PROJECT EXPLORER TAKES ITS SECOND STEP: GAS-608 IN ENGINEERING DEVELOPMENT

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Written for the Explorer Team
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Abstract

As a continuation of its Project Explorer series, the Alabama Space and Rocket Center is sponsoring the development of two additional Get Away Special payloads. This paper gives details of GAS-608, including descriptions of its six experiments in organic crystal growth, roach eggs, yeast, radish seeds, bacterial morphology, and silicon crystals. It also presents a brief summary of GAS-105 and the Space Camp program for stimulating student first-hand participation in space flight studies.

Continuing its series of Project Explorer payloads, the Alabama Space and Rocket Center (ASRC) is sponsoring its second Space Shuttle Get Away Special, GAS-608. Currently in its development phase, GAS-608 will carry six student experiments in a standard 200-pound, 5-cubic-foot cannister. In addition to these experiments, which will involve biology, crystal growth, and biochemistry, the cannister will also carry a centralized package for electronics and power supply. The purpose of this paper is to briefly review Project Explorer and its activities and to present some details of the components of GAS-608, along with a quick look at GAS-105.

Background

Conceived to stimulate interest in space flight in the educational community, Project Explorer is a program created by ASRC in cooperation with the National Aeronautics and Space Administration (NASA) and local universities. It is conducted with technical assistance from the Alabama/Mississippi Section of the American Institute of Aeronautics and Astronautics, Marshall Amateur Radio Club (MARC), and numerous volunteer-consultants. Explorer supports the Center's vigorous and expanding set of activities for youth and adults in the famous Space Camp. It does so by providing technical personnel to explain space flight principles and current NASA programs.

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Less well known are Explorer's arrangements to promote wider participation in space flight by offering actual flight opportunities. Students attending Space Camp whose experimental proposals are accepted are then invited to develop them in full with aid from Explorer personnel. The initial payload in the Explorer series, GAS-007, was successfully flown on the Space Shuttle Columbia as mission STS-61C in January 1986. Papers in earlier proceedings volumes of the GAS users' symposium furnish the reader with more depth on the design and development of GAS-007 (1-4, 6, 8). Details of the post-flight review of its results are given by Rupp (7) and also in another paper submitted for the proceedings of this conference (9).

Motivated by the success and appeal of GAS-007, ASRC has reserved the use of two additional payloads to develop new sets of student experiments. The first of these, GAS-105, is in development cooperatively with the Consortium for Materials Development in Space under the direction of Francis Wessling at the University of Alabama in Huntsville (UAH). Details on it have been provided by Wessling (5). GAS-608, the subject of this paper, is being developed separately in cooperation with UAH.

GAS-608 Experiment 1

Experiment #1, being prepared by Bryan Agran of Rye Brook, New York, will investigate the effect of low gravity on the incubation of fertilized eggs of the cockroach, *Periplaneta americana*. Some 10-20 capsules of 30 eggs each will be held in place with soft plastic packing inside a sealed, thermally insulated chamber. The eggs will be selected so that they represent different growth-cycle stages. An eight-week supply of food and water for the roaches will be carried as a "contingency hatching" measure. Humidity control is to be provided with a "dimplewick" water container. Agran's design calls for an ambient temperature range of about 10 ^{o}C to 30 ^{o}C for the dry nitrogen gaseous environment at one atmosphere pressure. After the mission has ended the sample roaches will be returned to Earth for hatching. Their behavior will be compared with a ground-based control sample to seek differences in balance, orientation, equilibrium, and habits such as feeding and reproduction.

Radish Experiment

As Principal Investigator for Experiment #2, Jay Andrews of Manlius, New York, is developing a study of the germination and growth of *Raphanus sativus* (radish) in an anaerobic environment under microgravity conditions. Sample seeds will be retained on a tray inside a chamber with dry nitrogen gas thermally controlled to a range of 20 ^{o}C to 30 ^{o}C. A directionally uniform low-intensity lamp will provide illumination for growth. Infrared photographs and atmospheric samples will be taken at timed intervals to support the study. Upon receipt of a start signal Andrews' apparatus will pressure-feed nutrients to the seeds in the form of Knop's solution and White's solution, along with dilute methylene blue. At a scheduled time the plants will be exposed to Formalin to terminate their growth. The preserved specimens will be subjected to post-flight morphological analysis and microscopic examination of tissue orientation and organization.

Yeast Genetics

The third experiment on GAS-608, static in nature, is being directed by Greg De Lory of San Francisco, California. De Lory's objective is to determine the effects of certain high-energy space radiations on the genetic mutations of a yeast, *Sacchoromyces cerevisiae*, and its variants. Some 30 lyopholized, or freeze-dried, samples of this yeast will be tested. Among these will be the haploid (single-strand) strains LBL1, LBL1/n, and KK1-122; a diploid (double-strand) strain that is

a hybrid of LBL1/n and KK1-122; and possibly tetraploid (quadruple-strand) strains. The samples are to be kept in small tubes secured in an aluminum performated plate which serves as a support structure. After reaching orbit the specimens will be exposed to X rays, gamma rays, and cosmic rays (ionizing charged, heavy atomic nuclei). Thermoluminescent detectors may be used as a passive particle counting system. Upon return to Earth the yeasts are to be examined for the radiations' effects on mitotic and meiotic chromosomal changes. The responses of the flight yeasts to selected chemically treated test plates will help determine any genetic changes, and these results will be compared to the patterns shown by Earth-based control samples.

Bacteria Morphology

Experiment #4, with Tom Malone of Roswell, Georgia, as Principal Investigator, will seek to find the influence of low gravity on colonial morphology of a specie of phototrophic bacteria in an anaerobic environment. A secondary objective is to evaluate the effects of bactericidal and bacteriostatic agents on growth of the colonies. Malone's approach is essentially visual: his bacteria will be exposed to a light source for a fixed time, photographs made periodically, and the growth process terminated upon signal. A post-flight analysis using photomicroscopy will compare morphology for the colonies flown in space to that for Earth-based control samples. The hardware plan calls for a sealed chamber which houses a 35 mm camera with a large film capacity; a thermometer; small fluorescent lamps as light sources; resistance heaters for thermal control; and sample plates treated with a sulfur agar growth medium. In addition to these major components there will also be a TattleTale II microprocessor with 224 K bytes of random access memory for sequencing, timing, thermostatic functions, and storage of data. Upon receipt of a start signal and electrical power from the central electronics assembly, the microprocessor, using a custom-written program, will exercise complete control over the experiment.

Silicon Growth

The fifth experiment has been dubbed SIGMA for short--Silicon Ingot Growth for Microgravity Application--by its Principal Investigator, Seth Watkins of Rye Brook, New York. In his arrangement several silicon samples will be heated in a furnace for approximately 50 minutes each. Crystal growth will be initiated for the samples in a dry nitrogen atmosphere. With electrical power provided from the central electronics assembly, Watkins' experiment is intended to run automatically once the start signal has been received. The objective of his study is to evaluate the influence on crystal quality, including dopant distribution, of the space environment. A comprehensive determination of the properties of the space-grown product will be made upon return of the samples to Earth.

Organometallic Crystals

Growth of linear conducting organometallic crystals by an electrochemical process is the general objective of Experiment #6. Developed by Ray Cronise IV of Huntsville, Alabama, his plan is to try to use the microgravity environment to eliminate the lattice defects which customarily reduce electrical conductivity in Earth-grown crystals. In this experiment Cronise will have three small samples of potassium tetracyanoplatinate (TCP) organometallic "complexes," and possibly their halogen derivatives, in aqueous solution. Application of a small voltage across each of the electrolytic cells is expected to form the desired products. Thermal control is particularly important to the growth process, and special design features are being incorporated throughout the apparatus to minimize heat losses. Additional details of Experiment #6 are given in Cronise's paper for this symposium (10).

MARCE

As was the case for GAS-007, the lifeblood of the GAS-608 cannister will be a system prepared for Explorer by MARC. This portion of the payload, designated as MARC Experiment (MARCE), will have a physical configuration similar to that used for GAS-007. Among its major components for this new payload are a microprocessor with memory for data storage and a solid rocket booster battery having a capacity of 50 amp-hr at 28 vdc. The battery will supply electrical power to heaters and other equipment in the cannister. The radio subsystem previously incorporated in MARCE for GAS-007 will be removed. Modifications to the microprocessor software will be made to fit the requirements of the six experiments. MARCE will again provide signals for power-on and power-off, sequencing, and timing. Such measurements as voltages and cannister temperature and pressure will be stored in its memory for post-flight analysis.

Development Status

When development of the individual GAS-608 experiments has been completed, the integrated package will be subjected to systematic testing prior to shipment to the Kennedy Space Center. While a precise mission assignment has not yet been made, it is expected that GAS-608 will be Shuttle-launched into a low Earth orbit with an inclination of 28°. A minimum mission duration of five days is being sought for full experimental results.

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