SPACE SHUTTLE PAYLOADS
PAYLOAD INTEGRATION
ULTRAVIOLET SPECTROMETERS
FLUID DYNAMICS
GRAVIRECEPTORS

LUMINESCENCE
NITROGEN DIOXIDE
CHEM. COMPOSITION
CENTRIFUGING
FUNGI
AIRGLOW
THERMAL ENVIRONMENTS

D7-12

N86-27304

8P

8960

CU IN SPACE: The University of Colorado Get Away Special Payload G-285

Presented by CU508845

Kent Tobiska
University of Colorado
Boulder, CO 80309

Getaway Special Team
University of Colorado

PROJECT OVERVIEW

The University of Colorado's first Get Away Special was conceived by a dozen science and engineering students in the spring of 1984. Since that time, the project has grown to include over 100 undergraduate and graduate students who have provided the experimental objectives, design, construction, integration, testing and management of the payload. Faculty and staff of the university and its affiliated laboratories as well as engineers from local industries have provided many useful suggestions at all stages of development.

The principal motivation for developing this payload is to provide university students with the opportunity to participate in space science and engineering beginning at the ground level. At the same time, they are contributing their results from new science and technological discoveries to several disciplines.

There are four separate experiments integrated into the single payload of G-285 which are supported by internal payload power, thermal environment control, command and data handling facilities and structural subsystems. The four experiments contained in this payload are: a single spectrometer performing two experiments- one to study night time shuttle glow phenomena in the ultraviolet and the other to observe NO2 concentrations over equatorial latitudes in the day; a fluids mannagement experiment using centrifugation for particle/liquid/vapor separation; and an experiment using Phycomyces fungi to study the gravireceptor mechanism theory.

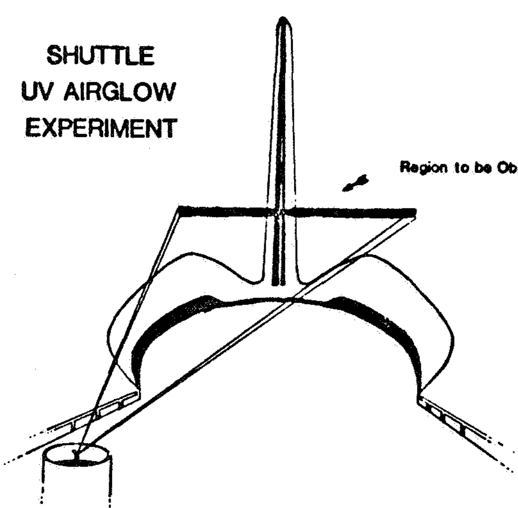
The experiments are supported by a microprocessor, data storage devices, power and thermal control subsystems. All these are located within a sealed aluminum container. The container, a refitted sounding rocket casing, has a top and bottom which bolt to the main body of the rocket section. The top section holds a five inch diameter quartz window through which light enters the spectrometer. A rotating mirror assembly and one of two battery boxes are mounted on the outside of the top section below the interface plane of the MDA. A second battery box is attached to the bottom section of the sealed container. All payload items except the battery boxes and mirror assembly are located inside the sealed rocket section to insure containment and to prevent outgassing of materials. The container will be sealed prior to launch and purged with one atmosphere of argon.

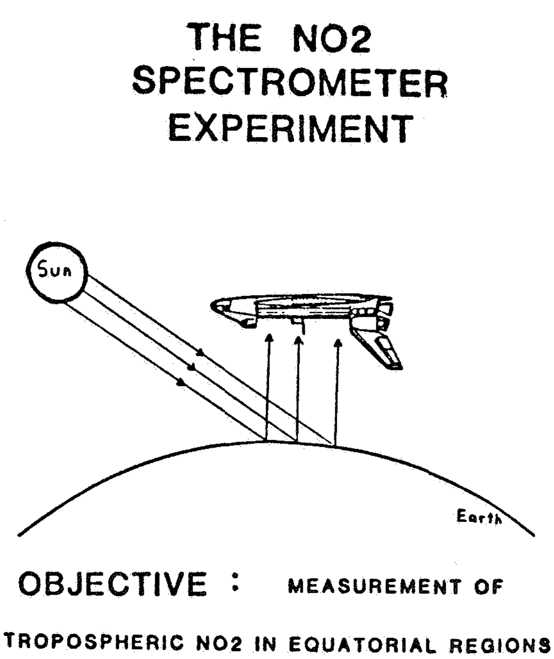
THE SCIENCE: Atmospheres, Fluids, Biology

A,B) UV/VIS Spectrometer Experiments

The objective of the shuttle glow experiment is to conduct a general survey of atmospheric emissions near moving surfaces during dark portions of each shuttle orbit. The 1900-3100 A (UV) wavelength range of the refitted Ebert-Fastie spectrometer yields information about atomic and molecular interactions occurring in the near-shuttle environment. A rotating mirror assembly set at the correct tail-viewing angle focuses light into the spectrometer from the vicinity of the rear stabilizer (tail). The second spectrometer experiment makes use of the instrument's visible light sensitivity by taking nadir observations of tropospheric NO2 over equatorial latitudes during sunlit portions of each shuttle orbit. With the mirror assembly used in the night-time glow study commanded to an upright position, continuum emission from visible NO2 enters the spectrometer through the quartz window. Data for both atmospheric experiments are stored on the same storage device.

To successfully perform both spectrometer experiments, the instrument is mounted vertically with respect to the GAS can. This gives visible light direct access to the optical train of the spectrometer during daylight. During dark orbit segments, the instrument's field of view is directed onto the rear stabilizer by the mirror assembly, which rotates through 7.5 degrees of arc using ten positions, resulting in 30x3 cm spatial resolution. This configuration allows for the aquisition of data both on and off the shuttle tail surface with a spectral resolution of less than 10 A.



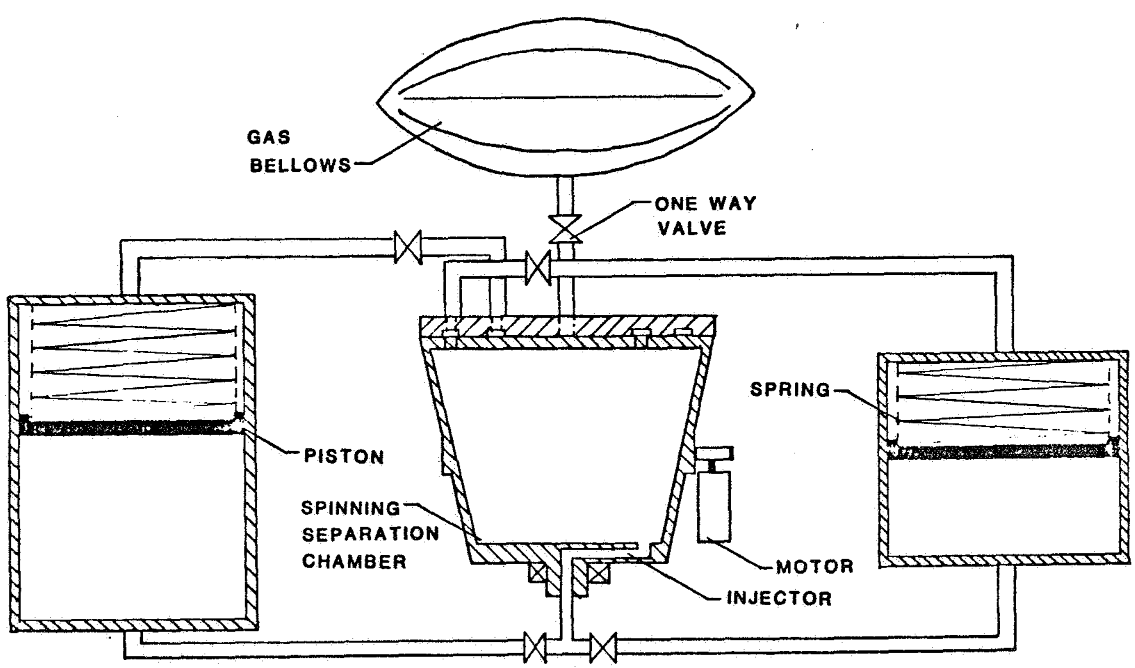


C) Fluid Management Experiment

Management of fluids in space is complicated by the behavior of fluids in the absence of gravity as well as by the limited quantity of fluids that are typically available for use. Three specific model problems have directed the designing efforts: liquid degassification, solid-liquid-gas separation, and algae growth, separation and harvesting. To address these problems, a system has been designed that is conservative, requiring little energy, and can be applied to a wide variety of fluids management challenges.

The apparatus incorporates a centrifugal approach using a truncated cone-shaped spinning separation chamber, coupled with density-dependent valving. Degassification of fluids and the separation of multi-phased media is achieved while creating the pumping pressures needed to move the separated media to desired areas. Data is retrieved through photographic and pressure measurements. Upon return of the shuttle, the results should doccument the overall viability of fluids management by centrifugation in a microgravity environment.

SCHEMATIC OF FLUID MANAGEMENT EXPERIMENT



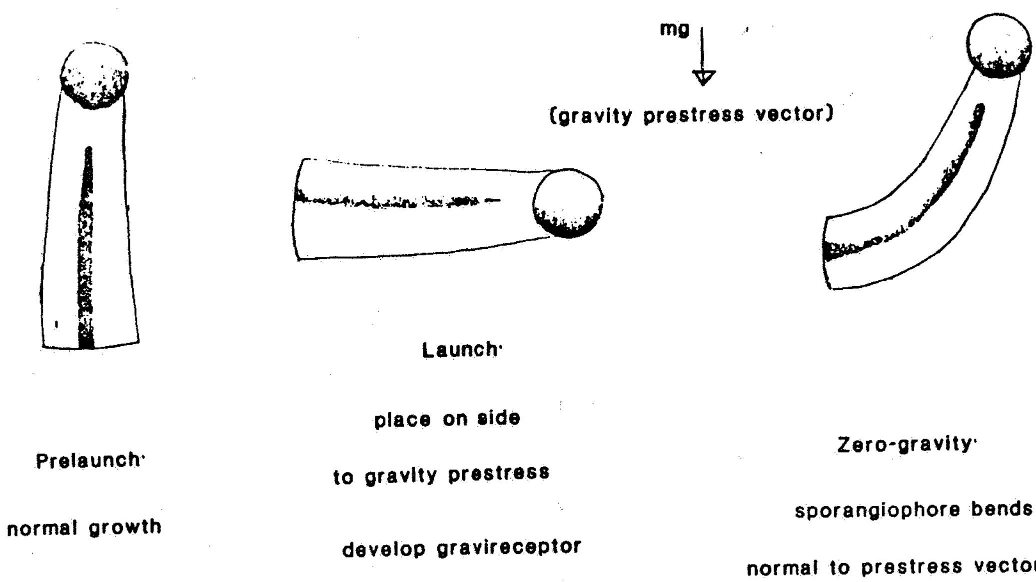
D) Phycomyces Fungi Experiment

The final experiment is designed to study the harmless, non-toxic single-celled Phycomyces fungi to verify a current theory on plant cell susceptibility to gravity and acceleration stresses. A zero-gravity environment is required to verify the proposed mechanism for cellular reorientation: it is anticipated that the sporangiophores will bend toward the normal with respect to the gravity forces generated by the shuttle takeoff acceleration vector.

Because the G-285 payload must sit unattended for 2-3 months prior to launch, students have performed experiments aimed at prolonging the dormancy of the fungus which otherwise has a shelf-life of only a few weeks. Five days prior to launch, growth is initiated in the fungi by dropping inactive spores onto a growth medium. At launch, the beds containing the growing phycomyces will be rotated on a gimbal assembly through 90 degrees and locked into place. Data pertaining to the subsequent growth patterns will be recorded on film for two hours after launch.

PHYCOMYCES FUNGI

EXPERIMENT



ORIGINAL PAGE IS
OF POOR QUALITY

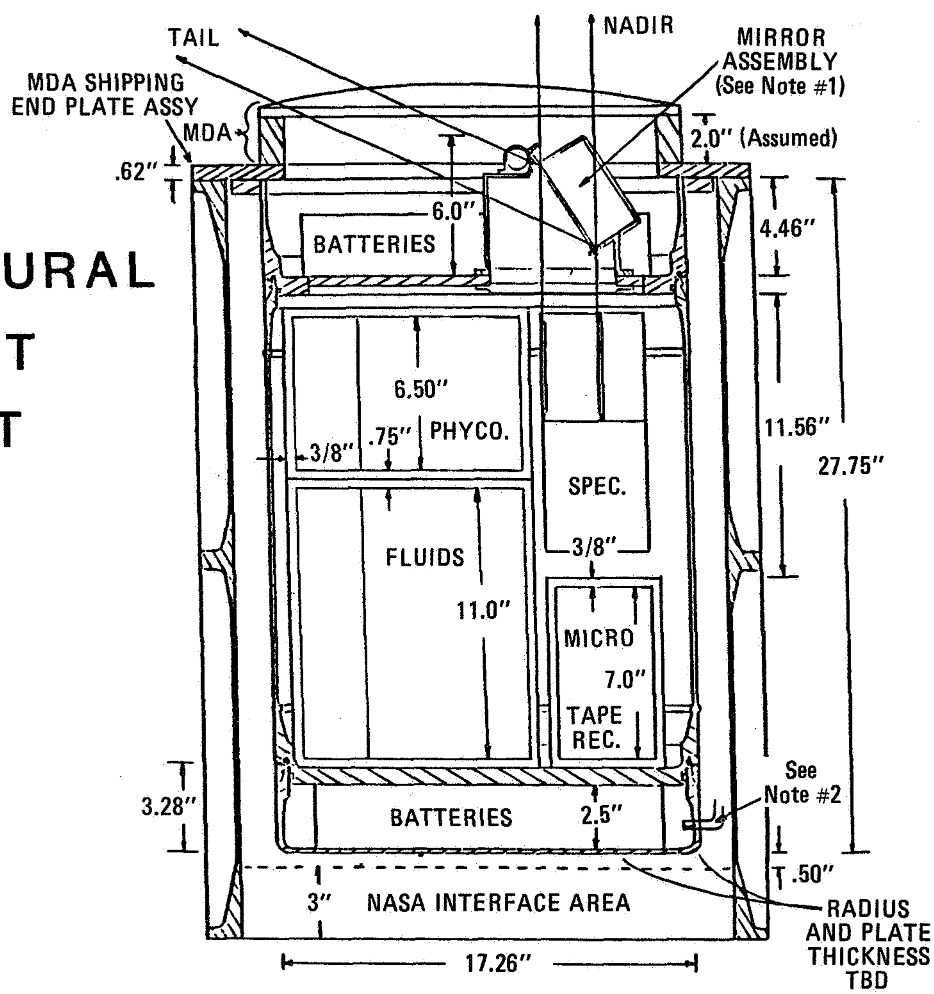
ENGINEERING SUBSYSTEMS

A) Support Structure

GAS experiments must be fully self-supported and self contained. The University of Colorado payload requires the five cubic feet user space of a cylinder 28.25 inches in height and 19.75 inches in diameter. G-285 requires the lid of the cannister to opened during flight to accomodate the two atmospheric experiments, thus restricting any exposed surfaces to non-outgassing space qualified materials. For this reason, G-285 uses a sounding rocket casing (6061 T-6 Al) to house the experiments and their supporting equipment.

The bottom of the rocket casing is also fabricated out of 6061 aluminum and is designed to withstand the shuttle's extreme buffeting with only small deflections. The loading of the support structure has been analyzed using a worst-case scenario. At about 1000 Hz, the effective loading would be as much as 188 times its static weight. Even in this extreme case, the weight of the structure can be kept low enough to meet NASA's weight requirements while providing a safe environment for the internal science and engineering packages.

STRUCTURAL SUPPORT SIDECUT

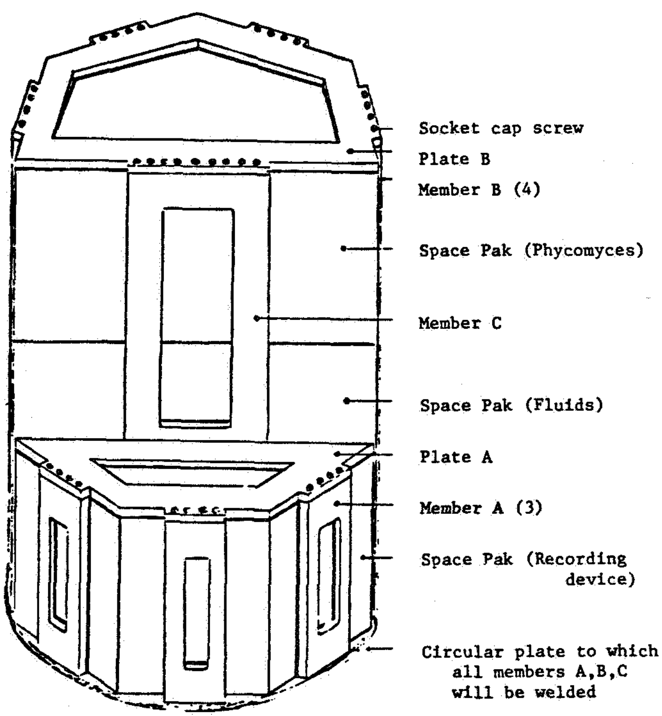


B) Space Paks

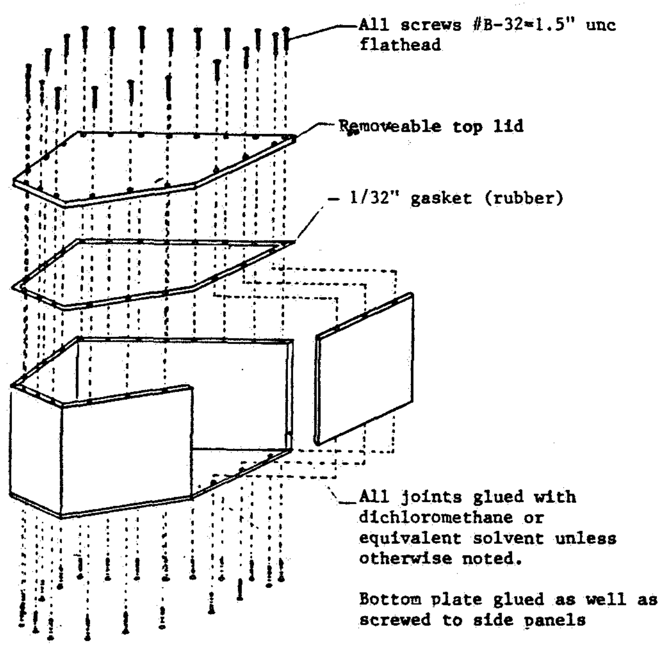
Internal to the rocket section, individual quasi-hexagonal space paks contain the fluids management experiment, fungus experiment, and the microprocessor/data storage units. (The spectrometer and bright object sensor are not housed within a space pak). The space paks are constructed of polycarbonate material (Lexan) to provide strength, low weight, visibility from the outside, and ease of construction.

Space paks serve two functions: to provide a mounting surface for the experiment apparati and to isolate one system from another. Each space pak is sealed with an O-ring and contains one atmosphere of air at the time of installation. The rocket cannister as a whole is purged with argon prior to flight, in order to maintain a non-emitting environment for the spectrometer experiments.

SPACE PAKS within Structural Casing



Structural Material: Aluminum 2024-T4*



ALL PANELS MACHINED FROM 3/8" THICK POLYCARBONATE

*Rubber will be used between space paks and all plates and members

EXPLODED VIEW

TYPICAL SEALED CONTAINER ASSEMBLY

C) Power Subsystem

The power subsystem provides electrical power for all four experiments and all support equipment in the canister. The G-285 payload has the somewhat prodigious power requirements of sequentially running the fluids experiment motor drive, data storage devices, MDA, spectrometer, and a series of thermistors that maintain an ambient thermal environment in the sealed rocket canister. Silver-zinc batteries will supply all power to the payload. For safety considerations, fuses have been inserted into most of the circuits.

The batteries are constrained both upon activation as well as during flight by two battery boxes that are attached top and bottom to the outside of the sealed container. Since the battery outgasses during discharge, it is necessary to vent any pressure buildup and possible combustion of gas mixture through purge valves located on the upper end plate.

D) Thermal Subsystem

The thermal environment of G-285 could be considered an exercise in extremes. While worst case scenarios of the cargo bay facing into direct sunlight and toward deep space occur infrequently, the sensitive design of the spectrometer and the fluids management vessels containing liquid require an active temperature monitoring system to prevent overheating and/or freezing of the experimental components. Maximum heat loss from the container occurs while performing the two atmospheric experiments with the open MDA. Maximum heat gain occurs when the shuttle cargo bay is illuminated by solar radiation.

An operational scenario has been devised to maintain the most stable thermal environment possible in addition to insulating the can's interior. The biology experiment reaches completion two hours after the shuttle is launched, and has no residual thermal requirements beyond maintaining a suitable environment for the photographic film on which its results are stored. The fluids management experiment, time-lined to operate for approximately two hours, will be kept at a relatively constant temperature by means of small thermmistors placed strategically throughout the rocket section. Power to run the centrifuge motor will add a small amount of heat to the system, but is not anticipated to significantly affect the results of the experiment. At the completion of the fluids study, the MDA is commanded open and held in an upright position. The spectrometer is powered up for the next 48 hours, during which time the shuttle glow and NO2 observations are made. In the event that the thermistors are unable to keep the spectrometer sufficiently warm (as heat is being radiated outward to space), or that the can interior heats up due to solar illumination, the microprocessor will automatically close the MDA. Because the temperature is constantly monitored, in the event that interior temperatures stabilize within the preset limits, the MDA will be reopened and data collection will resume.

COMMAND AND DATA HANDLING SUBSYSTEM

The Command and Data Handling Subsystem of the University of Colorado Get Away Special project consist of a controlling microcomputer and two types of data storage units. The microcomputer system is comprised of National Semiconductor MA2000 Macrocomponent modules. The central processing unit module (MA2800) incorporates an 8 bit NSC 800 microprocessor operating at 2.5 MHz, 4K bytes of ROM, 2K bytes of RAM and a real time clock. These modules represent a family of stackable microcomputer function blocks which are configured in such a manner as to interface with the following systems:

I. UV/NO2 Spectrometer
II. Fluids management experiment
III. Data storage devices
   a. Bubble memory
   b. Hard disk
IV. Bright object sensor (to protect the UV experiment photomultiplier tube from direct sunlight)
V. Network of pressure and temperature sensors

Data acquired from the UV/NO2 experiment, the fluids management experiment, the pressure and temperature sensors will be stored, along with time tags, in bubble memory. The hard disk system, which has never been used in this environment before, will be used as the secondary data storage system and will continue to collect data after the bubble memory has been completely filled.