5.0 REPORT ON OPPORTUNITITES AND/OR TECHNIQUES FOR HIGH-CALIBER EXPERIMENTAL RESEARCH (OTHER) PROPOSALS FOR SSPEX

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5.1 Introduction

Unlike the previous summary reports, the only unifying factor among the experiments discussed in this section is that they are all unique Opportunities and/or Techniques for High-caliber Experimental Research (OTHER!). Many of the investigations discussed in this report were submitted to the SSPEX workshops as abstracts, although several additional experiments have been added as a result of workshop discussions. Despite the enormous diversity of the investigations proposed, several common concerns have emerged regarding the availability of "standard" items.

Several people expressed a desire for one or more windows. These can be located either in the lab module, as a transparent hatch cover or in the habitability module. In general, these would *not* be in constant use -in fact they probably would be used only rarely. Windows should "look" both "upstream" and "downstream" from the station and should also be available for Earth and "deep space" views. Because they would be used only occasionally, positioning behind mobile equipment racks in the lab module could be considered.

Another requirement of several of the proposed investigations is the development of automated tether systems; if possible, small (<500 m) tether systems should be able to travel along tracks spanning much of the station. Another possibility is the attachment of small tethers to one or more remote manipulator arms(s) or to one or more deployable booms. A boom which can hold a shield several hundred meters "in front of" the station (or above it) in order to avoid local contamination is a necessity for several experiments. Of course, investigators assume some astronaut EVA time for limited servicing, equipment and/or sample changes, as well as deployment or retrieval of the experiment.

One additional factor which requires thought is the degree of overlapping needs or use of common equipment for very different experiments. For example, the experiment proposed by Walker could provide a very large shield to create the ultra high vacuum required by Duba or Nuth (see abstracts). Could such an ultrahigh vacuum facility be useful to a larger community? Could the small tethers required by Lopez be used to deploy and retrieve Stephens' artificial comet? Could the rail gun proposed for the cratering experiments be used to fire projectiles into the atmosphere at speeds greater than 25 km/s and thus create an artificial meteor? Could the dust collectors proposed by Corso be mounted on *all* tethered upper atmospheric research satellites?

Along these same lines, mutual interferences among experiments--or Space Station operation--must be considered. As examples, could particles released by Strong or Stephens interfere with the collection efforts of Walker? How many tethers could be deployed around the station, and in which directions, before they constitute a navigational hazard? How large a disturbance to microgravity experiments would result by firing projectiles into the upper atmosphere (or doing cratering studies)?

Many of the experiments described in the abstracts are in the "formative" stage of development. Still, all of the proposals utilize the space station environment for investigations which could never be performed on Earth. None are suitable for flight on the KC-135, although several could be developed as Shuttle experiments. In some cases (e.g. Strong (12) and Williams (8)) development of Shuttle experiments is under way.

The following includes brief descriptions of 13 experiments; 9 of these were presented to workshop participants. Another is mentioned in the "Banks" Report as a candidate for IOC. Two more experiments were discussed by participants at the workshop, as an outgrowth of other experiments already under discussion. A final "calibration" experiment was discussed by Boynton at an earlier meeting. Considering the number and variety of Planetary Science experiments which keep emerging these should be considered as the vanguard of many more proposals.

5.2 Specific Experiments

Ultrahigh Vacuum Petrology Facility

Duba proposes placing a large (>3 m diam.) shield in front of (or above) the Space Station. The region behind the shield would experience a very low pressure due to the shield "sweeping" ambient gas away as it travels at orbital velocity (8 km/s). Pressures of 10^{-15} torr of H and He seem possible, while atom partial pressures less than 10^{-20} torr could be obtained. In this very low pressure region Duba proposes to study the high temperature metamorphism of carbonaceous chondrites. In particular he proposes to measure the variation in the electrical conductivity of the sample as a function of both time and temperature in order to test the theory that the observed differences in composition of asteroids (as a function of their orbital semi-major axis) could be due to electromagnetic heating during the early history of the solar system.

Artificial Comet-Free Flyer

Stephens proposes placing several large "chunks of ice" into orbit in which finely dispersed dust particles and several radio thermometers have been frozen. The object of the experiments is to determine the dependence of the temperature structure within the comet on both the composition and concentration of the dust. In particular, he wants to test the hypothesis that a significant quantity of volatiles could be trapped inside of "dead" comets and protected by a highly efficient insulating layer of "hardened", extremely porous dust.

Artificial Comet - Tethered

In this experiment Stephens proposes to tether materials similar to those described in (2) in order that the "comets" can be recovered for later study on earth. In this way the thickness of the insulating layer, as well as its structure could be determined and correlated with its "insulating efficiency".

An additional advantage of tethered comets is observation of the development of the dust plume as a function of exposure to various levels of solar insulation.

Cosmic Dust Detector

Wolfe proposed placing a relatively large (1-2 m^2) acoustic impact detector on the space station in order to measure the long term anisotropy of the flux of cosmic dust particles. Using acoustic spectral analysis he feels that it is possible to derive some compositional information about the impacting particle as well as its directions and momentum. In this way, information about both the flux and composition of asteroidal, cometary and interstellar particles might be gained.

Cosmic Dust Collector

In this experiment, Wolfe proposes placing an electrostatic decelerator on the space station. The detector is capable of decelerating particles entering the collector with velocities as high as 25-30 km/s, and will simultaneously reject relatively slow moving debris in the vicinity of the station. Periodic return of the collector surface would allow the recovery of pristine cosmic dust samples which have not been contaminated by the earth's atmosphere. Such materials would constitute an extremely valuable resource to the exobiology community.

Dust Collection using Tethered Satellites

Corso proposed outfitting satellites lowered into the Earth's upper atmosphere with cosmic dust collectors. In this way he hopes to collect large numbers of relatively uncontaminated particles soon after their arrival. In fact, using this method it could be possible to determine to within a few hours the time of arrival of particular particles and thus correlate them with known meteor showers. Such a collection would be complementary to both the stratospheric and space station efforts.

Artificial Magnetosphere

Lopex proposes suspending a strong magnet from a tether approximately 200 m or so above the space station in order to create an artificial magnetosphere. Diagnostic probes could be suspended on mobile tethers downstream from this magnet to probe its interaction with the ambient plasma. In addition ionic tracers such as Barium could be released "upwind" at will. A series of non-tethered experiments might also be necessary to probe the effect of the tether on the plasma sheath.

Micro-gravity Petrological Studies

Williams and Lofgren have constructed a highly efficient furnace system which accurately controls the redox conditions under which the experiments are performed. They propose to fly this system aboard space station in order to study the effect of cooling rate on the resulting texture of chondrule-like materials. Efforts to study this problem in 1 g are frustrated by the settling of early condensates from the melt and, in some cases, by buoyancy driven convection.

Slitless UV Spectrometer (Construction and Calibration)

Wdowiak, et al. have proposed the construction of a Slitless UV Spectrometer to obtain meteor spectra, and especially to determine the relative ratios of the biogenic elements in these meteors. If the cratering community (or SDI) places a rail gun (or similar facility) into orbit it might be possible to fire projectiles of known composition into the earth's atmosphere along well determined trajectories at speeds approaching 25 km/s. Such a facility not only could be used to accurately calibrate the spectrometer but could also be used to test models of atmospheric entry phenomena.

ODACE - Orbital Determination and Capture Experiment

Walker proposed building a large dust collector (10 m x 10 m) with the capability to determine the velocity of the impacting particle. When "interesting" particles are observed the small cell (10 cm x 10 cm) containing the particle would be returned to earth for study. At this time it might be possible to precisely determine the orbital parameters of the particle as well as a significant amount of compositional and structural information. A cosmic dust collector is mentioned in the Bank's Report as a high priority item for IOC.

High Velocity Sputtering of Amorphous Silicates

This experiment grew out of discussions with Al Duba and others at the workshop. If we put a hole in the middle of Al Duba's shield (which could be closed off -of course) then this would be an excellent source of 7-8 km/s oxygen, nitrogen, helium and hydrogen atoms with which to carry out sputtering experiments. It might also be possible to charge these atoms using an electron gun so that one could electromagnetically separate the beam into its atomic components. This device could serve as a useful experimental facility for material science experiments. In particular, Nuth wants to study the metamorphism of amorphous iron and magnesium silicates exposed to such a beam in order to better understand the processing of these materials via shocks in the interstellar medium.

Particle Release Experiments

Strong and coworkers have not yet established a definitive set of particle release experiments to be performed from the space station, in part because they have not yet carried out a planned series of releases from the space shuttle. These experiments will take advantage of the unique observational capabilities of the AMOS Facility in Hawaii in order to measure various properties of the released particles such as the scattering, absorption and extinction efficiencies as well as the speed with which the particles become aligned in the earth's magnetic field. The results of these early shuttle experiments will determine the particular experiments which best utilize the unique opportunities afforded by the space station.

Calibration of Gamma and X-ray Remote Sensing Probes

Boynton mentioned this possibility at a previous meeting and it is included here for completeness. He suggests that the best place to calibrate a remote sensing tool such as a gamma ray or x-ray fluorescence spectrometer is in the space environment. On earth, only single line gamma ray sources are available for use as excitation probes for natural samples. Similarly, no continuous "natural" x-ray spectra are available with which to calibrate x-ray fluorescence detectors. Much better instrument calibrations would be available if one could observe transported natural samples such as basalts, granites and various ices - or even observe various parts of the station itself prior to launch to their ultimate planetary targets.