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RESULTS OF THE JOINT UTILIZATION OF LASER INTEGRATED EXPERIMENTS

FLOWN ON PAYLOAD GAS-449 ABOARD COLUMBIA MISSION 61-C

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ABSTRACT

The high peak power neodymium YAG laser and the HeNe laser aboard GAS-449 have demonstrated the survivability of the devices in the micro-gravity, cosmic radiation, thermal, and shock environment of space. Some pharmaceuticals and other materials flown in both the active and passive status have demonstrated reduction in volume and unusual spectroscopic changes. X-ray detectors have shown cosmic particle hits with accompanying destruction at their interaction points. Some scattering in the plates is in evidence. Some results of both active and passive experiments on board the GAS-449 payload are evaluated.

INTRODUCTION

GAS Payload G-449 (Fig. 1) was successfully flown aboard Columbia Mission 61-C between January 12, 1986 and January 18, 1986.

Payload GAS-449 operated as expected and was turned on during orbit #3, 3 hours and 43 minutes mission elapsed time and was turned off during orbit #8, at 10 hours and 48 minutes mission elapsed time. The timer on board GAS-449 operated for 30 minutes from start¹.

The payload was under development for over 2 1/2 years and combined the invited efforts of experimenters throughout the United States. The payload was flown upon the maiden flight of the GAS bridge². A total of 13 GAS containers were flown upon the bridge.

The experiments were divided into four separate sections which were BMJ, LEDAJ0, CROLO, and BLOTY. The BMJ experiment investigated the effects of neodymium and helium-neon laser light upon desiccated human tissue undergoing cosmic ray bombardment along with medications exposed to laser light and cosmic radiation bombardment. LEDAJ0 investigated radiation effects and some laser effects upon medications and medical/surgical materials and health care products. CROLO was designed to investigate cosmic radiation effects upon laser optical protective eyewear. BLOTY was designed to evaluate blood typing in zero gravity.

Six months after the mission was flown there have been some results which are now ready for publication. We expect that at year's end there will be additional material available for publication. Some of the results are as follows:

The 1 megawatt peak power miniature Q-switched YAG laser built and supplied by Laser Photonics, Orlando, Florida (Fig. 2) flown on board the payload operated as anticipated and pre-flight and post-flight testing indicates the laser to be fully operational. There appears to be no damage or side effects to the laser. The HeNe laser, supplied by Gammex Inc., Milwaukee, Wisconsin, in pre-flight and post-flight tests showed no operational damage or side effects.

EXPERIMENT REPORTS

EXPERIMENT BMJ - PRELIMINARY REPORT

Benjamin Narodick, M.D., Investigator, Cancer Chemotherapy Drug Project

The experiment BMJ was conducted to determine the effect of cosmic radiation, zero gravity and laser radiation on drugs, some of which are used in cancer therapy.

Background

- A. It has been widely reported that crystal formation in space (not being subjected to gravity) results in structural arrangements different from those in gravity³. There are also indications that changes in the molecular structure of solid substances can also occur perhaps due to being subjected to cosmic radiation.
- B. Cancer chemotherapy drugs vary in their ability to destroy cancer cells and while they have proved useful as an adjunct to surgery and X-ray radiation, mortality rate studies have been disappointing. It is possible that changes in molecular structure might enhance their effectiveness.
- C. Certain drugs, such as porphyrins, are known to concentrate in tumor tissue and acting as a photosensitizer, releases singlet oxygen when exposed to laser radiation. This photo therapy effect is now limited to superficial tissue. Space changes might enhance the sensitivity of the various drugs to laser light so that deep seated cancers might be effected by photo radiation.

Procedure

The most effective cancer chemotherapeutic drugs were studied for inclusion in the experiment. All were crystalline and of sufficient potency to be placed in a small glass vials and still be sufficient for study upon return from space. The manufacturers of the drugs were contacted and approval was obtained for these companies to conduct investigations and to report any alteration that might have occurred.

Because of space limitations, the drugs were placed in three groups:

- A. Nineteen vials subjected to cosmic radiation and weightlessness.
- B. Eight vials subjected to cosmic radiation, weightlessness and YAG laser irradiation.
- C. Three vials subjected to cosmic radiation weightlessness and HeNe laser radiation.

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Fig. 1

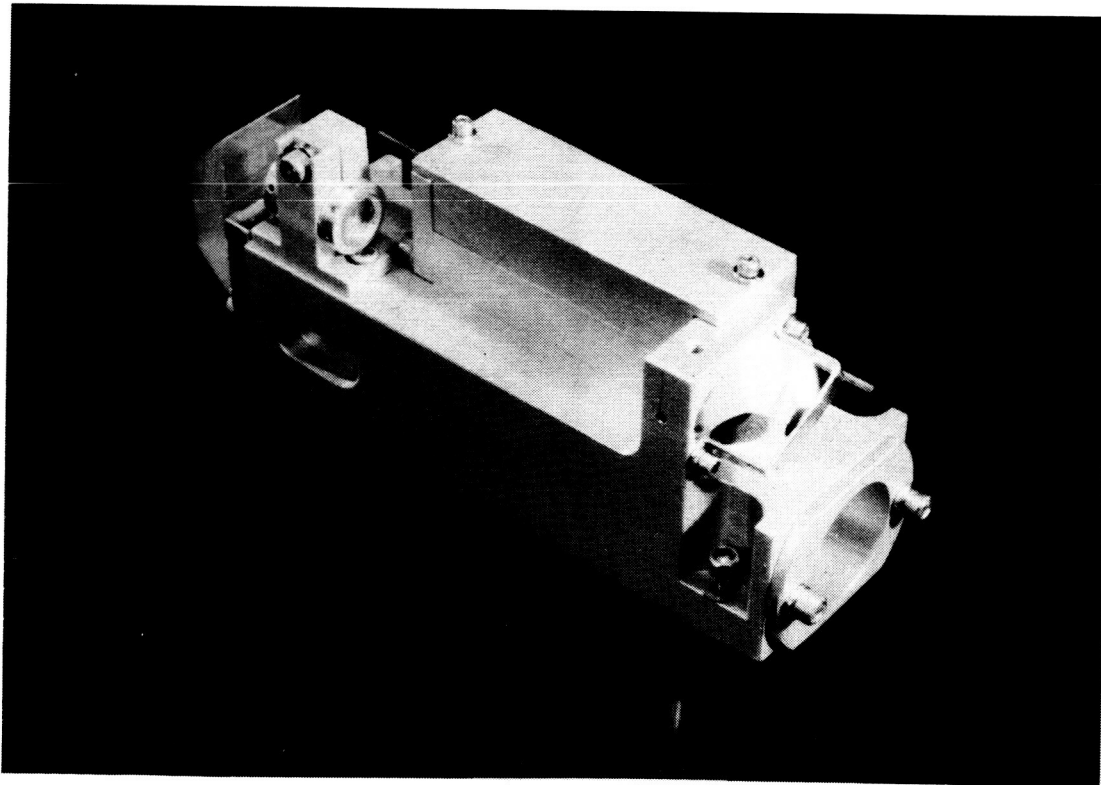


Fig. 2

Eleven different cancer chemotherapy drugs from the four major pharmaceutical companies and nine porphyrin compounds were distributed in the three groups. Doubles account for the number discrepancy.

Results

Upon opening the BMJ experimental compartment of GAS-449, some changes were immediately apparent. Although all vials were completely filled prior to flight, it is to be noted that two containers contained clumps of material, one approximately 20% of its initial volume (Fig. 3). All samples were returned to the manufacturers for complete analysis. Preliminary reports have been requested from the pharmaceutical companies. One has already been received showing no apparent chemical changes but animal studies have yet to be completed. One investigator has suggested that some unusual ultra-violet responses have occurred and there have been other hints of changes in the effectiveness of some of the drugs. I anticipate that final reports will be available by January 1, 1987.

Laser Carbon Experiment: Erich C. Muehlenbeck, M.D., Investigator

Electron microscopy and chemical studies are ongoing - reports due December 1986.

Tissue Experiment: Joseph H. Bellina, M.D., Ph.D.

Investigation in progress. Report is expected by the end of the year.

Optical Wave Guide Experiment: Stephen N. Joffe, M.D.

Currently evaluating transmission of Nd YAG laser wavelengths through the materials in the experiment.



Fig. 3

EXPERIMENT LEDAJ0 - PRELIMINARY REPORT

Leon Goldman, M.D.

Specimens were examined grossly under sterile techniques. One-half of the specimens have been sent to manufacturers for detailed investigation. Official report by research area is expected by the end of the year.

EXPERIMENT CROLO - PRELIMINARY REPORT

R. James Rockwell, Jr.

Effects Of Space Radiations On Laser Eye Protective Filters

Following the return of the filters, spectrographic analysis was performed and all cases were shown to have what appeared to be the same spectrographic characteristics on all filters as prior to flight. There appeared to be some surface changes that would require electron microscope analysis. This is being pursued at this time.

General conclusion: It appears that based upon the experiences from this flight, eye projection would provide adequate protection for laser exposure had they been required to be used.

EXPERIMENT BLOTY - PRELIMINARY REPORT

R. Tom Morehead, M.D., Thomas A. Olsen, MT (ASCP) SBB, Ellet H. Drake, M.D.

Erythrocyte Agglutination In Micro-Gravity

We tested the hypothesis that antibody mediated erythrocyte agglutination would be retarded in near zero gravity by launching a self contained experiment on board the Columbia space shuttle January 12, 1986. Experiment tested Rh, ADO and Coombs sensitized human red blood cells against their appropriate anti sera and diluents. A self contained device was built which mixed and pumped the reagents through tubing and collected the agglutinates on filter paper after optimal mixing and delay. The device was flown aboard GAS-449 in an insulated cannister which was carried on the bridge of the payload bay of the Columbia. The experiment was initiated on the third orbit about 3 hours and 43 minutes after launch. After conclusion of the experiment, the agglutinates were held on filter paper.

Both the Rh and Rh control test systems failed because of crystallization of the high protein antibody reagent. The remaining three systems functioned as expected. After comparing these results to similar experiments adopted in our lab under full gravity, we conclude that ADO and Coombs sensitized blood grouping tests do occur under micro-gravity although the agglutinates formed may be smaller and less discrete. We are exploring reasons for this difference. To our knowledge, this is the first experiment that tests blood agglutination in space.

DETECTORS

Investigation into the cosmic radiation effects upon CR-39, Lexan and X-ray plates will be part of a future paper. However, the X-ray plates (Kodak EP-21) have exposure and particle hit points. The CR-39 and Lexan are under evaluation and because of their attitude relationship to each experiment, we do not expect results before the end of the year. The materials mentioned were flown as detectors to ascertain cosmic radiation hit points and were located at discrete positions in each cannister aboard the payload.

OTHER PHENOMENON

Additionally, there are pits (Fig. 4) on the outside surface of the cannister containing the laser. The cannister is made of 303 stainless. The source of these pits is undetermined.

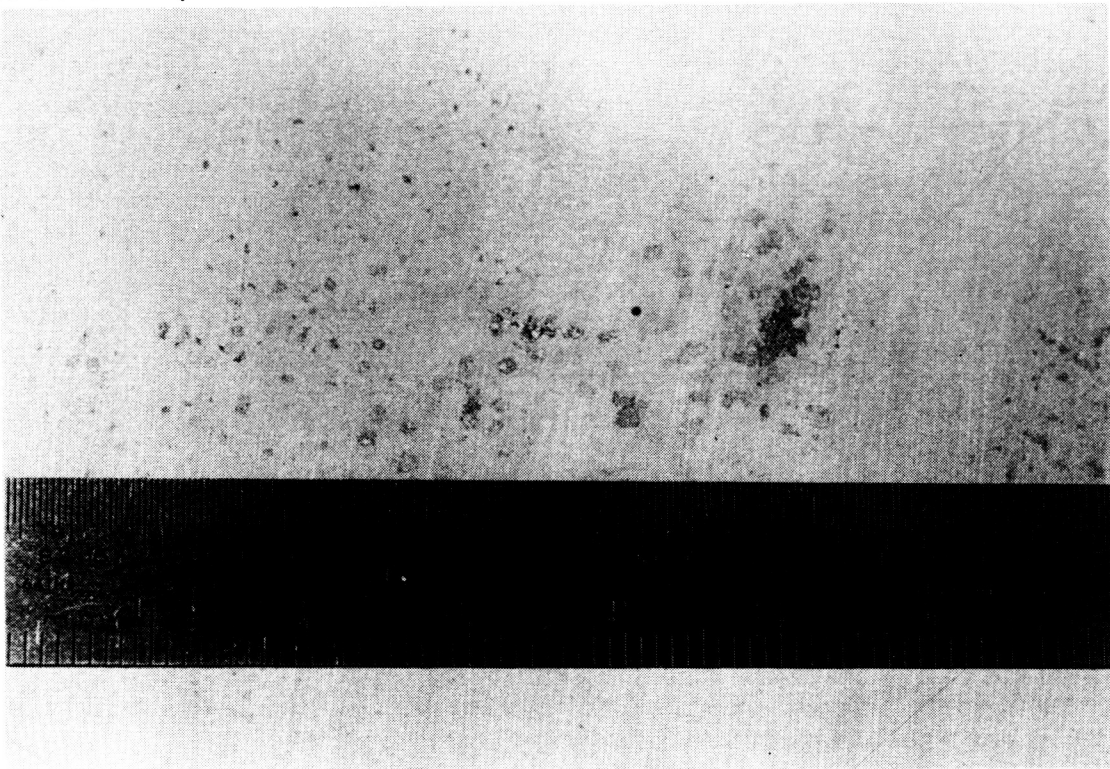


Fig. 4

CONCLUSION

The performance of GAS-449 on board the Space Shuttle Columbia Mission 61-C performed in some instances as expected and in many instances beyond our expectations, an example of which is the YAG laser. Continuing investigation into the experiments is expected to yield additional positive results. Some data may remain unexplained due to phenomenon not understood at the present. The systems which triggered the experiments functioned perfectly and the timing of the experiment was 30 minutes. There have not been reports from all of the investigators at the time of this writing. Investigation into the experiments will continue and will be the subject of a future paper.

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CONTINUING POST-FLIGHT INVESTIGATION

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2. Space Shuttle Mission 61-C Press Kit, December 1985;
3. Crystal Growth of Artificial Snow, Shigeru Kimura, Akihito Oka, Minoru Taki (Asahi Shimbun Co.) Ryushi Kuwano, Hiromi Ono, Riichi Nagura, Yoshito Narimatsu, Jun Tanii, Yotsuo Kamimiyata (NEC Corp.), NASA Conference Publication 2324, 1984 Get Away Special Experimenter's Symposium