LONG DURATION EXPOSURE FACILITY--RESEARCH OPPORTUNITIES IN THE 1980's;

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The first flight of the Long Duration Exposure Facility (LDEF), which is planned for launch late in 1983 and for recovery 1 year later, will accommodate approximately 50 experiments encompassing science, application, and technology disciplines. The second flight of the LDEF with a new set of experiments is anticipated shortly after the facility is retrieved from the first mission. This paper describes research opportunities with the LDEF in the mid-1980's.

The LDEF is basically a cylindrical structure, 10 meters long and 5 meters in diameter, on which tray-mounted totally self-contained experiments are transported to, exposed in, and returned from space with the shuttle. The LDEF is 3-axis passively stabilized while free flying in space. The trays for experiments can accommodate 75Kg of hardware and they are approximately 1.5 meters long, 1 meter wide, with varying depths. The LDEF is tailored to provide low-cost opportunities for experiments which have modest needs for electrical power and data processing and for experiments which benefit from postflight laboratory investigations of retrieved hardware. Many of the LDEF experiments are totally passive. Standard experiment power and data systems (EPDS) are available for experiments which do require power and data processing.

The LDEF research opportunities can best be illustrated by describing typical experiments planned for the first mission.

THE ELEMENTAL AND ISOTOPIC COMPOSITION OF THE INTERPLANETARY DUST: This completely passive experiment is being developed by Robert Walker and Ernst Zinner of Washington University, Hugo Fechtig and Norbert Pailer of the Max-Planck Institute, and E. Igenbergs of the University of Munich to trap ejecta of impacting dust particles in space for postflight laboratory measurements of the elemental and isotopic composition. The impacting dust will include cometary dust and possibly dust from the outer atmospheres of red giant stars and the remnants of supernova. Recent meteorite studies indicate that an isotopic heterogeneity may be best reflected in cometary dust. If the dust isotopic compositions reflect these different origins, the data will profoundly influence the thinking on nucleosynthesis and possibly provide a fundamental link between planetary science and high-energy astrophysics.

Thin tantalum-coated films stretched above germanium targets will be used to trap the impact ejecta. A CAMECA IMS 3F ion probe will be used to make the isotopic analysis. Two trays of these targets will be flown on the first LDEF mission.

THE CHEMISTRY OF MICROMETEOROIDS: This already-developed experiment employs passive high-purity gold targets to collect the residue in and around micrometeoroid impact craters for postflight laboratory chemical analysis. The targets are mounted in active clam-shell type housings which will close to protect the targets from contamination during the LDEF launch and retrieval and open in space to expose the targets to micrometeoroid impacts. The investigators are Fred Hörz, David McKay, and Donald Morrison of NASA Lyndon B. Johnson Space Center, Donald Brownlee of the University of Washington, and Robert Housley of Rockwell International Science Center.

Current hypotheses indicate that most of the impacting particles will have cometary origins and thus they will provide a unique opportunity to study early solar system processes at relatively large distances from the sun ($\geq$20AU) in contrast to asteroidal meteoroids (2 to 4AU). The recovered cometary dust residue may reflect pressure and temperature conditions in the solar nebula that are not represented in presently known meteorite classes and analysis of comet dust may offer potential insight into the formation of the comets themselves. A large array of microanalytical tools including electron microprobe, scanning electron microscope with energy dispersive analyzer, and ESCA spectroscopy and ion probe mass analyzer will be used in the laboratory analyses of the collected residue.

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INTERPLANETARY DUST EXPERIMENT: This active experiment will record cosmic dust impacts on six orthogonally-located groups of very sensitive metal oxide silicon capacitor-type micrometeoroid impact detectors. Particles as small as 10^{-17}gm will be detected--particles so small that they are likely to be affected by non-gravitational forces. These particles can therefore act as a sensitive indicator of interplanetary conditions such as electric charge and geomagnetic effects, morning--evening asymmetry, seasonal effects, solar rotation modulation, solar activity correlation, and correlations with comets and meteor streams. Fred Singer and John Stanley of the University of Virginia and Philip Kassel, Jr. of the NASA Langley Research Center are the investigators.

The power and data storage for this experiment is provided by an EPDS which is self contained in the tray housing the experiment. The recorded data will include the time of impact events on each detector group.

HIGH RESOLUTION STUDY OF ULTRA-HEAVY COSMIC RAY NUCLEI: This passive experiment, which has been developed by Denis O'Sullivan, Alex Thompson, and C. O. Ceallaigh of the Dublin Institute for Advanced Studies and by Klaus-Peter Wenzel and Vincente Domingo of the European Space Agency, will significantly increase the world data sample of ultra-heavy cosmic ray nuclei. Special emphasis will be placed on the relative abundancies in the range of $Z>65$ which is thought to be dominated by r-process nucleosynthesis. Reliable source spectrum will provide details of the environment such as temperature and time-scale-data important to both astrophysics and nuclear physics.

The experiment will consist of 16 trays of Lexan polycarbonate track detectors.

INTERSTELLAR GAS EXPERIMENT: This experiment by Don Lind of the NASA Lyndon B. Johnson Space Center and Johannes Geiss and Fritz Buhler of the University of Bern will collect, using metal foils, interstellar gas at several locations around the Earth's orbit. Observed regularities in the abundance of elements and their isotopes upon which the theory of nucleosynthesis rests have been obtained from solar system abundancies even though this sample represents a small fraction of the material in the universe. Even a small sample of extra solar system isotopes will give significant insight into the processes which occured in the original nuclear synthesis and those which have been going on in our galaxy.

The experiment hardware acts as a simple camera with high-purity copper-berylium foils serving as the film. The experiment housing will mount and thermally control the foils, establish the viewing angles and viewing direction, provide baffling to reject ambient neutral particles, provide a voltage grid to reject ionospheric-charged particles, sequence collecting foils, control exposure times, and protect the foils from contamination during the deployment and retrieval of the LDEF from space. After retrieval, the entrapped atoms will be analyzed by mass spectroscopy to determine the relative abundance of the different isotopes of the noble gases Helium and Neon.

In summary, the LDEF will provide many opportunities for research in the mid-1980's. Over 200 researchers are participating in the experiments on the first mission and it is expected that follow-on missions will each involve similar numbers of researchers. As the experiments for the first mission illustrate, LDEF can accommodate very exciting experiments. Researchers who have worked with Apollo-returned Lunar samples can certainly appreciate the value of returning the experiment hardware for postflight analysis and in these austere budget times all can appreciate the advantages of low-cost research opportunities.