands Space Harbor, Banjul, Ben Guerir and Moron.

SPACELAB D2

Overview

The Spacelab D2 mission is the second under German mission management and responsibility. The D1 mission was conducted in November 1985 with German and European astronauts on board.

Besides continuing research areas and scientific experiments from D1, the D2 mission will be multi-disciplinary covering the fields of materials and life sciences mainly dedicated to micro-g research and also to technology, automation, robotics and Earth and space observations. Both the D1 and D2 missions are the only two Spacelab missions with payload operations control from foreign countries. Mission management resides in the German Research Aerospace Establishment (DLR) and program management in the German Space Agency (DARA). Tasks performed by DLR are training of astronauts, flight planning and flight operations and payload control and operations. Some 16 experiments are furnished by DLR, covering the fields of material sciences, life sciences, robotics (ROTEX) and earth observation (MOMS-02). DASA/ERNO Raumfahrttechnik is responsible for payload integration, including preparation, corresponding tests and mission support. The experimental program of the D2 mission is oriented towards the goals of the space utilization program of the Federal Republic of Germany and also of the microgravity program of ESA. D2 includes some 90 experiments ranging from investigations of the dynamics of the solidification boundary to the electrofusion of cells. Numerous universities, research institutes and industrial concerns in Germany and other countries, contribute to the scientific experimental program.

The cooperation with NASA goes beyond the provision of the Shuttle/Spacelab System. The experiment Baroreflex and two further investigations are supported by the U.S. agency. Furthermore ESA, CNES (France) and MITI (Japan) are taking part in the mission. To guarantee that the D2 mission goes successfully, the payload specialists and the flight operations crew have been prepared for their tasks under "real" conditions. The cooperation between the astronauts in space and the experts on Earth has been practiced within the framework of these "integrated simulations", as they are known.

For this purpose, the astronauts were "on board" the DLR Spacelab simulator in Cologne-Porz, while the ground teams were in the DLR Space Operation Control Center in Oberpfaffenhofen. "Shuttle" and "ground" worked round-the-clock in two 12-hour shifts. Voice communication was by radio, as during the real flight. DLR's Control Center at Oberpfaffenhofen offers scientific spaceflight a modern ground system that allows control of all the experiments. During the D1 mission, some still had to be monitored from Houston because the data transmission capacity was insufficient at that time. However, it has been expanded considerably since then, and the data transmitted via satellite are now received by ground stations on the premises of the DLR and then forwarded to the computer installations in the Control Center.

Once the data have been edited and stored, they are distributed to the computers of the experimenters in the user control rooms in real-time mode. The main data stream is forwarded to the processing system of the Control Center. It is there that telemetry and telecommand data processing, mission planning and timeline compilation are handled, as well as distribution of the roughly 10,000 parameters to the workstations in the control and user rooms.

Payload Operations

The task "payload operations" covers all activities for operation of the payload, i.e. the experiments on board and the support from ground control during the preparation and execution of the D2 mission. A large variety of activities are included: The responsibility to operate the payload lies within the German Aerospace Research Establishment (DLR). This means that the D2 mission will be executed from two different agencies, NASA and DLR, and from two different countries, the United States and Germany. The Mission Control Center (MCC) in Houston and the German Space Operations Center (GSOC) at Oberpfaffenhofen near Munich are supporting the mission in close cooperation.

In GSOC is located the mission operation support team which includes all the experimenters/investigators and their technical industrial support. The cadre team directs the entire payload and is split into several subteams responsible for real time mission execution, replanning efforts and communication (data, voice, TV). In case of anomalies, experimenters and cadre team together to work out a solution that the astronauts in orbit will execute. The astronauts in orbit will work in two shifts around the clock, so GSOC and MCC are staffed for 24 hours a day during the 9-day mission. Three voice loops, data channels and TV channels are available between the orbiter/Spacelab and the two control centers. For communication between the two control centers, 19 voice loops, data lines, TV-lines and fax lines will be used via different satellite systems.

SPACELAB D2 PAYLOADS

MATERIAL SCIENCES EXPERIMENT DOUBLE RACK FOR EXPERIMENT MODULES AND APPARATUS (MEDEA)

Material Sciences Experiment Double Rack for Experiment Modules and Apparatus (MEDEA) MEDEA is located in rack 3 of the Spacelab module and accommodates three different experiment furnace facilities. These furnaces are the Elliptical Mirror Furnace (ELLI), the Gradient Furnace (GFQ) and the High Precision Thermostat (HPT).

The Elliptical Mirror Furnace is used for long-term crystallization experiments performed in microgravity. Crystal growth is established by moving the sample along the main axis of the furnace traversing the focus. The Gradient Furnace studies material processing in microgravity by direct solidification methods using metallic crystals grown at high temperatures. The High Precision Thermostat investigates critical phenomena of metals under precisely controlled temperature conditions.

Experiments

- FLOATING-ZONE-GROWTH OF GaAs

GaAs is the most important material for high-speed electronic circuits, especially optoelectronic devices. Under 1g, only crystals of a few mm in diameter can be grown due to the unfavorable ratio of density to surface tension. In the D2 experiment, a crystal of 20 mm diameter will be crystallized, allowing a quantitative evaluation of the expected reduction of the structural defects in comparison with CZ- or Bridgman-grown material.

- FLOATING ZONE CRYSTAL GROWTH OF GALLIUM-DOPED GERMANIUM

In-situ Seebeck measurements will be used to control non- stationary thermocapillary-driven flows during floating zone crystal growth of gallium doped germanium. With the first sample, the influence of growth parameters will be investigated through several runs. The results will be used to optimize the processing parameters for the second sample. Quantitative post- flight analysis of convective effects will be made through extensive measurements of micro- and macro-segregations.

- HYSTERESIS OF THE SPECIFIC HEAT CV DURING HEATING AND COOLING THROUGH THE CRITICAL POINT

During the D2 mission, CV will be measured while heating and cooling the test substance SF6 through the critical state to investigate relaxational effects. These are considered to be the dominant mechanism for the surprising results of the CV- measurements during the D1 mission. A new spherical cell, housed in the slightly refurbished High Precision Thermostat, is heated and cooled only by radiation from the surrounding shell. CV is determined by the temperature difference between the cell and the shell. Additionally, the temperature field in the fluid is measured by several thermistors to help answer the open question of the temperature equilibration at the critical point. On line data processing during the mission provides the possibility of changing the experiment timeline if necessary.

- DIFFUSION OF NICKEL IN LIQUID COPPER-ALUMINUM AND COPPER-GOLD ALLOYS

The diffusion of nickel in liquid Cu-Al and Cu-Au alloys will be observed at 1150 1/2 C under minimized influences of convection. The aim of this work is to determine the diffusion coefficient of nickel with respect to the concentration of the solute atoms Al and Au. The concentration of the solute atoms is ranging from 0 to 5.5 at percent.

- DIRECTIONAL SOLIDIFICATION OF GE/GaAs EUTECTIC COMPOSITES

The eutectic melt in Ge-GaAs solidifies into the layered structures having varied composition of the sub-micron thickness. The microstructures thus formed are compared in the light of the effects of gravity during unidirectional solidification.

- CELLULAR-DENDRITIC SOLIDIFICATION WITH QUENCHING OF ALUMINUM-LITHIUM ALLOYS

Critical microgravity experiments in the cellular and dendritic regimes will be carried out on aluminum-lithium alloys. Quenching at the end of the experiments will retain the tip radius and the microsegregation. Reliable data for 3D-solidification with pure diffusion in the liquid phase thus will be obtained, which will be used to test the theories of pattern formation and selection, especially of the primary spacing. The comparison with 1-g samples will enable the effects of convection to be evidenced. *Directional Solidification of a Cu-Mn alloy Three experiment runs of directional solidification of a Cu- Mn alloy under low gravity will be used to investigate the transition from diffusive to diffusive-convective transport within the melt in front of a planar moving solidification interface. The thermosolutal instable system also will be used to study the onset of convection with increasing instability produced by the solidification parameters and to analyze the impact of g-jitters on the transport mechanisms and the concentration of the solidified crystal. Microanalysis of the concentration of the solid will be done afterwards on metallographic cross sections and the determined variations will be correlated to the different variations of the experiment parameters.

- THERMOCONVECTION AT DENDRITIC-EUTECTIC SOLIDIFICATION OF AN AL-SI ALLOY

Following the D1 experiments with an Al-Si alloy, the influence of the silicon content and the crystallization parameters on the dendrite morphology and eutectic microstructure is investigated utilizing a close eutectic aluminum-silicon alloy.

- GROWTH OF GaAs FROM GALLIUM SOLUTIONS

The aim of this experiment is to improve the crystal quality by investigating the following objectives under reduced gravity as well as under Earth conditions: - dopant inhomogeneities on the macro and micro scale - crystal perfection with respect to low defect density and the distribution of defects - crystal perfection with respect to stoichiometry and residual impurity concentration - studies of the influence of different transport phenomena in the solution - studies of growth kinetics and mechanisms of dopant incorporation

WERKSTOFFLABOR (WL) MATERIAL SCIENCES LABORATORY

Located in rack 8, this facility consists of five furnaces, a fluid physics module and a crystal growth module. The experiments study several areas of metal processing, crystal growth for electronics applications, fluid boundary surfaces and transport phenomena.

Facilities

Isothermal Heating Facility (IHF) is a high temperature furnace used to process metal samples that investigate a variety of topics.

Heater Facility, Turbine Blade Facility (HFT) is designed for processing special metallic alloys. The samples as processed and solidified under microgravity conditions and cast into the shape of turbine blades.

Gradient Heating Facility (GHF) provides the necessary heating and cooling for experiments investigating crystal growth, melting solidification and eutetics.

Advanced Fluid Physics Module (AFPM) is a multipurpose facility designed to enable investigations on the behavior of fluids in a microgravity environment. AFPM is an improved version of units flown on Spacelab 1 in 1983 and D1 in 1985. High Temperature Thermostat (HTT and HTS), which consists of two identical furnaces, were developed to study diffusion processes in liquid metals under microgravity conditions.

Cryostat (CRY) attempts to grow high-quality crystals of biochemical macromolecules by diffusion of protein into corresponding saline solutions.

Experiments

- OSIRIS: OXIDE DISPERSION STRENGTHENED SINGLE CRYSTALLINE ALLOYS IMPROVED BY RESOLIDIFICATION IN SPACE

The experiment shall prove that, with an extensive elimination of the terrestrial gravity field, a single crystalline material can be produced with a finely distributed particle inclusion. The intended matrix material is a nickel- based alloy, which is to be solidified with a dispersion of yttrium oxide particles. Due to the application-oriented objectives of the project, turbine blade-shaped sample will be processed. For the remelting of shaped material, a ceramic mold skin will be applied. An important role plays the computer-assisted simulation of the ground and flight experiments. The time-dependent crystallization parameters in the system furnace/sample are evaluated 3-dimensionally.

- IMPURITY TRANSPORT AND DIFFUSION IN InSb MELT UNDER MICROGRAVITY ENVIRONMENT

Impurity diffusion experiment for compound semiconductor, InSb, melt will use the Isothermal Heating Facility (IHF) in the D2 mission. Impurity transport and diffusion behavior in the micro-g environment will be studied using the diffusion couple method where Zn, Ga, As, Se and Te are to be selected as the impurity species. The diameter effects and the temperature dependency on diffusion will be seen in addition to the function of plug structure located at the diffusion couple edges, which is aimed to compensate the material volume change upon solid-liquid phase transformation.

- CELLULAR-DENDRITIC SOLIDIFICATION AT LOW RATE OF ALUMINUM-LITHIUM ALLOYS

Under diffusive conditions, the deep cell-dendrite transition will be investigated by solidifying three aluminum- lithium alloys in the GHF. In non-dimensional form, the data points for the primary spacing will be used to construct a 3D- representation. The microsegregation and macrosegregation of lithium will be analyzed. Also to be studied is the organization (defects, disorder) of the cellular and dendritic bi-dimensional arrays. The influence of convection will be deduced from a comparison with 1g samples.

- DIRECTIONAL SOLIDIFICATION OF THE LIF - LIBAF3 - EUTECTIC

The lamellar eutectic system LiF - LiBaF3 shall be directionally solidified in a gradient furnace. The influence of the growth parameters gravity, melt composition, growth velocity and temperature gradient on the eutectic microstructure will be examined.

- SEPARATION BEHAVIOR OF MONOTECTIC ALLOYS

By directional melting of sandwich-like samples of Al-Si-Bi alloys in which Bi-droplets are dispersed, the transport mechanisms of droplets in Al-melts will be investigated. The sandwich-like samples consist of periodically arranged cylinders of an Al-Si alloy. Ahead of the melting front there exists a temperature gradient which leads to a motion of the droplets within the Al-Si matrix melt. The droplets are free to move in as much as the melting front moves in a controlled manner through the sample. The droplet free zones will lead to a strong reduction of possible scattering and coagulation events of droplets of different sizes.

Therefore, at the end of an experiment there will be enough droplets located within the molten zone. From the spatial arrangement of the droplets and a comparison with computer simulations of the whole process, conclusions shall be drawn concerning the transport of Bi droplets in a temperature gradient. The investigations are relevant for the improvement of terrestrial industrial casting processes currently being under investigation.

- LIQUID COLUMNS' RESONANCES

This experiment will measure the resonance curves of liquid columns between coaxial circular disks and to test the corresponding theoretical models. The experiment will be performed in the Advanced Fluid Physics Module (AFPM). The supporting circular disks are vibrated with varying frequency. The response of the liquid column is observed by position and pressure sensors.

It is intended to investigate two liquids differing in viscosity and surface tension and to use several liquid volumes and surface shapes. The resonance frequencies first are roughly determined by applying a frequency ramp and subsequently may be checked more accurately by frequency variation from hand. The interest in liquid columns has been stimulated by the numerous applications to crystal growth by the floating zone or traveling- heater techniques.

- STABILITY OF LONG LIQUID COLUMNS

The aim is to measure the outer shape deformation of long liquid bridges under microgravity when subjected to mechanical disturbances, namely change of geometry, rotation and vibration. This configuration has, aside of its own relevance in fluid mechanics and interface science, a well-known application in materials processing, particularly in the floating zone technique of crystal growth in the semiconductor industry.

As a spin-off of this research, this configuration has proved to be a unique accelerometer at very low frequencies. The aim is at gathering experimental data to validate several theoretical predictions on equilibrium shapes, stability limits and dynamics of stable and unstable bridges, to provide further guidance to more realistic and complex modeling.

- HIGHER MODES AND THEIR INSTABILITIES OF OSCILLATING MARANGONI CONVECTION IN A LARGE CYLINDRICAL LIQUID COLUMN

The various types of liquid motion (convection) due to inhomogeneities of the interfacial tension in a free liquid surface are called Marangoni effects. The proposed experiment deals with investigations of higher oscillating modes of the Marangoni convection and their transitions into non-periodic states (turbulent convections) in a large liquid column as a function of the aspect ratio (height diameter) of the column and of the Marangoni numbers. This experiment will make use of the Advanced Fluid Physics Module.

- MARANGONI-BENARD INSTABILITY

The Marangoni-Benard instability will be studied in the steady state to measure the critical Marangoni number and to observe the inverse bifurcation behavior. The transient behavior will be studied to observe the effect of a nondistribution. Finally, by heating in the opposite direction, transverse capillary-gravity waves will be observed .

- ONSET OF OSCILLATORY MARANGONI FLOWS

The investigators intend to perform a systematic study of a series of cylindrical floating zones characterized by different values of the aspect ratio of disk diameter to determine the influence of sample geometry on oscillations onset and to determine the critical conditions and obtain a better understanding of the flow organization during oscillatory conditions.

- MARANGONI CONVECTION IN A RECTANGULAR CAVITY

There are various types of liquid motion (convection) due to inhomogeneities of the interfacial tension in free liquid surfaces which are called Marangoni effects. The experiment investigates one of the Marangoni effects, namely thermocapillary convection driven by temperature gradients applied parallel to the free liquid-gas surface. The experiment investigates the pure thermocapillary effect under microgravity to reduce the complexity of the highly non-linear coupled hydrodynamic system on Earth.

- STATIONARY INTERDIFFUSION IN A NON-ISOTHERMAL MOLTEN SALT MIXTURE

A new interdiffusion experiment on a molten salt mixture will be performed as the necessary continuation of the preceding D1 experiment. It is shown that the stationary state which was far from being obtained in D1, due to a smaller than predicted interdiffusion coefficient, should then be attained during a 24- hour duration experiment. In addition, the investigators intend to evidence a variation of the interdiffusion coefficient with the mixture composition.

- TRANSPORT KINETICS AND STRUCTURE OF METALLIC MELTS

Diffusion processes in melts are more or less disturbed under 1-g by convections which contribute to the atomic mixing process in a similar but irregular way. It is the goal of the D2 experiments to determine the temperature dependence of the diffusion coefficients for materials which are as much as possible different from Tin. Furthermore, there are different aspects to use the experimental opportunities of the D2 flight: continue self-diffusion experiments on other materials; continue inter- diffusion experiments with complex formation; determine inter- diffusion coefficients for the "Compound Project Monotectic Alloys" and complete measurements in the system started in D1.

- NUCLEATION AND PHASE SELECTION DURING SOLIDIFICATION OF UNDERCOOLED ALLOYS

Metallic melts of various alloys, embedded in a liquid matrix of boron-trioxide, will be cooled below their solidification temperature in their liquid state. Since under microgravity conditions, sedimentation is reduced by orders of magnitude, a contact of sample with crucible is avoided leading to the elimination of heterogeneous nucleation by wall contact. It is the goal of this experiment to determine the degree of undercooling for different alloy compositions by measuring the recalescence temperature and comparing with nucleation theory. In addition, the influence of undercooling on the grain size and phase selection will be investigated.

- HEATING AND REMELTING OF AN ALLOTROPIC FE-C-SI ALLOY IN A CERAMIC SKIN AND THE EFFECT OF THE VOLUME CHANGE ON THE MOLD'S STABILITY

The skin technology is to be tested with allotropic and non- allotropic materials for its suitability for remelting processes. For this purpose a melting sample with sections of Fe-C-Si alloys with different compositions will be remelted in a zirconia mold and solidified directionally. The interpretation will concentrate on the skin behavior, the crystallization of the graphite and the distribution of the elements in the transition zone.

- IMMISCIBLE LIQUID METAL SYSTEMS

NUCIM is an experiment investigating the behavior of two liquid immiscible metals in contact with different ceramic materials. In particular the Cu-Pb system with two different compositions will be investigated in contact with vitreous carbon, boron nitride and sapphire.

- CONVECTIVE EFFECTS ON THE GROWTH OF GaInSb CRYSTALS

This experiment will check the effects of convection on the chemical segregation of the components of highly concentrated terrary semiconductors. The purpose is to obtain homogeneous crystals, which is not possible on Earth.

- VAPOR GROWTH OF INP-CRYSTAL WITH HALOGEN TRANSPORT IN A CLOSED AMPOULE

It is well known that the mass transport phenomena are strongly affected by gravity. In the D2 mission, vapor growth of InP epitaxial layer with halogen transport in a closed ampoule is proposed to study the relation between the gravity and epitaxial layer quality.

- SOLUTION GROWTH OF GaAs CRYSTALS UNDER MICROGRAVITY

The solution growth experiment of GaAs crystals under microgravity planned aboard the D2 mission involves a technique that avoids the surface-tension-induced convection which destroys diffusion-controlled crystal growth, even under microgravity.

- CRYSTALLIZATION OF NUCLEIC ACIDS AND NUCLEIC ACID-PROTEIN COMPLEXES

The main purpose of this research project is to study the structure of ribosomal 5S RNAs, their protein complexes and the structure of the elongation factor EF-TU complex. The ribosomal 5S RNAs and their binding proteins are essential for the function of ribosomes, and their complexes also are considered to be good model systems for the study of RNA-protein complexes. The elongation factor EF-TU is required for protein synthesis. Since this protein forms in addition specific complexes with GTP and GDP, it also has been considered as a model system for the important class of regulatory G-proteins.

The objective is to explore all possibilities to crystallize these important biological molecules and their complexes to determine their three dimensional structure by x-ray analysis. The purpose of this project is to determine the influence of microgravity on the crystallization of these molecules during the D2 Spacelab mission.

- CRYSTALLIZATION OF RIBOSOMAL PARTICLES

The main goal of our project is to elucidate the model of the ribosome. The investigators are pursuing single crystal X-ray crystallographic studies and support them with information obtained from neutron diffraction and three-dimensional image reconstruction from electron-micrographs. The investigators believe that at microgravity more isotropic crystals can be grown.

HOLOGRAPHIC OPTICS LABORATORY (HOLOP)

The Holographic Optics Laboratory (HOLOP) is a multi-user experiment facility where fluid physics experiments are conducted under microgravity conditions. Located in rack 11, the aim of HOLOP is to investigate phenomena such as transient heat transfer, mass transfer, surface convections and particle motion in gatical transparent media through holographic methods. One of the four experiments is a test subject for studying the application of "telescience" techniques for preparation of utilization of space station missions.

- MARANGONI CONVECTION IN A RECTANGULAR CAVITY

There are various types of liquid motion (convection) due to inhomogeneities of the interfacial tension in free liquid surfaces which are called Marangoni effects. The MARCO experiment investigates one of the Marangoni effects, namely thermocapillary convection driven by temperature gradients applied parallel to the free liquid-gas surface. MARCO investigates the pure thermocapillary effect under microgravity to reduce the complexity of the highly non-linear coupled hydrodynamic system on Earth.

- INTERFEROMETRIC DETERMINATION OF THE DIFFERENTIAL INTERDIFFUSION COEFFICIENT OF BINARY MOLTEN SALTS

Interdiffusion coefficients are transport data that are difficult to measure. Under microgravity conditions, it is possible to exclude convection and to obtain exact reference values for the diffusion coefficients. The initial concentration step profile is generated with a flowing junction cell and the diffusion process is observed by means of holographic real time interferometry. The chosen system is Potassium Nitrate/Silver Nitrate at eutectic composition. The diffusion coefficient is going to be determined in dependence on temperature.

- IDILE: MEASUREMENTS OF DIFFUSION COEFFICIENTS IN AQUEOUS SOLUTION

IDILE is an experiment dedicated to measurements of diffusion coefficients through interferometric holography observation of refractive index changes due to evolution of concentration profiles as a function of time.

- NUGRO: PHASE SEPARATION IN LIQUID MIXTURES WITH MISCABILITY GAP

Phase separation of a demixing binary liquid mixture under 1-g conditions is observed by holographic image recording. A pressure jump technique is applied to induce the phase transition.

Radiation Detector (RD) is a set of four experiments in which different types of material and biological probes are exposed to different environmental conditions. The scientific products will be brought back for analyses to learn and develop techniques for radiation protection in space.

BAROREFLEX (BA)

The Baroreflex (BA) experiment is located in rack 12. This experiment will investigate the theory that lightheadedness and a reduction in blood pressures in astronauts upon standing after landing may arise because the normal reflex system regulating blood pressure behaves differently after having adapted to a microgravity environment.

In particular, the ability of the body's blood pressure sensors to control heart rate (the baroreceptor reflex) will be measured to see if the predicted impairment does indeed occur. Space-based measurements of the baroreflex will be compared to ground-based measurements to see if microgravity affects the reflex.

The tendency of a person to faint because of inadequate blood flow to the brain is called orthostatic hypotension. When standing on Earth, gravity tends to pull blood toward the feet and the baroflex acts to increase heart rate and blood pressure in the blood vessels, maintaining normal blood flow to the head. However, in microgravity the body does not have to make such cardiovascular adjustments to compensate for changes in body position.

In space, blood shifts naturally toward the head rather than the feet and the baroflex is not utilized during postural changes. Therefore, impairment or desensitization of normal baroreflex control of blood pressure may occur.

The purpose of this experiment is to determine if there are changes in the baroreflex in microgravity and if so, how they contribute to postflight orthostatic hypotension. Although orthostatic hypotension disappears within a few days after flight, it is very important to understand the causes of this condition which affects the health and safety of the astronauts, including the ability to land the Shuttle at the end of the mission.

The experiment uses the Baroreflex cuff, a silicone rubber cuff which seals around the neck when pressure is applied. The pressure system is controlled by a microprocessor. The crew member wears a rubber neck chamber and electrocardiograph (ECG) electrodes. Pulses of pressure and suction, which mimic natural blood pressure, are applied through the neck chamber and transmitted through the neck to baroreceptors. The heart rate change provoked by each pressure pulse is measured from the ECG. Heart rate changes will be measured before, during and after the spaceflight.

The Microgravity Measurement Assembly (MMA) is the core acceleration measurement system of D2. It consists of 6 tri-axial accelerometers, four of which are permanently mounted in experiment racks. Two packages can be placed at any suitable location within the Spacelab module.

- RESIDUAL ACCELERATION IN SPACELAB D2

The majority of investigations performed on D2 is intended to make use of the state of weightlessness which is virtually simulated in a freely drifting spacecraft. Deviations of the spacecraft's dynamic state from ideal free fall conditions result in residual gravity-like accelerations. Despite orders of magnitude below 1-g, this microgravity condition can seriously affect the results of experiments. A detailed knowledge of the residual acceleration history, therefore, is mandatory for a thorough experiment analysis.

For the reason, Spacelab D2 is equipped with various measurement systems to detect the spatial and temporarily variation of the acceleration vector. There is, however, a lack of measurement data in the low-frequency range due to general sensor bias problems. Acceleration data in this regime will be estimated on the basis of a dynamic atmospheric model and the attitude data of the orbiter.

- TRANSFER FUNCTION EXPERIMENT

The proposed Transfer Function Experiment will cover the empirical and systematic investigation of the disturbance transmissibility characteristics and the transfer functions of the spacecraft structure under weightlessness. The microgravity transfer function describes the transmissibility behavior of a flexible spacecraft structure. It describes how a flexible structure will respond with vibrations/accelerations when excited at another location of the structure by a disturbance source. It will be extended by an impulse hammer enabling the measurement of inflight structural transfer functions.

The results of this experiment will substantiate and improve understanding of the on-orbit dynamic behavior of microgravity spacecraft structures. The evaluation of on-orbit transfer function measurements and comparison with on-ground test data and analytical predictions will improve the microgravity dynamics database and will directly support the preparation of further Spacelab missions and subsequent orbital microgravity spacecraft such as EURECA and Columbus.

ROBOTICS EXPERIMENT (ROTEX)

ROTEX is a robotic arm that operates within an enclosed workcell in rack 6 of the Spacelab module and uses teleoperation from both an on-board work station located in rack 4 and the ground. This precise robotic arm uses teleprogramming and artificial intelligence to look at the design, verification and operation of advanced autonomous systems for use in future applications.

ROTEX is comprised of:

*A robot arm with six joints which can reach in all directions to grasp objects

*Two torque sensors located of the back of the gripper to ensure that the robot arm does not become overloaded

*A gripping assembly containing laser distance-measuring devices, tactile sensors and stereo television cameras which give a direct view of the object

*Two fixed video cameras that provide stereo pictures of the whole assembly. For future spaceflight, it will be necessary to reduce the operational costs of space systems. In this context, the application of robotic systems will play a key role. The technology-transfer or spin-off back to terrestrial applications is expected to be larger than in many other areas and important in terms of political economics. Manipulators and robots will be used for assisting in and carrying out different tasks in space laboratories ("internal" use) and in free space ("external use"), in particular:

- exchange of orbit-replaceable units (ORU)
- handling of experiments and manufacturing processes
- assistance in rendezvous/docking
- repair
- supply and maintenance of free-flying platforms or geostationary satellites
- refueling and "garbage collection"
- assembly of structures

The performance of diverse tasks by space manipulators requires a hierarchically and modularly structured automation concept tunable to the special operational case, which in addition allows human interference on different levels of supervisory and decision control. This in term yields the requirements for the hardware and software concepts to be realized, covering the range from telemanipulation up to a completely autonomous operation. Independent of the different tasks and application scenarios, development of space robot technology tends to focus on the following topics:

- intelligent, sensor-controlled, light-weight manipulators
- modular gripper and tool systems for high versatility
- improved man-machine interfaces for teleoperation and supervisory control ("telerobotics" and "telescience") concepts
- stepwise increase of planning and decision autonomy by knowledge-based technology,
- cooperation and coordination of multi-arm and multi-robot system.

ANTHRORACK (AR)

The payload element "Anthrorack," developed for ESA, is designed to investigate human physiology under microgravity conditions. AR will provide a set of common user stimulation and measurement instruments, supported by centralized services including power supply, control and data handling. The AR is composed of the following service elements:

- Blood Sample Collection Kit
- Urine Monitoring System
- High Speed Centrifuge
- Respiratory Monitoring System
- Ergometer
- Peripheral Blood Measurement System
- Manual Blood Pressure Measurement System
- Limb Volume Measurement Device
- Electrode Contact Impedance Meter
- Ultrasound Monitoring System

AR components essentially are accommodated in a double rack. The ergometer is mounted to the experiment section of the lab's main floor.

- CARDIOVASCULAR REGULATION AT MICROGRAVITY

The mechanisms involved in the cardiovascular adaptation to microgravity will be examined during inflight studies of the responses to acute redistribution of body fluids. Intravenous saline loading is superimposed on the microgravity-induced fluid shifts. Supplementary pre- and post-flight procedures include quantification of changes in myocardial and skeletal muscle mass by magnetic resonance imaging and characterization of adrenergic function by in-vivo and in-vitro experiments.

- THE CENTRAL VENOUS PRESSURE DURING MICROGRAVITY

The central venous pressure (CVP) is theorized to increase during weightlessness because of a central blood volume shift. Although CVP is an important physiological parameter, it never has been registered in humans during the launch conditions or long term weightlessness. Significant "microgravity" adaptation may occur while the astronauts are waiting on the launch pad in supine seated launched position. The aim of this experiment is to measure the CVP in two crewmembers during the supine seated position on the launch pad, the microgravity onset and the early adaptation through an arm vein.

- LEG FLUID DISTRIBUTION AT REST AND UNDER LBNP

Human adaptation to microgravity is a complex process involving multiple organ systems. Among these, the function and control of health and vessels are changed due to the lack of gravitational stress. First, body fluids shift towards the upper part of the body. Next, the body becomes dehydrated due to increased excretion and possibly, decreased fluid intake. As a result, the autonomic response patterns may be altered. Dehydration and disuse lead to volume reduction, especially in the lower limbs. Textural changes of the skin, musculature and vessels are anticipated to occur.

- DETERMINATION OF SEGMENTAL FLUID CONTENT AND PERFUSION

In weightlessness, the lack of hydrostatic pressure induces a large cephalad fluid shift that in turn causes a reduction in total body fluid. The hypothesis is that this results in a new body fluid distribution pattern. Different body segments are affected to different degrees. Additionally, reduced peripheral demands due to muscular underloading and a change in the activity pattern of the cardiovascular autonomic control system contribute to induce a process of cardiovascular adaptation.

- LEFT VENTRICULAR FUNCTION AT REST AND UNDER STIMULATION

This experiment intends to get insight into the mechanisms underlying cardiovascular adaptation to weightlessness. The experiment emphasizes the role played by the heart in the process of adaptation to weightlessness and readaptation to Earth's gravity.

- PERIPHERAL AND CENTRAL HEMODYNAMIC ADAPTATION TO MICROGRAVITY DURING REST EXERCISE AND LOWER BODY NEGATIVE PRESSURE IN HUMANS

This experiment will investigate the cardiovascular reflexes during weightlessness in man by applying standard stimuli to the body and record the induced changes. Cardiovascular parameters to be measured include Echo Cardiograph (ECG), cardiac output (rebreathing method), arterial blood pressures during rest and during isometric exercise (sustained handgrip exercise) and dynamic exercise (bicycle exercise on a specially constructed mechanically breaked ergometer).

However, during this experiment the subcutaneous blood flow on the forearm will be studied. This way it will be possible to calculate the changes in both total peripheral resistance as well as forearm vascular resistance as an expression of cardiovascular regulation. The experiments will be performed preflight and inflight.

- TONOMETRY - INTRAOCULAR PRESSURE IN MICROGRAVITY

Microgravity leads to an increase in intraocular pressure due to a fluid shift from the lower to the upper part of the body. Up to now little was known about the peak values and the adaptation process. The greatest alteration in intraocular pressure is expected during the early phase after launch. Because the astronauts are fastened in during this phase, measurements have not been performed. To solve this problem and to save crew time, a tonometer was developed which enables self tonometry. Initial measurements during so-called "parabolic flights" could demonstrate the practical use of the new equipment under microgravity conditions without any problem.

- THE CENTRAL VENOUS PRESSURE DURING MICROGRAVITY

The central venous pressure (CVP) is theorized to increase during weightlessness because of a central blood volume shift. Although CVP is an important physiological parameter, it never has been registered in humans during the launch conditions or long term weightlessness. Significant microgravity adaptation may occur while the astronauts are waiting on the launch pad in supine seated launch position. The purpose of this experiment is to measure the CVP in two crew members during the supine seated position on the launch pad, the microgravity onset and the early adaptation to weightlessness by means of a thin catheter introduced through an arm vein.

- TISSUE THICKNESS AND TISSUE COMPLIANCE ALONG BODY AXIS UNDER MICRO-G CONDITIONS

A new method will be introduced to quantify fluid shifts within superficial tissues along the body axis of a human subject. Furthermore, the distensibility of these tissues will be measured. The methods will be applied under micro-g conditions, to answer basic questions of the salt-water balance of humans under extreme conditions.

- CHANGES IN THE RATE OF WHOLE-BODY NITROGEN TURNOVER, PROTEIN SYNTHESIS AND PROTEIN BREAKDOWN UNDER CONDITIONS OF MICROGRAVITY

Under conditions of microgravity, there is a fluid shift away from the peripheral muscles of the lower limbs towards the viscera of the gut and splanchnic regions of the body. This is accompanied by a negative fluid and nitrogen balance, the latter of which results in a reduction of muscle tone, muscle fatigue and muscle atrophy. The purpose of the present study is to measure the rates of whole-body nitrogen turnover (flux), protein synthesis and protein breakdown in 3 astronauts before, during and after the D2 mission to identify the mechanism(s) responsible for the negative nitrogen balance.

- REGULATION OF VOLUME HOMEOSTASIS IN REDUCED GRAVITY POSSIBLE INVOLVEMENT OF ATRIAL NATRIURETIC FACTOR URODILATIN AND CYCLIC GMP

The objective of this investigation is to study the involvement of hormonal systems in the readaptation of humans to weightlessness. In detail, possible alterations in the plasma levels and urinary excretion rates of atrial natriuretic factor, of urodilatin and of cyclic GMP will be studied. These factors are important hormones and parameters regulating volume homeostasis which is known to be markedly altered in weightlessness. Thus, the current investigation is aimed at gaining a better understanding of volume homeostasis under microgravity conditions.

- EFFECTS OF MICROGRAVITY ON GLUCOSE TOLERANCE

Based on results from simulation experiments on the ground, it is hypothesized that an abnormal glucose/insulin relation and an impaired glucose tolerance occurs in spaceflight. The metabolic imbalance may increase with progressive exposure. It is anticipated that the results of the study in space will have significance for both the assessment of metabolic responses to weightlessness and for clinical medicine on Earth. *The Influence of Microgravity on Endocrine and Renal Elements of Volume Homeostasis It is hypothesized that the renal excretion of electrolytes and water in humans increase upon entering the microgravity environment and that a new state of adaptation is reached in regard to volume homeostatic mechanisms. Therefore, the purpose is to investigate the lack of hydrostaticendocrine and renal elements of volume homeostasis in human test subjects.

- EFFECTS OF SPACEFLIGHT ON PITUITARY-GONAD-ADRENAL FUNCTION IN THE HUMAN

Spaceflight conditions are very strong, stressful stimuli and are expected to have some impact on individual working capacity. A very important topic, on the other hand, is the circadian rhythmicity of hormonal secretion. Such regular rhythms might be disrupted by incorrect time shift schedules. The aim of this study is to check blood, urine and saliva to detect any signs of adrenal/reproductive glands disturbance occurring in microgravity to better design working/resting rhythms during next flights. It is in fact of enormous relevance to human species survival and to subject's space work motivation that the hormonal milieu, somehow responsible for subject's well-being and working capacity as well as for reproductive and sexual equilibrium, keep within normal ranges in microgravity conditions.

- ADAPTATION TO MICRO-G AND READAPTATION TO TERRESTRIAL CONDITIONS

In this experiment, the observation of the Renin- Angiotensin- Aidosterone System, which is one of the main factors in the regulation of salt-balance and blood pressure, will be made. *Pulmonary Stratification and Compartment Analysis with Reference to Microgravity The in-orbit elimination of the gravity vector provides an unique opportunity to study the effect of gravity on the distribution of ventilation in the human lung. The primary scientific objective of this experiment is to test, whether entry into orbit will alleviate the inhomogeneity in the distribution of the ventilation-volume ratio, as measured by a multiple breath gas wash-in/wash-out test.

- PULMONARY PERFUSION AND VENTILATION IN MICROGRAVITY REST AND EXERCISE

Gravity is considered to be the most important factor influencing the distribution of both ventilation and blood perfusion in the lung. According to current hypotheses, both these processes take place mainly in the lower part of the lungs. However, the degree of unevenness is different between ventilation and perfusion, so that upper parts (with respect to the G vector) are relatively over-ventilated with respect to perfusion and lower parts are relatively over perfused with respect to ventilation.

The concept described has a major impact on present scientific and clinical understanding of the pulmonary function. The concept, however, is hypothetical and remains to be proven by direct experimental evidence. The proposed experiments include methods and procedures for such studies.

- VENTILATION DISTRIBUTION IN MICROGRAVITY

Under normal gravity conditions on Earth, the lower part of the lung ventilates almost twice as much as the upper part of the lung. The major scientific objective of this experiment, carried out in the Anthrorack facility, is to understand the role of gravity in determining the pattern of ventilation in the lungs and the components involved in ventilation.

This will be accomplished by studying the influence of microgravity on lung ventilation, lung blood flow, capillary volume, the lung's liquid content and changes in the breathing pattern.

In a parabolic aircraft flight, an experiment was conducted to look at some of these changes. Data from this experiment showed a much more even pattern of ventilation in the lung than expected when in microgravity. It also was observed that the lung volume decreases significantly and the pattern of breathing is changed.

The flight of this experiment aboard the Spacelab D2 mission will help to define the effects of microgravity on the lung. This experiment will use experiment specific equipment called the "Respitrace."

- EFFECTS OF MICROGRAVITY ON THE DYNAMICS OF GAS EXCHANGE, VENTILATION AND HEART RATE IN SUBMAXIMAL DYNAMIC EXERCISE

Before, during and after the D2 mission, pseudo-randomized power changes between 20 w and 80 w of cycle ergometer exercise will be applied as stimulus to study the kinetics of oxygen consumption, C02-output, ventilation, blood pressure and heart rate. A major intention is to find out whether the determination of C02 kinetics qualifies as a method for monitoring endurance performance during space flight.

- CARDIOVASCULAR REGULATION IN MICROGRAVITY

The objective of this experiment is to study the cardiovascular effects of microgravity on subjects at rest and during exercise.
This study, performed in the Anthrorack facility, will study the multiple mechanisms believed to be responsible for rapid and effective adaptation to microgravity as well as the cardiovascular dysfunction that is observed on return to Earth. An additional objective is to validate 24-hour, 5-degree head-down bedrest as a model for studies of acute cardiovascular response to weightlessness.

This experiment uses specific equipment called the Doppler flow device along with the Blood Pressure Measurement System. Based on current evidence, upon entering microgravity, astronauts experience a dramatic fluid shift from the lower into the upper part of the body. This occurs primarily because of the loss of all hydrostatic gradients; the compressive force of the muscles and blood vessels in the legs and dependent abdominal areas is therefore unopposed by gravity and propels fluid headward. As a result of this fluid shift, central blood volume and cardiac pressures increase, simulating an expansion of the intravascular volume and setting in motion a cascade of volume- regulating mechanisms.

The end result of this process is a reduction of fluids in the lower part of the body and a loss of the excess fluid in the upper part of the body that had shifted headward. Significant net losses of body fluid therefore are experienced by crewmembers in space during the first few days in microgravity and in the ensuing week or so, other elements of the cardiovascular system change to accommodate the loss of fluid and gravity stimulus.

The objectives of this experiment are to study the multiple mechanisms believed to be responsible for the adverse responses in astronauts upon landing, including hypovolemia, altered neurohumoral control mechanism and structural changes affecting the cardiovascular system and to examine interactions between these mechanisms. Understanding these processes suggest methods for countering their unwanted effects.

Two different in-flight procedures will be performed: rapid intravenous saline loading and lower body negative pressure. Both procedures are based on collaboration among several groups of D2 investigators and both will produce detailed data on cardiovascular and neurohumoral responses.

BIOLABOR (BB)

The Biolabor will be used to perform research in electrofusion of cells, cell cultivation, botany experiments and zoological experiments. The Biolabor facility is a life sciences and biotechnology research device developed by Germany (MBB/Erno) for use in the Shuttle/Spacelab. Biolabor consists of a cell electrofusion workbench equipped with a microscope, a cell electrofusion control unit, two cell cultivation incubators, a 41 C cooler and two middeck-mounted cooling boxes.

The workbench can accommodate a series of experiment- specific test chambers, including chambers to support electrofusion of different protoplasts of plant species and chambers for electrofusion of mammal cells. The workbench microscope allows observation of the test chambers by the crew and the experimenter via downlinked video. Biolabor experiments include:

- DEVELOPMENT OF VESTIBULOCULAR REFLEXES IN AMPHIBIA AND FISHES WITH MICROGRAVITY EXPERIENCE

This experiment will examine whether the functional development of the vestibular system of lower vertebrates is affected by a short lasting stay under micro-g conditions during very early periods of life. Vestibulocular reflexes are a useful tool to determine efficiency changes of the developing vestibular system. After the spaceflight, the extent of these reflexes will be determined for each of the very delicate animals throughout its life until metamorphosis. For this purpose, a closed living system will be constructed which also allows the recording of the reflexes without changing the environment.

- COMPARATIVE INVESTIGATIONS OF MICROGRAVITY EFFECTS ON STRUCTURAL DEVELOPMENT AND FUNCTION OF THE GRAVITY PERCEIVING ORGAN OF TWO WATER LIVING VERTEBRATES

This contribution is a survey of the DLR-part of the space experiment "The Observation of Gravity and Neuronal Plasticit" or STATEX II. The main points are the morphological differentiation of the vestibular organs and their subunits in weightlessness and an analysis of the loop swimming behavior following gravity variations. For the first time, the development of two different aquatic vertebrates, exposed to identical experimental conditions in space, can be compared.

- STRUCTURE- AND FUNCTION-RELATED NEURONAL PLASTICITY OF THE CNS OF AQUATIC VERTEBRATES DURING EARLY ONTOGENETIC DEVELOPMENT UNDER MICROGRAVITY- CONDITIONS

On the basis of behavioral studies, the influence of about 9 days of near weightlessness during early ontogenetic development of larvae of a type of colored perch fish and tadpoles of the South American clawed frog will be investigated by means of light and electronmicroscopical techniques and biochemical analyses especially with regard to the differentiation of gravity-related integration centers in the central nervous system.

- IMMUNOELECTRON MICROSCOPIC INVESTIGATION OF CEREBELLAR DEVELOPMENT AT MICROGRAVITY

By means of immunoelectron microscopy the influence of weightlessness on structural and functional parameters of the cerebellum of cichlid fish and clawed toad larvae will be investigated using poly- and monoclonal antibodies against specific cell adhesion molecules.

- GRAVISENSITIVITY OF CRESS ROOTS

Gravity sensing systems in plants are characterized by three intracellular components:

- sedimenting particles functioning as statoliths
- the ground cytoplasm as surrounding medium and
- membranes (probably inner membranes) functioning as signal transducers.

The experiment gravisensing will determine threshold value, the minimum dose for cress roots cultivated on a 1g centrifuge and under reduced gravity, respectively, using a threshold value centrifuge. In a second approach, the fine structural characteristic of the gravity perceiving cells (statocytes) is correlated with this threshold value by preparation of the seedlings in orbit for electron microscopy on ground. Finally the summation of subminimal doses is proven and again correlated with the fine structure of statocytes to obtain first information on a "memory" of plants for the stimulus gravity.

*CELL POLARITY AND GRAVITY

The microgravity experiments described below shall elucidate the question as to whether gravity is a polarizing factor in higher plant cells and if so, what its rank is among other polarizing factors.

- INFLUENCE OF GRAVITY ON FRUITING BODY DEVELOPMENT OF FUNGI

The D2 mission provides an excellent opportunity for obtaining information on the ultrastructure of fruiting bodies grown under micro- and 1-gravity conditions. These results are expected to improve knowledge about the mechanisms of graviperception and the influences of weightlessness on fungal morphogenesis.

- SIGNIFICANCE OF GRAVITY AND CALCIUM-IONS ON THE PRODUCTION OF SECONDARY METABOLITES IN CELL SUSPENSIONS

The influence of gravity and calcium metabolism on metabolite production, growth and regeneration capacity of cell cultures will be investigated. Simulation experiments, using a clinostat and a centrifuge specifically adapted to cell cultures, will be conducted on Earth. In addition, experiments with calcium chelators, calcium ionophores and calmodulin antagonists are planned. In this experiment, for the first time in manned space flight, fluid cultures beside solid cultures will be exposed to microgravity and cosmic radiation. The aim of the experiment is to improve properties of the yeast by durable fixed genetic mutations. The genome of the HB-L29 yeast, used in the experiment, shows two additional chromosomes in comparison to cultures investigated up to now.

- INFLUENCE OF CONDITIONS IN LOW EARTH ORBIT ON EXPRESSION AND STABILITY OF GENETIC INFORMATION IN BACTERIA
- PRODUCTIVITY OF BACTERIA
- FLUCTUATION TEST ON BACTERIAL CULTURES

Unexpectedly, bacteria, when growing in low earth orbit, have shown differences in growth rate and amount of final biomass produced as compared to their counterparts on Earth. These earlier studies will be continued to include measurements of the yield of specific products, of the stability of genetic information and of the re-adaptation to growth at 1-g.

- CONNECTIVE TISSUE BIOSYNTHESIS IN SPACE: GRAVITY EFFECTS ON COLLAGEN SYNTHESIS AND CELL PROLIFERATION OF CULTURED MESENCHYMAL CELLS

Astronauts, experiencing long periods of space flight, suffer from severe degeneration of bones. As it seems, lack of mechanical load decreases connective tissue biosynthesis in bone forming cells. To test this assumption cultured mesenchymal cells, which actively produce connective tissue proteins, will be kept under microgravity during the D2 mission. Composition, relative amount and structure of synthesized proteins, which consist mainly of collagen, will be characterized. The same will be done with control cultures incubated at normal gravity and hypergravity.

- ANTIGEN-SPECIFIC ACTIVATION OF REGULATORY T-LYMPHOCYTES TO LYMPHOKINE PRODUCTION
- GROWTH OF LYMPHOCYTES UNDER MICRO-G CONDITIONS

An experimental 1-g test system was devised involving the foreign antigen-driven stimulation of regulatory T cells by antigen-presenting accessory cells. Under conditions of weightlessness, undisturbed antigen-mediated cluster formation between responsive T cells can be expected which is anticipated to lead to elevated levels of secreted lymphokines. The amount of representative lymphokines produced under micro-g and 1-g conditions will be determined. These measurements might provide new insights into the interactive relationship between T cells and accessory cells.

- ENHANCED HYBRIDOMA PRODUCTION UNDER MICROGRAVITY

During the Spacelab D2 mission, the United States and Germany will carry out collaborative studies to evaluate whether the microgravity environment can be used to produce cells with useful properties.

Specifically, the experiments will examine the process of cell electrofusion, where electric currents are used to join cells with different characteristics to produce hybrids. These experiments will examine the fusion of human blood cells, called lymphocytes, with tumor cells. The resulting fusion products, hybridoma, may produce proteins that can be used to kill cancerous cells.

Previous experiments on sounding rockets have shown an increase in the efficiency in hybridoma production in microgravity. The joint U.S./German experiments will probe the possible causes of this increase.

As their contribution to the research, the German Space Agency developed the Biolabor, a multi-user cell fusion device. The U.S. science team will provide the cell samples and will carry out the post-flight analysis. In addition to the hybridoma experiments, Biolabor also will be used to carry out plant cell fusion experiments.

This experiment will attempt to determine the extent to which the microgravity environment will enhance the generation of hybrid cells produced by electrofusion. Dr. David W. Sammons, University of Arizona, Tucson, and his German collaborators will attempt to fuse B lymphocytes P white blood cells that produce antibodies that circulate in the blood stream P with cells from myeloma P tumors that afflict bone marrow. The science team hopes to produce hybridoma that efficiently produce highly specific antibodies.

Experiments carried out in the European Texus sounding rocket program have demonstrated that performing cell electrofusion in microgravity increases the number of fusion events as well as the number of recoverable, viable cell hybrids. During the D2 mission, crew members will use the Biolabor hardware to carry out experiments to reveal the causes for the increase in the efficiency of cell electrofusion during the sounding rocket flights.

Several days prior to the launch of the Spacelab D2 mission, the U.S. science team will begin preparing Myeloma and B lymphocyte cells. The various cell types will be loaded in flexible, gas-permeable flasks, which will be stored in incubator boxes in the Shuttle middeck 12 hours before launch.

On orbit, the cells will be transferred to incubators in the Biolabor facility in the Spacelab module. During the third mission day, lymphocytes and myeloma cells will be centrifuged and combined in the fusion chambers. Electric pulses of varying lengths will be applied to the different samples. Following cell-electrofusion, some of the sample sets will be "fixed" for later study. Others will be incubated for the remainder of the mission. Ground control experiments will be carried out in parallel with the flight experiments in a laboratory at the NASA Kennedy Space Center.

- CULTURE AND ELECTROFUSION OF PLANT CELL PROTOPLASTS UNDER MICROGRAVITY: MORPHOLOGICAL/BIOCHEMICAL CHARACTERIZATION

Plant cell protoplasts of different origin (leaf tissue, cell cultures) and fusion products, formed therefrom by electrical cell fusion techniques, will be cultured for about 10 days under 1-g conditions and compared to identical samples kept under 1-g both in orbit (1-g reference centrifuge) and on the ground. To monitor possible morphological and physiological/metabolical deviations occurring under 1-g, sample specimen are taken and metabolically quenched in defined time intervals. The analytical part will cover microscopy, determination of cellular pool sizes of intermediates of energy and carbohydrate metabolism and protein analysis.

- YEAST EXPERIMENT HB-L29/YEAST: INVESTIGATIONS ON METABOLISM

In this experiment, for the first time in manned space flight, fluid cultures (Saccharomyces uvarum var. carlsbergensis) beside solid cultures will be exposed to microgravity and cosmic radiation. The purpose of the experiment is to improve properties of the yeast by durable fixed genetic mutations. The genome of the HB-L29 yeast used in the experiment shows two additional chromosomes in comparison to cultures investigated up to now.

COSMIC RADIATION EXPERIMENTS

On the D2 mission, detectors will be worn by the astronauts and placed near the biological experiments as control indicators. They also will be placed in the biostacks, which are stacks of trays containing small biological specimens such as plant seeds, insect eggs and bacterial spores, alternating with radiation detectors. The results of these experiments will contribute to the assessment of the biological effects of specific cosmic radiation and so help to reduce the health risks for future human exploration missions.

- BIOLOGICAL HZE-PARTICLE DOSIMETRY WITH BIOSTACK

This experiment is part of a radiobiological space research program including experiments in space as well as at accelerators on Earth. The program has been specially designed to increase knowledge on the importance, effectiveness and hazards to humans and to any biological specimen in space of the particles of high atomic number and high energy of the cosmic radiation. Its unknown proper biological effectiveness may significantly affect the design of the space station and its operation. Findings of earlier Biostack experiments clearly indicate the significance of high energy particles. More detailed information is necessary and requires more investigations in this matter.

- PERSONAL DOSIMETRY: MEASUREMENT OF THE ASTRONAUT'S IONIZING RADIATION EXPOSURE

Personal dosimetry of the astronauts' ionizing radiation exposure is an indispensable part of the biomedical surveillance in human spaceflight. The different components of the cosmic radiation field are to be measured with different, passive and tissue equivalent, radiation detectors, each specialized for the registration of, respectively, the heavy ions, the nuclear disintegration stars, and the sparsely ionizing background radiation, i.e., the electrons, protons and rays. Small stacks of these detectors are to be attached to the astronauts' bodies in the vicinity of potentially critical organs to establish a permanent record of the astronauts' exposure to the cosmic radiation field.

- MEASUREMENT OF THE RADIATION ENVIRONMENT INSIDE SPACELAB AT LOCATIONS WHICH DIFFER IN SHIELDING AGAINST COSMIC RADIATION

The experiment has the objective to document the radiation environment inside the Spacelab and to compare the experimental data with theoretical predictions. This will provide radiation baseline data required for the flight personnel and any radiation sensitive experiment and material. These data are necessary for establishing radiation protection guidelines and standards for the presence of people in space. For this purpose, containers with different kinds of radiation detectors will be placed in locations which differ in shielding against cosmic radiation. The analysis of the dosimeters will be performed after flight in the laboratories of the investigators.

- CHROMOSOME ABERRATION

Chromosomal aberrations, micronuclei and sister-chromated exchanges will be analyzed in the peripheral lymphocytes of astronauts. The analysis will be performed shortly before and after the space flight and 4 weeks, 6 months and 1 year after the flight. The data obtained will be used as a biological dosimeter for the exposure of astronauts to ionizing radiation during the space flight.

- BIOLOGICAL RESPONSE TO EXTRATERRESTRIAL SOLAR UV RADIATION AND SPACE VACUUM

The photobiological and photobiochemical response to solar UV radiation in space will be studied in spores of Bacillus subtilis and in DNA isolated from Hemophilus influenzas. For that purpose, 2 exposure trays, accommodating the biological samples for exposure to space vacuum and/or to selected intensities and wavelengths of extraterrestrial solar UV radiation, will be mounted onto the User Support Structure.

USER SUPPORT STRUCTURE (USS) PAYLOADS

A structure mounted in the Columbia's cargo bay near the module provides support for additional experiment facilities which can be connected to the module for power and data, but which may run independently.

The Material Science Autonomous Payload (MAUS) is comprised of two experiments: one explores diffusion phenomena of gas bubbles in salt melts, while the other performs research of complex boiling processes.

- POOL BOILING

Nucleate pool boiling in theory is strongly gravity dependent. The MAUS experiment with its good zero-g quality should confirm results of KC-135 parabolic flight missions that pool boiling is quasi gravity independent.

- GAS BUBBLES IN GLASS MELTS

The shrinking of a single oxygen bubble in a cylindrical sample is observed to determine the diffusion coefficient in a soda-lime-silica melt. A camera takes pictures of the bubble in certain time intervals. The diffusion coefficient can be calculated from this radius-time dependence by means of a finite differences method.

- REACTION KINETICS IN GLASS MELTS

Goal of these experiments is the determination of diffusion coefficients in order to verify mathematical models describing mass transport in glass melts. Two types of experiments will be conducted: interdiffusion between glass melts of the system and corrosion of silica glass by alkali silicate melts. Sixteen individual samples in four separate furnaces will be processed at temperatures of 1470 K and 1520 K for 20 or 40 minutes of annealing time.

The Atomic Oxygen Exposure Tray (AOET) is a self-standing facility located on the support structure that performs experiments in the field of material science. The AOET uses the orbiter as an exposure laboratory to obtain inside reaction rate measurements for various materials interacting with atomic rate measurements for various materials interaction with atomic oxygen with the low-Earth orbital environment.

AOET is dedicated to investigate the erosion effects on a technological basis. Erosion is supposed to be a vital problem for the realization of future space vehicles like Columbus, the European segment of the U.S. Space Station Freedom. The lifetime of its structural materials is defined to 30 years. Prime candidates are fiber reinforced materials which have to be protected against erosion.
The AOET is a quasi passive sample array mounted onto the Unique Support Structure within the cargo bay such that the samples are facing the incoming atmospheric flow. The 124 sample plates are either circular or rectangular sized, depending on post mission analysis needs.

The Galactic Ultrawide-Angle Schmidt System Camera (GAUSS) is an ultraviolet camera used to provide wide-angle, photographic coverage of the galaxy. Pictures taken of the Milky Way galaxy, younger stars and the gas clouds, which they warm up, will extend the knowledge of our galaxy significantly. A number of exposure of the Earth's atmosphere also are planned when the orbiter bay faces the Earth. The GAUSS camera is a mirror system for the ultraviolet with a field of view of 145 degrees. About 100 exposures of the Milky Way and the upper atmosphere shall be taken.

The Modular Optoelectronic Multispectral Stereo Scanner (MOMS) is an advanced camera system for Earth observation. The instrument is located on the USS platform and provides imaging data from space for photogrammetric mapping and thematic mapping applications. It is an improved instrument based on MOMS-01 that was flown in 1983 and 1984.

MOMS-02 improves existing Earth observations with its long- track, high-performance stereo capabilities and digital images of higher geometric resolution and accuracy. Through the high geometric resolution and geometric accuracy of the threefold stereo module, it is possible to derive digital terrain models with a precision of better than 5 m. The optimized multispectral module aims at improved thematic information. New understandings in applications such as cartography, land use, ecology and geology are expected.

CREW TELESUPPORT EXPERIMENT (CTE)

This experiment combines an onboard computer-based, multi- media documentation file, including text, graphics and photos, with a real-time, graphical communication between the on-orbit crewmember and the ground station. The result of CTE will enhance the effectiveness of the following areas: * On-orbit payload operations * Scientific return * Crew to ground interaction * Contingency maintenance tasks for systems and payloads Equipment used for the CTE is the interactive Hypermedia documentation file stored on an optical disk and a Macintosh portable computer equipped with a pen-activated, interactive graphics tablet as a peripheral.

SHUTTLE AMATEUR RADIO EXPERIMENT (SAREX)

Students in the United States and around the world will have a chance to speak via amateur radio with astronauts aboard the Space Shuttle Columbia during STS-55. There also will be voice contacts with the general ham community as time permits. Also during the mission, an antenna test will be conducted on orbits 61 and 62 involving many amateur radio stations in the southern U.S. who will measure the exact time of acquisition of signal and loss of signal along with other data.

Shuttle Commander Steve Nagel (call sign N5RAW), Pilot Jerry Ross (N5SCW) and payload specialists Hans Schlegel (DG1KIH) and Ulrich Walter (DG1KIM) will talk with students in nine schools in the United States and with students in France, Australia and South Africa using "ham radio."

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

- Meadow Village Elementary, San Antonio, Texas (WA5FRF)
- Fairmont Elementary, Deer Park, Texas (N5NBM)
- John S. Ward Elementary, Houston (N5EOS)
- Cumberland Junior High, Sunnyvale, Calif. (WZ6N)
- Mudge Elementary, Fort Knox, Ky. (KE4NS)
- Seven Mills and Lotspeich Elementary, Cincinnati (KF8YA)
- St. Martin's Episcopal, Metairie, La. (N4MDC)
- Trumansburg Middle, Trumansburg, N. Y. (N2PNA)
- Air Force Academy, Colo. (K0MIC)

The international schools that will communicate with the crew are:

- Westering High School, Port Elizabeth, South Africa
- Sisekelo High School, Swaziland, South Africa
- Tamworth High School, New South Wales, Australia
- Gladstone State High School, Gladstone, Queensland, Australia
- French Air Force Academy, Salon de Prov, France

The astronaut/student radio contact is part of the SAREX project, a joint effort by NASA, the American Radio Relay League (ARRL) and the Amateur Radio Satellite Corporation (AMSAT).

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

SAREX is a secondary payload located in Columbia's crew cabin. Another amateur radio experiment, called SAFEX, will be aboard the Spacelab D2 module and will be operated by licensed German payload specialists. SAFEX uses an external dual band 2 meter/70 cm antenna mounted on the outside of the Spacelab while SAREX uses a window-mounted antenna in the Shuttle's cockpit.

Information about orbital elements, contact times, frequencies and crew operating schedules will be available during the mission from NASA, ARRL and AMSAT.

The ham radio club at the Johnson Space Center (W5RRR) will be operating on amateur short wave frequencies, and the ARRL station (W1AW) will include SAREX information in its regular voice and teletype bulletins.

There will be a SAREX information desk during the mission in the JSC newsroom. Mission information will be available on the computer bulletin board (BBS). To reach the bulletin board, use JSC BBS (8 N 1 1200 baud), dial 7713-483-2500, then type 62511.

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

STS-55 SAREX Frequencies

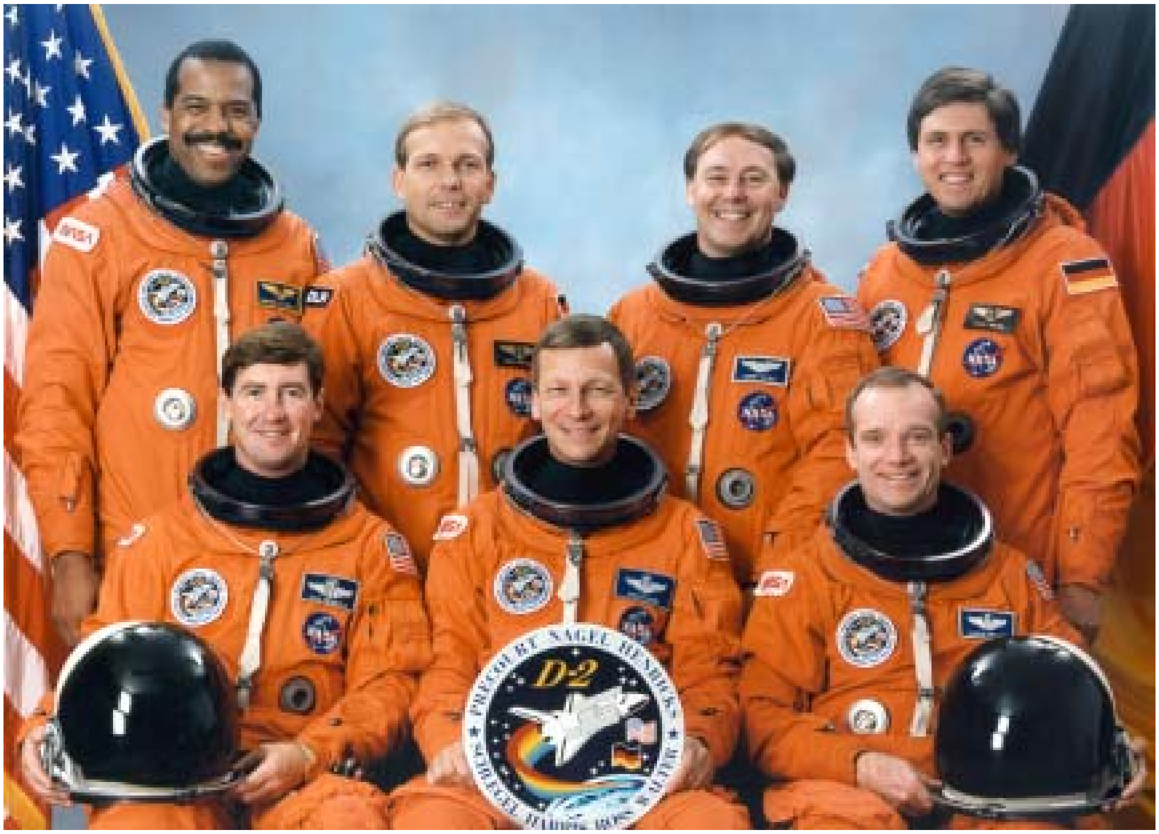
Routine SAREX transmissions from the Space Shuttle may be monitored on 145.55 MHz for downlink. This 600 kHz spacing in the transmit/receive frequency pair is compatible with amateur VHF equipment.

Voice Uplink Frequency	144.91 MHz
	144.93
	144.95
	144.97
	144.99
Packet downlink frequency	144.55
Packet uplink frequency	144.49

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

3.860 MHz
7.185
14.295
21.395
28.395

STS-55 CREWMEMBERS



STS055-S-002 – STS-55 Columbia, Orbiter Vehicle (OV) 102, crewmembers, wearing their launch and entry suits (LESs), pose for their official crew portrait. Five NASA astronauts and two German payload specialists, assigned to fly aboard OV-102 in support of Spacelab Deutsche 2 (SL-D2), are pictured. On the front row (left to right) are pilot Terence T. Henricks, mission commander Steven R. Nagel (holding crew insignia), and mission specialist Charles J. Precourt. In the back are (left to right) mission specialist Bernard A. Harris Jr., payload specialist Hans Schlegel, mission specialist and payload commander Jerry L. Ross, and payload specialist Ulrich Walter. In the background are the United States and German flags. Portrait made by NASA JSC contract photographer Robert L. Walck.

BIOGRAPHICAL DATA

STEVEN R. NAGEL, 47, Col., USAF, will command STS-55. Selected as an astronaut in 1979, Nagel's hometown is Canton, Ill. He will be making his fourth space flight.

Nagel graduated from Canton Senior High School in 1964, received a bachelor's degree in aeronautical and astronautical engineering from the University of Illinois in 1969 and received a master's degree in mechanical engineering from California State University in 1978.

He first flew as a mission specialist on STS-51G in June 1985, a flight that deployed three commercial communications satellites. His next flight was as Pilot on STS-61A in November 1985, the first West German-United States cooperative Spacelab mission. His third flight was as Commander of STS-37 in April 1991, a mission that deployed NASA's Gamma Ray Observatory. Nagel has logged 483 hours in space.

TERENCE T. "TOM" HENRICKS, 41, Col., USAF, will be Pilot of STS-55. Selected as an astronaut in June 1985, Henricks considers Woodville, Ohio, his hometown and will be making his second space flight.

Henricks graduated from Woodmore High School in 1970, received a bachelor's degree in civil engineering from the Air Force Academy in 1974 and received a master's degree in public administration from Golden Gate University in 1982.

Henricks graduated from the Air Force Test Pilot School in 1983 and was serving as an F-16C test pilot at the time of his selection by NASA. He has logged more than 3,600 hours of flying time in 30 different types of aircraft and holds a master parachutist rating with 747 jumps to his credit.

His first space flight was as Pilot of STS-44 in November 1991, a Department of Defense-dedicated Shuttle flight that deployed the Defense Support Program satellite. He has logged more than 166 hours in space.

JERRY L. ROSS, 45, Col., USAF, will be Mission Specialist 1 (MS1). Selected as an astronaut in May 1980, Ross' hometown is Crown Point, IN, and he will be making his fourth space flight.

Ross graduated from Crown Point High School in 1966, received a bachelor's degree in mechanical engineering from Purdue University in 1970 and received a master's degree in mechanical engineering from Purdue in 1972.

Ross' first flight was as a mission specialist on STS-61B in November 1985, a mission that deployed three commercial communications satellites and on which Ross performed two spacewalks to test space station construction methods. His next flight was STS-27 in December 1988, a classified Department of Defense-dedicated mission. His third flight was on STS-37 in April 1991, a mission that deployed NASA's Gamma Ray Observatory and on which Ross performed two spacewalks, one to unstick a balky antenna on the satellite and another to evaluate space station hardware. Ross has logged 414 hours in space and 23 hours of spacewalk time.

BIOGRAPHICAL DATA

CHARLES J. PRECOURT, 37, Major, USAF, will be Mission Specialist 2 (MS2) on STS-55. Selected as an astronaut in January 1990, Precourt considers Hudson, Mass., his hometown and will be making his first space flight.

Precourt graduated from Hudson High School in 1973, received a bachelor's degree in aeronautical engineering from the Air Force Academy in 1977, received a master's degree in engineering management from Golden Gate University in 1988 and received a master's in national security affairs and strategic studies from the Naval War College in 1990.

Precourt graduated from the Air Force Test Pilot School in 1985 and served as a test pilot in the F-15E, F-4, A-7 and A-37 aircraft. He was selected as an astronaut after graduating from the Naval War College and has logged more than 4,300 hours of flying time in 35 different types of aircraft.

BERNARD A. HARRIS Jr., 36, M.D., will be Mission Specialist 3 (MS3). Selected as an astronaut in January 1990, Harris was born in Temple, Texas, and will be making his first space flight.

Harris graduated from Sam Houston High School in San Antonio in 1974, received a bachelor's degree in biology from the University of Houston in 1978 and received a doctorate of medicine from Texas Tech School on Medicine in 1982.

Harris completed a residency in internal medicine at the Mayo Clinic in 1985, completed a National Research Council Fellowship at NASA's Ames Research Center in 1987 and trained as a flight surgeon at the Aerospace School of Medicine at Brooks Air Force Base in San Antonio in 1988.

Harris joined NASA in 1987, serving as a clinical surgeon and flight surgeon at the Johnson Space Center until his selection as an astronaut.

ULRICH WALTER, 38, will be Payload Specialist 1 (PS1). Nominated as a German astronaut by the German space agency in 1987, Walter was born in Iserlohn, Germany, and will be making his first space flight.

Walter graduated from Iserlohn's Markisches Gymnasium in 1972, graduated with a degree in physics from the University at Cologne in 1980 and received a doctorate in solid state physics from the University of Cologne in 1985. He performed post- doctoral work at the Argonne National Laboratory in Chicago in 1986 and at the University of California-Berkley in 1987.

HANS WILHELM SCHLEGEL, 41, will be Payload Specialist 2 (PS2). Nominated as a German astronaut in 1987, Schlegel was born in Oberlingen, Germany, and will be making his first space flight.

Schlegel graduated from Hansa Gymnasium in Cologne in 1970 and received a diploma in physics from the University of Aachen in 1979.

From 1979-1986, Schlegel was a member of the academic staff at Rheinisch Westfalische Technische Hochschule at the University of Aachen as an experimental solid state physicist. From 1986- 1988, he was a specialist in non-destructive testing methodology in the research and development department of the Institut Dr. Forster GmbH and Co. KG in Reutlingen, Germany.

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H. Martinides	Head of Microgravity Payload Division
K. Knott	Head of Columbus Interfaces and Payload Studies Division

SHUTTLE FLIGHTS AS OF FEBRUARY 1993

54 TOTAL FLIGHTS OF THE SHUTTLE SYSTEM -- 29 SINCE RETURN TO FLIGHT

OV-102 Columbia (13 flights)	OV-099 Challenger (10 flights)	OV-103 Discovery (16 flights)	OV-104 Atlantis (12 flights)	OV-105 Endeavour (3 flights)
		STS-56 04/08/83 - 04/17/93		
		STS-53 12/02/92 - 12/09/92		
		STS-42 01/22/92 - 01/30/92		
STS-52 10/22/92 - 11/01/92		STS-48 09/12/91 - 09/18/91		
STS-50 06/25/92 - 07/09/92		STS-39 04/28/91 - 05/06/91	STS-46 07/31/92 - 08/08/92	
STS-40 06/05/91 - 06/14/91		STS-41 10/06/90 - 10/10/90	STS-45 03/24/92 - 04/02/92	
STS-35 12/02/90 - 12/10/90	STS-51L 01/28/86	STS-31 04/24/90 - 04/29/90	STS-44 11/24/91 - 12/01/91	
STS-32 01/09/90 - 01/20/90	STS-61A 10/30/85 - 11/06/85	STS-33 11/22/89 - 11/27/89	STS-43 08/02/91 - 08/11/91	
STS-28 08/08/89 - 08/13/89	STS-51F 07/29/85 - 08/06/85	STS-29 03/13/89 - 03/18/89	STS-37 04/05/91 - 04/11/91	
STS-61C 01/12/86 - 01/18/86	STS-51B 04/29/85 - 05/06/85	STS-26 09/29/88 - 10/03/88	STS-38 11/15/90 - 11/20/90	
STS-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-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-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-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