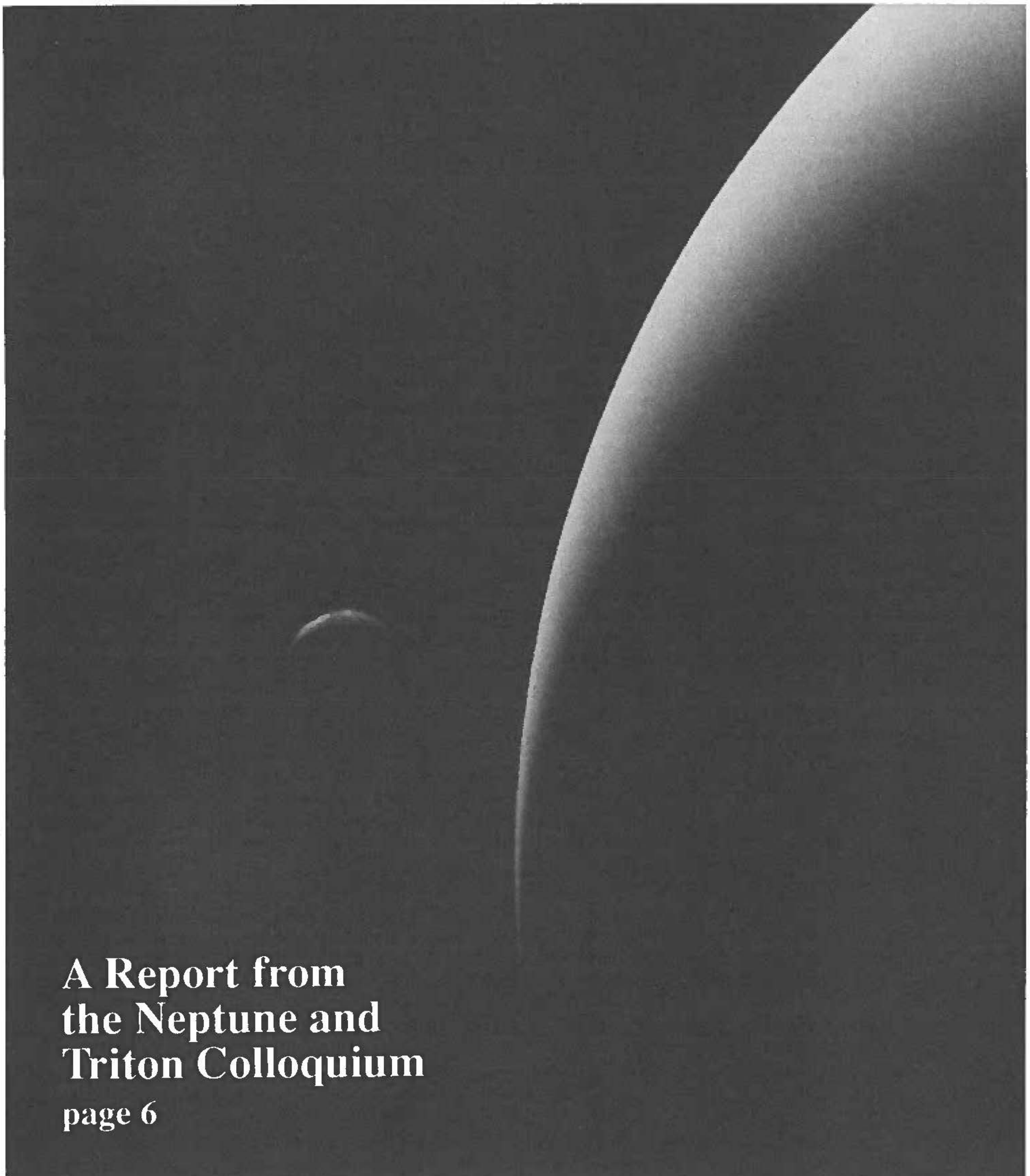
Lunar and Planetary Information
BULLETIN
MAY 1992/NUMBER 63 • LUNAR AND PLANETARY INSTITUTE • UNIVERSITIES SPACE RESEARCH ASSOCIATION



A Report from the Neptune and Triton Colloquium
page 6

NASA PHOTO-34761

Goldin Succeeds Truly as Agency Head

Daniel Goldin became Administrator of NASA on April 1, after Richard Truly resigned February 10. In his resignation letter to the President, Truly wrote,

> "In the last six years since I arrived to join the NASA leadership just after the Challenger tragedy, I have watched the talented men and women of this elite agency turn heartbreak and disarray into the impressive achievements and superb organization of today. With 20 safe and successful Shuttle flights in the last 40 months, scientific discoveries pouring in, Space Station Freedom on track, and our wind tunnels testing the airframes and spacecraft of tomorrow, they deserve to be very, very proud. With your support, their opportunities to inspire America's people and drive our country's competitiveness are boundless. Their achievements result from working daily in a fishbowl world of difficult and exacting tasks, tough judgments and carefully balanced risks; not an endeavor which some would have you think has quick, brilliant and easy solutions."

Goldin, vice president and general manager of TRW Space and Technology Group, was nominated by President Bush and received strong recommendation from Vice President Quayle, who chairs the Space Council. Confirmed by the Senate March 31, Goldin assured the press that he intended to maintain NASA's independence. "I don't know how to manage if I can't be in charge," he stated. The following day, he addressed the NASA employees, including the following remarks.

> "We need to do a better job of clearly depicting the relationship of the space program to the Americans' everyday lives, to what they do, along with how they do it, and why they do it, and why we do it—in the workplace, the classroom, the home, and the market places of today and tomorrow. We must communicate how NASA will improve the American taxpayer's quality of life. It's a real challenge but I believe we can meet it.
>
> NASA today stands ready to address some of the key challenges that face the America of tomorrow. Our cutting-edge technology programs will increase our future competitiveness. Our science programs will help us better understand the universe we live in and the origin of life. The mission to planet Earth will help us better understand and care for our fragile planet. Our life sciences and microgravity research programs could lead to even greater contributions to medical technology, and our aeronautics program will help the nation to push the edge of technology and maintain one of the strongest export markets that we have. And our technological programs, meanwhile, could be the deciding factor in whether or not the U.S. is competitive in the high-technology market place of tomorrow and could have a real impact on the first martians. Those young children sitting in America's classrooms today will be the astronauts and explorers of tomorrow.
>
> If we are to respond to the challenges of today and if we are to successfully implement our programs, it will take teamwork and it will take extra effort. Today I would like to ask all of you, every employee in NASA, especially me—I'm an employee of NASA as of 3:10 today—in addition to our contractor team, to set clear goals for ourselves. Goals that go beyond the norm, not goals that are beyond what is achievable but goals that will cause you to stretch, to reach a little further and a little higher than you have in the past. I'm convinced with your help, NASA will be recognized as the standard for quality, innovation, and management techniques. NASA will be recognized as the type of organization that the American public will look to and support as we strive to break down the barriers to space exploration, understanding the universe, understanding the planet Earth, and as we compete in the marketplace of high technology.
>
> Will it be a challenge? Yes it will. But it could be fun and it could be rewarding. Yes, because I believe NASA has the most talented men and women in the federal government and in the U.S. marketplace.
>
> For the last 30 years I've dealt closely with NASA and members of the NASA team, and I cannot begin to tell you what an exceptional knowledge and skill base this agency has. I do not see my challenge as a new administrator to get good people; we already have them. My challenge is to convince you that you can do more, do it a little better, do it for less, if we use more innovative management techniques, and if we fully utilize the individual capabilities of each and every NASA employee. My job is not to tell you what to do, not to direct control; you know what to do. My goal is to empower all of you to do it." ⌀

NASA PHOTO S92-31008

The *Lunar and Planetary Information Bulletin* is published quarterly by the Lunar and Planetary Institute, 3600 Bay Area Boulevard, Houston TX 77058-1113

Pam Thompson, Editor

Editorial and production support are provided by the LPI Publications Services Department. Copy deadline for the August issue of the LPIB is July 5, 1992.

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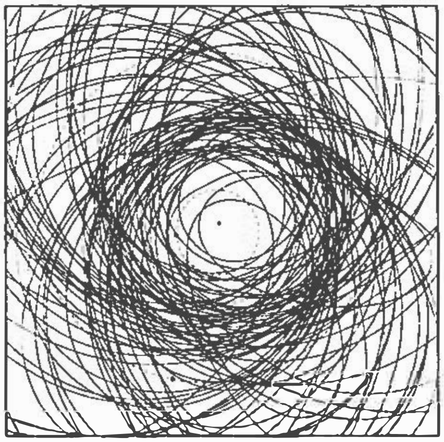
Phone: 713-486-2175, Fax: 713-486-2162; EMail: SPAN LPI::THOMPSON

Correction—The escape velocity for 951 Gaspra was given incorrectly in the February issue. It should be 8 m/s. We regret the error.
—Ed.

NEWS FROM SPACE



Art courtesy of R. P. Binzel

ASTEROID WORKSHOP STUDIES PRESENTED TO CONGRESS

On March 31, NASA presented Congress with summaries of workshop studies on detecting Earth-orbit-crossing asteroids and determining how to deal with such threats. The two workshops were in response to a congressional request included in the 1991 NASA authorization bill.

The NASA-sponsored Near-Earth-Object Detection Workshop judged asteroids with diameters 1 km or larger the most dangerous objects in terms of potential for causing catastrophic global effects on Earth. Impacts of such asteroids are extremely rare and a potential impactor can be detected with current ground-based technology, most likely decades in advance of any collision.

The workshop's proposed detection plan builds on research programs that NASA has funded for a number of years. The plan calls for a coordinated international network of specialized ground-based telescopes for detecting Earth-approaching asteroids.

The Near-Earth-Object Interception Workshop was hosted by the Department of Energy's Los Alamos National Laboratory in January 1992. Participants at this three-day workshop discussed various schemes for preventing an asteroid from colliding with Earth.

HUBBLE FINDS NEW EVIDENCE FOR MASSIVE BLACK HOLES

Astronomers report that they have found new evidence that a black hole, weighing three million times the mass of the Sun, exists at the center of the nearby elliptical galaxy M32, based on images obtained with NASA's Hubble Space Telescope (HST). The images show that the stars in M32 become extremely concentrated toward the nucleus. This central structure resembles the gravitational "signature" of a massive black hole. The presence of a black hole in an ordinary galaxy like M32 may mean that inactive black holes are common to the centers of galaxies. The new HST images show that M32 is an interesting "laboratory" for testing theories of the formation of massive black holes; they were analyzed by Dr. Tod R. Lauer of the National Optical Astronomy Observatories, Tuscon, Dr. Sandra M. Faber of the University of California, Santa Cruz, and other members of the HST Wide Field/Planetary Camera Imaging Team.

M32 is quite small and compact as elliptical galaxies go, containing about 400 million stars within a diameter of only 1000 light years. At a distance of 2.3 million light-years, M32 is one of the closest neighbors to the Milky Way galaxy.

Ground-based images do not have enough resolution to detect the effects of a massive black hole on the structure of M32. The HST images show that the density of stars in the nucleus appears to increase steadily toward the center, with no sign of leveling off. These results are very similar to predictions for what a massive black hole should do to the central structure of a galaxy.

"This is the densest stellar system known to astronomers," says Lauer. "The density of stars at the center of M32 may be over 100 million times greater than the distribution of stars in the neighborhood of the Sun. A visitor to a planet at the center of M32 would see a starry night sky so saturated with stars that their combined light would be brighter than 100 full moons. The night would never get darker than mid-twilight on the Earth, and one could even read a newspaper by starlight."

A black hole at the center of M32 would have the paradoxical effect of stabilizing the galaxy's nucleus because the stars orbit so rapidly around the black hole that they move past each other too quickly to gravitationally capture each other or collide. The black hole thus keeps the center of a galaxy "stirred up." In the absence of a black hole, however, the stars would move slowly enough to attract each other gravitationally. Collisions between stars would become much more frequent, and heavier, slower moving stars would sink to the center of the galaxy causing it to collapse.

If the core is really unstable, the researchers would expect to find evidence of merged and captured stars called "blue stragglers" (HST has in fact uncovered such stars at the core of a globular cluster, a much smaller aggregate of stars than M32). The shape of the starlight distribution at the core would also be different from that which HST detects. The Hubble images instead show that the population of stars in the nucleus is the same as that farther out in the galaxy, and that the shape of M32 remains constant into the center. This means that a core collapse has not recently occurred.

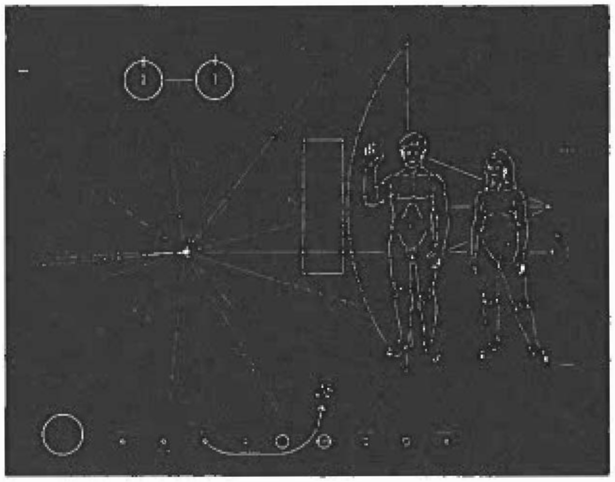
COMPTON OBSERVATORY DETECTS ACTIVE GALAXIES

NASA's Compton Gamma Ray Observatory has made the first detection of high-energy gamma rays from a class of active galaxies similar to quasars. The observations, made by the Energetic Gamma Ray Experiment Telescope (EGRET), suggest that high-energy gamma radiation provides a substantial contribution to the objects' overall luminosity.

These active galaxies are called BL Lacertae objects, a type of "quasar-like" object that emits vast but varying amounts of energy. The candidate objects are in the constellations Ursa Major, Pictor, and Camelopardalis. They are designated MK 421, 0537 - 441 and 0716 + 714, respectively. These new gamma ray results support the hypothesis that BL Lacertae objects, like quasars, may be powered by supermassive black holes. The detection of these high energy gamma rays also provides another piece of evidence suggesting their similarity to quasars and adds important new insight into understanding the nature of BL Lacertae objects.

PIONEER 10 CONTINUES EXPLORATION 5 BILLION MILES FROM HOME

Pioneer 10 was exactly 20 years into its mission and 5 billion miles from Earth on March 2, 1992. Eight of the spacecraft's 12 scientific instruments continue to send back data that characterize the heliosphere, the magnetic bubble of ionized gas that surrounds the Sun. "If we're lucky," comments Pioneer high-energy particle experimenter James Van Allen, "we may break out of the heliosphere into the interstellar gas before we lose contact with Pioneer around the year 2000. This would be the first direct measure of true interstellar space."



"Data may stop arriving around the year 2000 because of shrinking power for Pioneer's nuclear electric generators plus its ever-increasing distance," explains Richard Fimmel, Pioneer project manager at NASA Ames Research Center. The 570-lb spacecraft is already so distant that a radio signal takes 15 hours to complete the trip from Earth to spacecraft and back. When the 8-W signal reaches the three football-field-sized antenna dishes of NASA's Deep Space Network, it has the power of just 4.2 billionths of a trillionth of a watt.

One year after its launch in 1972, Pioneer 10 became the first spacecraft to visit Jupiter and its moons. Now traveling at about 28,900 mph, Pioneer is detecting changes in the solar wind and scientists will take advantage of its tremendous distance from Earth to try to detect gravity waves, tiny "jiggles" in the geometry of space predicted by

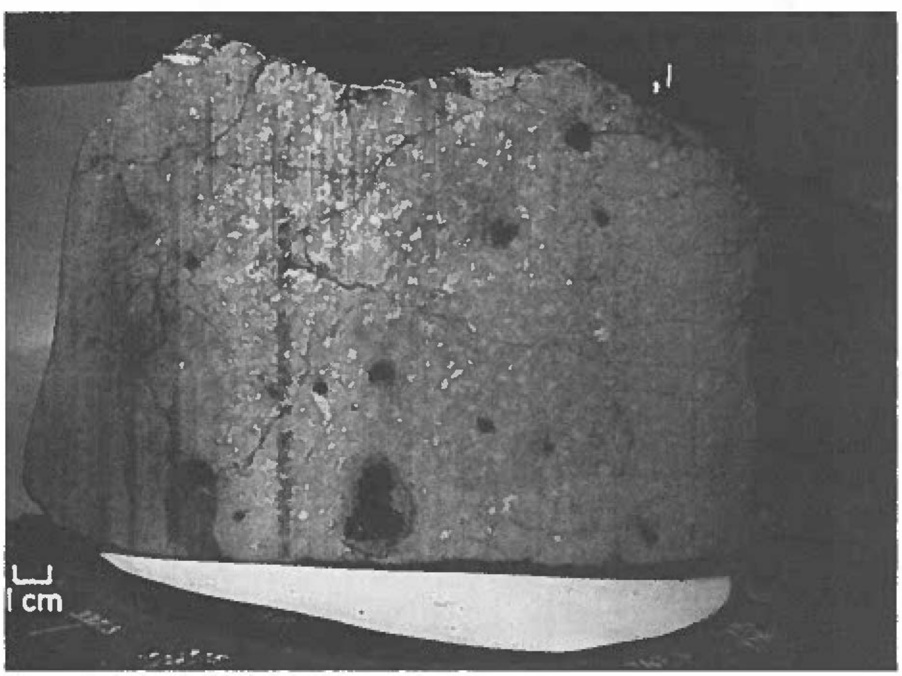
Albert Einstein. The spacecraft carries a plaque designed to tell extraterrestrials where it came from and what its creators look like. Scientists predict that in the vacuum of space Pioneer will certainly outlast its creators and possibly its home planet.

WATER IN SNC METEORITES SUGGESTS ANCIENT MARTIAN HYDROSPHERE

A team of scientists has measured oxygen isotopes in small amounts of water contained in six Shergotty-Nakhla-Chassigny (SNC) meteorites. Several types of evidence, such as relatively young crystallization ages and the composition of trapped volatiles, suggest that the SNCs are from Mars. Isotop analysis of the oxygen can be used to detennine whether the trapped water is extraterrestrial or terrestrial and thus may help to tell us if Mars once had a water-rich atmosphere or even flowing water on the surface. Were the channels seen in Mariner 9 and Viking images carved by water or by some other process?

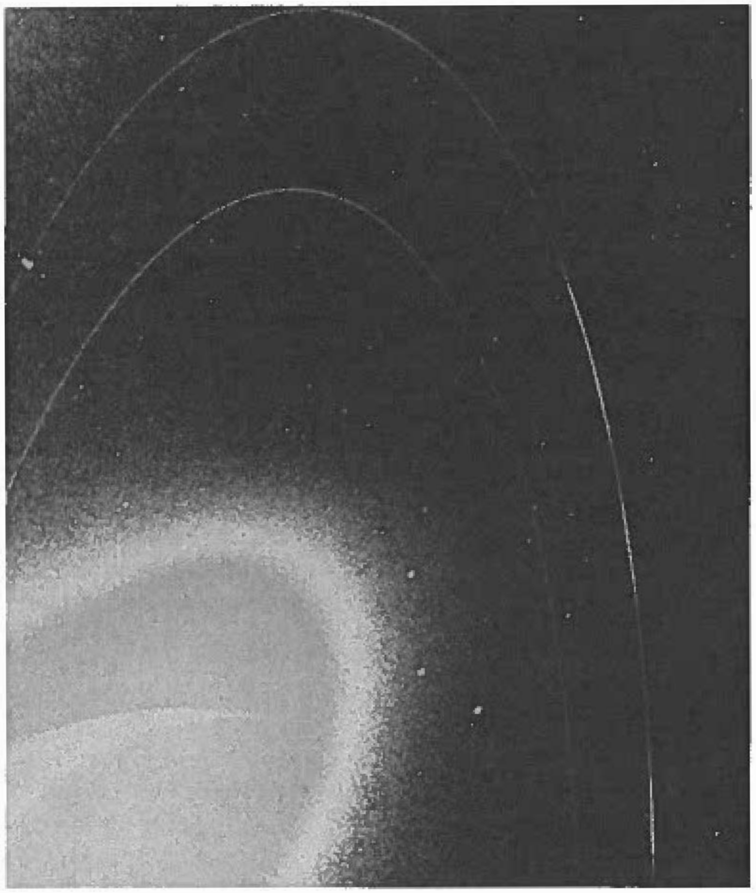
Dr. Everett Gibson of NASA's Johnson Space Center (JSC) Planetary Sciences Branch, Houston, Dr. Haraldur Karlsson, Texas Tech University, and scientists at the University of Chicago have concluded that some of the water is extraterrestrial, and furthennore, is not in oxygen isotopic equilibrium with the host meteorite. This latter finding seems to indicate that the lithosphere and hydrosphere fonned two separate oxygen isotop reservoirs at some time in martian history, one contributing the oxygen component to the silicates in the rock and one contributing a component to the water. "It's really a beautiful piece of scientific work to do this analysis," Gibson said. "We are extremely pleased with the results of this team effort." The results of the team's findings were published in the March 13 issue of *Science*.

The meteorites were heated in steps in a small vacuum system at JSC to extract trace amounts of water. The water samples were hand-carried to the University of Chicago for isotop analysis. Although the diameter of the water droplets was less than 1/64th-inch, the analysis was made successfully.



The inhomogeneous oxygen isotopes in the samples support the contention that Mars lacks plate tectonics. On Earth, oceans are cycled through the oceanic crust at midocean ridges resulting in relatively constant oxygen isotop compositions in both the hydrosphere and lithosphere. The research underscores other questions: What happened to the water on Mars? Will water on Earth disappear through a process we don't foresee?

"These are large and difficult questions to comprehend," Gibson said, "but perhaps if we can trace the origins and alterations of planetary atmospheres and oceans, the evolution of our solar system may be better understood." Other team members included Robert N. Clayton and Toshiko K. Mayeda of the Department of Geophysical Sciences and the Enrico Fenni Institute, University of Chicago.



In January, 1992, some two and a half years after the epochal encounter of the Neptune system by the Voyager 2 spacecraft in 1989, scientists gathered in warm sunny Tuscon, Arizona, to discuss the mysteries of the cold distant planet and their latest analyses of the Voyager data. More than 98 oral talks and posters were presented at the Neptune and Triton Colloquium by over 200 participating scientists from around the world, indicating the broad spectrum of interest in Neptune. Topics ranged from magnetospheric dynamics to frost particle migration on Triton.

Neptune and Triton THAW OUT

A Report from the Neptune and Triton Colloquium

by Paul Schenk

Despite a general similarity between Neptune and Uranus in size, density, atmospheric composition, and other parameters—even the tilt and offset of the magnetic field axis—differences between the two gaseous planets do exist. For instance, Neptune has an extra internal heat source, whereas Uranus does not. A variety of possible explanations for this difference, including solar heating and compositional gradients, were discussed by William Hubbard and others. Most models of the interior suggest that Neptune and Uranus are rock-poor with respect to solar abundances, an important constraint for formation models of both planets.

The dynamics of Neptune's atmosphere were described in detail by Andy Ingersoll. The transient nature of many of the cloud features makes wind pattern investigation difficult. The rotational oscillations of the Great Dark Spot and the latitudinal drift of smaller spots, however, appear to point to an atmosphere that has a low level of turbulent dissipation and a high degree of static stability, possibly because of high levels of water in the deep atmosphere.

The magnetic field of Neptune, like that of Uranus, is tilted and offset from the planet center. There are also strong local irregularities in the field, some of which may result from interactions with the numerous small moons and the rings within it. The origin of magnetic fields and their implications for planetary interiors are poorly understood. The potential implications for the internal structure of Neptune were discussed, as were plasma composition and structure within the magnetosphere.

Voyager resolved the telescopic ring mysteries with its observations of four slender rings orbiting Neptune. The discovery that the outer Adams ring possesses dense concentrations along arc segments was a new phenomenon in ring science. The small nearby moon Galatea appears to "shepherd" these arcs over time, although the rings themselves appear to be at most only 100 million years old.

Triton, Neptune's large icy satellite, justly shared equal billing with Neptune at this conference. Prior to the encounter, not even its size was known. The encounter revealed a complex and dynamic satellite that surprised nearly everyone. The surface of Triton is covered by methane and nitrogen frosts that are mobile over seasonal time scales. Changes in the color and brightness of Triton suggest that a dynamic event of some sort occurred between 1976 and 1983, possibly involving a major deposition of frost. Dale Cruikshank reported on the recent identification of CO and CO_2 ices on the surface, and Alan Stern reported the tentative identification of SO_2 frost. New models were proposed that describe the seasonal migration of frosts on Triton as being sensitive to surface elevation or surface roughness, effects that are now being searched for. The physical structure, composition, and behavior of these frosts were a constant source of debate throughout the conference. Models of the ultra thin atmosphere and ionosphere of Triton were also discussed.

Geologically, the evolution of the sparsely cratered surface of Triton remains as mysterious as it was the day of encounter. A variety of geologic terrains are present, all of which are very young and some of which are the result of extensive volcanic resurfacing. Several elliptical structures may be extrusions of relatively viscous lavas on the surface. Many other areas of Triton, however, including the nefarious "cantaloupe terrain" have defied coherent explanation.

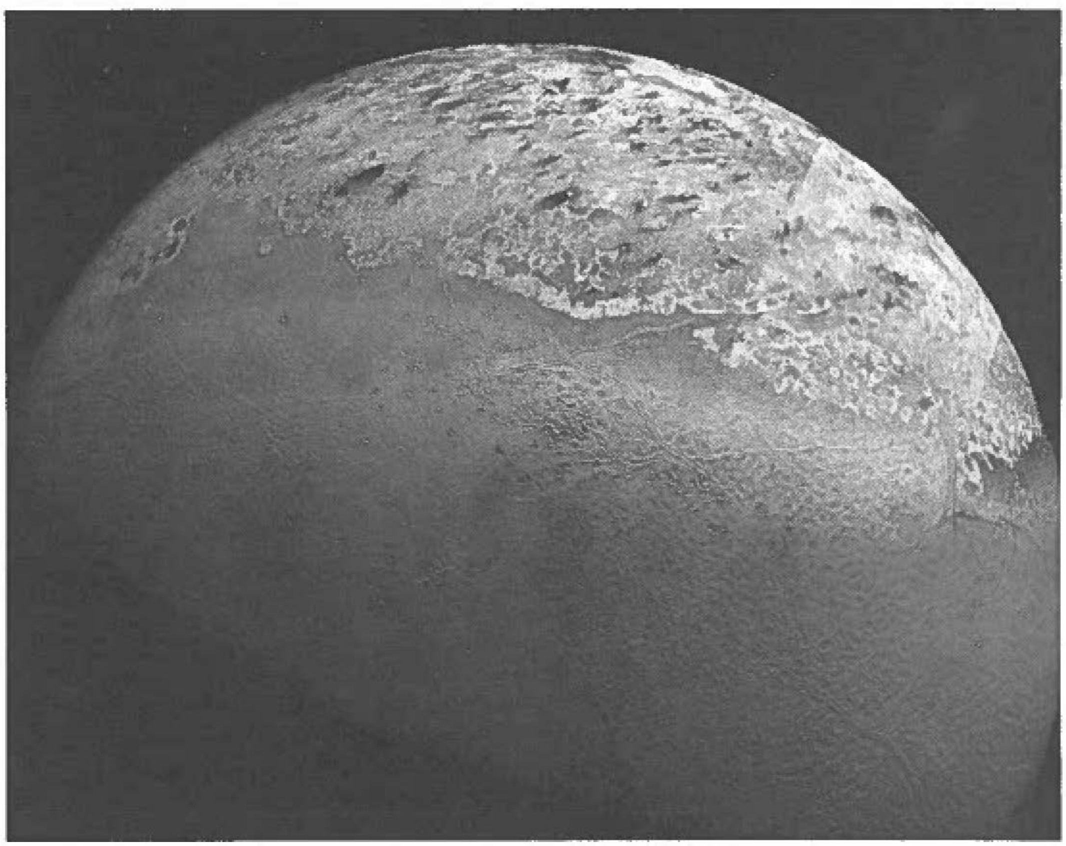
The two observed geysers have attracted the most attention on Triton. Although several new models were presented to power them, including methane sublimation to compete with solid-state greenhouses and "dust-devils," the geysers remain an important unresolved phenomenon.

It is clear, however, that Triton is the most complex and evolved of the many icy satellites in the outer solar system. This complexity probably stems from the complex orbital evolution of Triton, which is most likely a captured planetesimal. The tides raised on Triton during the postcapture evolution phase may have been powerful enough to almost completely melt the interior, the potential consequences of which were discussed in some detail by Bill McKinnon.

The Voyager glance at Neptune and Triton was very brief and as usual more questions were raised than answered. Some day Earth people will return to Neptune to answer some of these questions and indeed the conference concluded with a discussion of possible plans for a return mission to Neptune. One such mission could orbit the planet as early as 2021(!).

(Dr. Schenk is a Staff Scientist at the Lunar and Planetary Institute.)

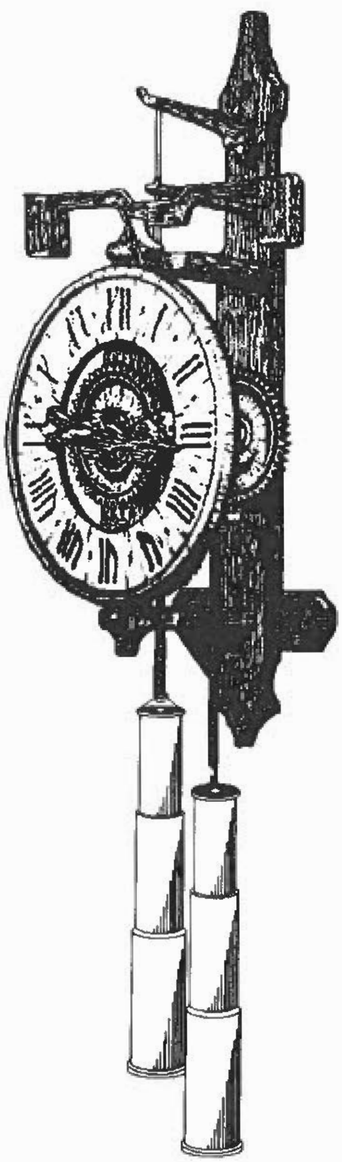
Upper left—Neptune's outer Adams ring shows denser concentrations of material along some segments of the ring, the first time scientists had observed this in the solar system.
JPL PHOTO P-34712



Right—The diversity of terrains seen on Triton probably stems from its complex orbital evolution as a planetesimal captured by Neptune. The so-called "canteloupe terrain" in the lower half of the image has not been convincingly explained as yet.
JPL PHOTO P-34764

NEW IN PRINT

These publications are available from the publisher listed or may be ordered through local bookstores.



COURTESY CAMBRIDGE UNIVERSITY PRESS

A REVIEW

UNUSUAL TELESCOPES

By Peter L. Manly
Cambridge University Press, New York, 1991. 221 pp.
Black and white photos and illustrations. Hardcover. $39.95

Imagine my disappointment on first receiving *Unusual Telescopes*. I had been forewarned of the impending publication by Oscar Knab, whose works appear prominently in the book, and I was expecting a "cookbook" approach to telescope design. A quick scan convinced me I had seen most of the photos and drawings in *Telescope Making, Sky and Telescope* "Gleanings," and other sources. Why were there no ray traces, no lens designs to guide construction of these telescopes? Furthermore, this quarto volume appeared quite small, and at $40.00, a bit expensive. Oh well, I had agreed to review, and review I would. (Thinks: might as well make the best of an unfortunate task.)

Grumpily, I plowed through half the first chapter before light began to penetrate my mental funk. The disappointment was entirely of my own making. I began to realize that this was Peter Manly's book, and he had the right to author it in his own way. Mr. Manly is a well-known writer in astronomy and fiction, with hands-on design and construction experience of astronomical instrumentation. We who appreciate the odd and unusual in telescopes are fortunate that he undertook the compilation of this somewhat arcane information for such a limited audience. (Thinks: Peter's not going to get rich off this one.) He treats us, in nine well-organized chapters, to an excellent review of the workable, the unworkable, and the somewhat workable in the realm of telescope design and construction. He further makes it plain that this is a not a book of *slightly* unusual telescopes; it must be a real oddball of some sort to make the cut.

Chapter 1, Optics, covers materials and designs for optical elements. For example, many of us realize that mirrors have been made from rocks (obsidian and granite), but did you know that some have been successful? Flexible mirrors (mercury and membranes) have been used in special applications, but did you know that a South American amateur has made a telescope using vacuum-(de)formed plate glass? Sufficient information and references are here to get a willing experimenter started toward further development of this technology. Few people would look at many of these designs as fruitful for development, but insights gained from knowing what has been tried can help us use our development time more effectively. The complete range of optical configuration is treated: multiple mirrors, tilted components, wide-field, double-field, convertible, and even gravitational, using stars and galaxies as optical elements.

The author's style is relaxed, conversational, and interesting. Those with interest in the history and practice of astronomical hardware, but with no inclination toward construction, will find a rich store of information and anecdote. The more mechanically addicted will appreciate the extensive references Mr. Manly provides. Many times have I wished to retrieve some particular jot, but decided that the difficulty of pursuit, say searching 30 issues of *Telescope Making*, outweighed the benefit. Were this book in my library (and it probably won't be soon, about which more anon) the exhaustive references would make the task trivial. I may be prone to belabor a point ("Nay," say some, "intent upon!"), but I frequently grab the telephone *in media dementia* and call a source for further information. Is anything more maddening than a tantalizing morsel of data flung into an article with no leads to the world at large? References are a Good Thing. Many references are a Very Good Thing. (Thinks: better quit editorializing and get on with the review.)

Succeeding chapters treat mountings, from zero to infinite axes (not the most interesting subject to some, but deadly serious to others), telescope and mount materials, drivers, movable scopes, moving and stationary eyepieces, limits on design (length, diameter, arrays, etc.), and, lastly, whimsical telescopes like one made from a beer can (the watermelon telescope didn't make the deadline).

You will find that reflectors may be bent, folded, tilted, tubeless, convertible, solid, all-sky, split-fielded, and double-fielded, with combinations of these characteristics. All-sky cameras have been made using hubcaps and plastic eggs. Refractors, likewise, have been folded in many different configurations, one of which, the Schupmann, uses a mirror (naturally) to correct most of the optical imperfections of the refractor.

Advantages of different mount arrangements are explored. There is a particularly interesting discussion of the el-el mount, which employs two orthogonal axes, both articulated in elevation, eliminating the notorious "zenith deadzone" of the altazimuth mount. The tendency to enlarge this list must be resisted, lest the review take on the appearance of an index minus page numbers. The reader will find useful and interesting ideas presented in every chapter, many of which could be fabricated by the handy amateur.

Unusual Telescopes is a delightful essay into a facet of astronomy that fascinates many, myself included. The book is also not as small as it first appears. A smaller-than-usual typeface reduces the physical bulk, but there is folio-class substance here. Further, the book is pleasant to hold and easy on the eyes due to its excellent quality; photos are sharp (some are also technically excellent), typography crisp (aesthetically approaching hot type), paper is fine with just enough gloss to allow sharp half-tones but yet not enough to glare. The cover is sturdy, with an attractive linen finish that is going to outlast the dear reader.

Cambridge University Press is not to be trifled with on quality (this is the first book in some time in which I found no typographical error or agrammatism), so if the reader is a librophile, this book is going to suit you just fine. It will make a useful addition to many libraries; alas, probably not mine. As much as I appreciate the obvious quality, as much as I enjoy the topic, and notwithstanding that it is the best book available on the subject, there are some awesome books out there in the $40.00 range that I still don't own, so I'll pass for now. (Thinks: one of my friends will probably buy it and I can borrow it. Please.) —Don Caron

(Don Caron is an active member of the JSC Astronomical Society. He currently leads the Telescope Making Special Interest Group of the Society.)

NEW FROM THE ASTRONOMICAL SOCIETY OF THE PACIFIC

VIDEO ON ASTRONOMICAL OBSERVATORIES

The Observatories, a film introducing modern telescopes and observatories, has been released by the nonprofit A.S.P. on videotape (in VHS or PAL format). Produced by the National Science Foundation in 1982, the half-hour color film features tours of Kit Peak, Arizona; the Very Large Array in New Mexico; Cerro Tololo Observatory, Chile; and the giant radio dish at Arecibo, Puerto Rico. During the tours, noted astronomers explain some of the techniques these observatories employ to search for other solar systems, probe the interior of the Sun, and observe galactic cannibalism. The tape is accompanied by an extensive nontechnical reading list on astronomical telescopes and observatories. $34.45 from A.S.P., Video Order Dept., 390 Ashton Avenue, San Francisco CA 94112.

NEW IN PRINT

SPECIAL ISSUE ON WOMEN IN ASTRONOMY

The first 1992 issue of *Mercury* magazine, published by A.S.P., is devoted to women in astronomy. Additional copies of the 48-page issue are available to libraries and the public. The issue includes the history of women in astronomy from the 1700s to the present (including a collection of photographs), reminiscences by Dorrit Hoffleit and Ann Boesgaard, and an interview with Vera Rubin, who pioneered our understanding of dark matter in the cosmos. There are also discussions of professional and family issues for women scientists, practical advice for young women considering a career in astronomy, and an extensive bibliography. $5.00 from A.S.P., Mercury Issue Orders, 390 Ashton Avenue, San Francisco CA 94112.

NEW TECHNICAL REPORTS FROM LGI

The Lunar Geotechnical Institute announces the availability of four new technical reports. As usual, these reports are free from LGI. The new reports are *Physical and Mechanical Properties of Lunar and Planetary Soils*, TR91-03; *Soviet Rover Systems*, TR92-01; *Chemical Engineering on the Moon*, TR92-02; and *The Investigation of the Frictional Properties of Lunar Soil and its Analogs*, TR92-03. The reports may be ordered from LGI, P.O. Box 5056, Lakeland FL 33807-5056. Phone: 813-646-1842; FAX: 813-644-5920.

NASA PHOTO P-17429

PLANETARY GEOSCIENCES HISTORY PROJECT SEEKS INPUT FROM THE COMMUNITY

Dr. Joseph Tatarewicz has begun work on a history of the planetary geosciences to about 1980. He seeks suggestions of people, institutions, events, and topics that should appear in such a history. This work, sponsored by the NASA History Division, examines the interaction of astronomy, geology, geophysics, and allied sciences in the study of solar system bodies, and the roles of institutions and individuals in promoting this study and providing its technological base.

The project, which will result in a scholarly monograph on the subject, will include a series of oral history interviews and a survey of archival documents. Interview transcripts and documentary materials will be placed in suitable archives where they may be consulted by other scholars. Anyone who wishes to discuss the project, make suggestions, or nominate individuals to be interviewed should contact the author at History Division/ADA-2, NASA Headquarters, Washington DC 20546: Phone: 410-531-1122.

Dr. Tatarewicz received his Ph.D. in History and Philosophy of Science from Indiana University in 1984. He is the author of *Space Technology and Planetary Astronomy* (1990, Indiana University Press), a contributor to *The Space Telescope: A Study of NASA, Science, Technology, and Politics* (1989, Cambridge), and has published in many professional journals in the history of science and technology.

PUBLICATIONS FROM LPI

QUANTITY	CODE	TITLE	PRICE	TOTAL

BOOKS

QUANTITY	CODE	TITLE	PRICE	TOTAL
	PRO-20	PROCEEDINGS OF THE TWENTIETH LUNAR AND PLANETARY SCIENCE CONFERENCE	$25.00	
	PRO-21	PROCEEDINGS OF LUNAR AND PLANETARY SCIENCE, VOLUME 21	$25.00	
	PRO-22	PROCEEDINGS OF LUNAR AND PLANETARY SCIENCE, VOLUME 22	$25.00	
	B-ORIGINS	ORIGIN OF THE MOON	$15.00	
	B-BASES	LUNAR BASES AND SPACE ACTIVITIES OF THE 21ST CENTURY	$15.00	
	B-PLANS	PLANETARY SCIENCE: A LUNAR PERSPECTIVE (SPECIAL PRICE; SLIGHTLY DAMAGED)	$5.00	

SLIDE SETS

QUANTITY	CODE	TITLE	PRICE	TOTAL
	S-IMPACT	TERRESTRIAL IMPACT CRATERS ★NEW★	$15.00	
	S-WINDS	THE WINDS OF MARS: AEOLIAN ACTIVITY AND LANDFORMS	$15.00	
	S-TOUR	A SPACECRAFT TOUR OF THE SOLAR SYSTEM	$17.00	
	S-STONES	STONES, WIND, AND ICE: A GUIDE TO MARTIAN IMPACT CRATERS	$15.00	
	S-VOLC	VOLCANOES ON MARS	$12.00	
	S-APOLLO	APOLLO LANDING SITES	$17.00	
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Back to the Moon—

EARLY ROBOTIC MISSIONS

by David C. Black and Paul D. Spudis

NASA's NEWLY RE-ESTABLISHED Office of Exploration is planning several small, robotic missions to the Moon within the next three years to begin the Space Exploration Initiative, the nation's program to return to the Moon and journey to Mars. The need for small, unmanned lunar missions is both technical and programmatic. To support extended human operations on and around the Moon we must acquire knowledge about the distribution of lunar resources and the detailed characteristics of the surface at proposed human outpost sites, and we must learn more about the gravity field and global terrain. For the program to succeed, we must demonstrate that innovative, inexpensive exploration techniques are feasible and will produce quality results.

A Workshop on Early Robotic Missions to the Moon was held at LPI, February 4--6, 1992, to assess instruments that could be used on these early unmanned missions. Instruments were evaluated mainly for scientific relevance and quality of the dataset that they would return; however, their usefulness in resource exploration and processing was also considered.

The Office of Exploration has established four themes for early lunar robotic missions: resources, terrain—both topography (altimetry) and surface morphology (imaging)—gravity, and lander missions.

ORBITAL AND LANDED PAYLOADS

Sixty instrument or mission concept proposals, about equally divided between orbital and landed operation, were considered.

The Lunar Exploration Science Working Group (LEXSWG), a standing advisory group to the Solar System Exploration Division of NASA's Office of Science and Applications (OSSA), has developed a prioritized list of global datasets with specific quantitative measurement requirements that are desired from lunar orbital missions (see table). The workshop found that there are excellent candidate instruments to obtain these datasets. At present there is no prioritized list of datasets expected from payloads landed on the lunar surface (although one is being developed by the LEXSWG).

We discussed landed payloads in the context of the proposed "common lunar lander," *Artemis*. Payload capability would be only about 65 kg for the first lander, but most proposals anticipate a 200-kg capability, which is being investigated for subsequent versions of *Artemis*. Also, the baseline design of *Artemis* has no provisions for power or communications. These engineering constraints did not affect the workshop's assessment of the various landed instruments.

While landed payloads in general are not as fully developed as orbital payloads, a wide and interesting range of concepts offers great scientific potential as well as being useful for exploring lunar resources.

RECOMMENDATIONS

We concluded that these missions offer the opportunity to do outstanding science, and that there are high-quality instruments that could be flown within three years, including landed science as well as orbital science instruments.

Flight-ready, new-generation instruments are, in general, not immediately available, and some of the more promising instruments that were reviewed, while not new in concept, are still at the advanced testing and breadboard stages. This is because relatively little lunar instrument development has been done during the past decade and a half, so most of the state-of-the-art instruments reviewed at the workshop were developed for nonlunar missions or their components have been qualified for spaceflight in other contexts. The suite of instruments that we recommend can be flown within three years, as long as prompt and adequate funding is made available to the instrument teams. The Office of Exploration should take the lead in establishing a flight instrument development program.

P. RAWLINGS

After being transported to the lunar surface by an Artemis lunar landing stage, the robotic rover surveys the planned landing site to ensure suitability prior to the piloted landing. A simple, automated lander the size of a compact car, the Artemis landing stage will enable small payloads to be launched to the Moon atop an expendable launch vehicle.

This instrument situation applies not only to the science payloads, but to the resource-utilization payloads that were reviewed at the workshop. The maturity of the proposed resource utilization concepts, potentially quite useful to achieving the goal of a permanent human presence, is not as advanced as many of those for science instruments; few have even breadboard hardware models. As with science instruments, there is a critical need for NASA to initiate resource instrument development. Resource-utilization instruments could be flown soon after more mature science instruments, provided that development starts soon.

The workshop also noted a pressing requirement for mobility on early landed science missions and that the JPL minirover is relatively mature and addresses most mobility needs for early exploration. The Office of Exploration should examine whether other engineering solutions could be developed quickly enough.

Orbital Mission 1—Resources

Three proposed instruments working together can provide global maps of lunar chemistry and mineralogy. We believe that given adequate and timely resources, flight-ready versions of these instruments can meet a launch date within three years. Their combined mass, power, and data-rates are plausible for orbiters of modest capacity.

A gamma ray/neutron spectrometer with a Ge detector would provide global chemistry with a low-resolution footprint (dependent on orbital altitude, but greater than 100 km). This is the only instrument that senses composition to depths greater than several micrometers. The scientific return is very high, but cooling the detector to 70° K poses a challenge. Should this preclude a 1995 launch, a similar instrument using a NaI detector could provide useful preliminary information until the Ge detector is launched later.

A soft X-ray fluorescence instrument, to be flown soon on the *Alexis* spacecraft, can detect all major elements with high spatial resolution (l-km pixels) to yield far more definitive constraints about regolith characteristics, origin, and evolution than was thought possible from an orbital mission until very recently.

A visible-infrared reflectance instrument provides information on minerals in surface soils. A full-scale imaging spectrometer collects image data in hundreds of spectrum channels; thus, each pixel has a single spectra of up to 256 points. If this instrument is not ready for flight in three years, a capable multispectral imager (of about six channels) could be sent on an early lunar mission. One of these instruments should be part of the first suite of instruments; the choice between them is a matter of technical readiness. The full-scale imaging spectrometer should be flown as early as possible.

Orbital Mission 2—Terrain

From the Apollo program, we already have some maps of the topography and gravity field of the Moon. However, serious gaps exist in these data in both coverage and quality. Instruments for a second orbiter should obtain global gravity and terrain information to support exploration and scientific studies.

A laser altimeter can collect global altimetry giving us an accurate picture of the lunar figure and gross topography of large regions. A number of the proposed altimeters have some flight hardware derived from the Mars Observer program. Which one to select is purely an engineering issue, as long as the instrument meets the LEXSWG requirements (see table).

Mapping variations in the gravity field on both the nearside and farside is important for operations in lunar orbit and to understand the internal composition and state of the Moon. Because global coverage is considered essential, two spacecraft are necessary to determine the gravity field (the nearside can be done with one); the second spacecraft is an extremely inexpensive "subsatellite" deployed directly from the main orbiter. The most rapid characterization of the global field would be achieved by a concept in which a passive laser reflector co-orbits with the main orbiter at a relatively low altitude. Instrument readiness will determine which technique is selected.

Coupling imaging with altimetry and gravity will achieve excellent science return as well as operational information that would be of long-term use to the Exploration Initiative. The imaging system should be capable of taking stereo imaging data at a ground resolution of 15 m/pixel; a high-resolution mode (2 m/pixel) would permit detailed study of specific sites for landed missions, either human or robotic. This global cartographic database will serve exploration needs in both science and operations. Several imaging systems were considered: All would provide quality data and all have some flight hardware available.

Lander Mission—Surface Rover(s)

Although landed payload instruments are not as highly developed, a capable suite of instruments can be available to fly on the prototype *Artemis* lander.

LEXSWG Orbital Dataset Requirements for Global Measurements

Priority	Measurement	Requirement
1	Elemental composition	< 100-km resolution < 20% precision
2	Topography	< 1-km resolution < + 10-m vertical
	Gravity	< 100-km resolution + 1 mgal
3	Mineral composition	< 500-m/pixel resolution + 5% abundance
4	Imaging	15 + 5-m/pixel resolution 100–300-m pos. accuracy
5	Magnetic	< 30-km resolution + 0.1-nT precision
6	Atmosphere	Species present, state < 100-km resolution + 10% precision
7	Surface thermal	< 100-km resolution 0.5° K (+ 4 mW/m²)

After considering several possibilities, the workshop concluded that a surface rover mission is a logical candidate for the first *Artemis* mission. JPL has been designing and fabricating test rovers for several years, including a set of mini-rovers, two of which could fit within the 65-kg payload of the first *Artemis* mission.

Several instruments could be mounted on such a rover to characterize in some detail the compositional and physical properties of a potential lunar outpost site. This mission could be either the prelude to more extensive surface investigation (by robotic or human missions) or a one-time exploration of a scientifically interesting or operationally challenging site.

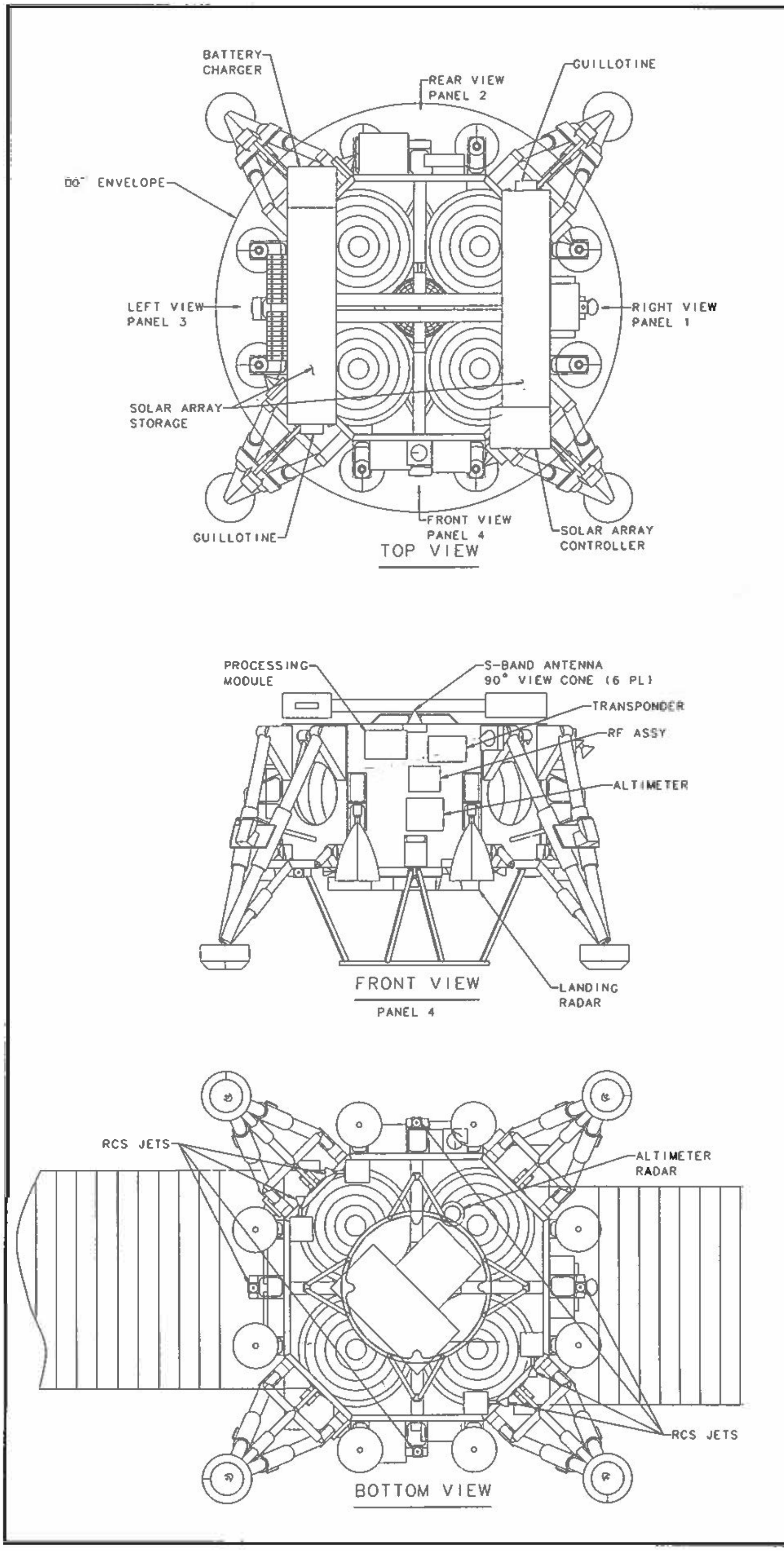
An alpha-proton backscatter spectrometer would provide important information on the chemical composition of lunar soils. A Mössbauer backscatter spectro-meter would complement the alpha-proton instrument and provide high-quality mineralogical data in addition to measurements of soil maturity. Stereo, high-resolution cameras would document compositional analyses, permit physical characterization of the site, and allow all of us on Earth to share the excitement of the first return to the Moon.

These instruments are a minimum to return excellent scientific and resource characterization data. Other instruments, in particular an evolved gas analyzer to measure *in situ* concentrations of solar wind hydrogen, should be added to the rover payload as resources permit.

CONCLUSIONS

Not only were logical collections of instruments identified to carry out specific exploration themes, but we found that it's highly probable that these instruments can be built, integrated onto a spacecraft bus, tested, and launched within the three-year schedule proposed by the Office of Exploration. This is indeed a "faster, cheaper, better" way of exploring space. Scientists who attended strongly endorse this new approach and stand ready to help the Office of Exploration carry out the Space Exploration Initiative.

(Dr. Black is Director of LPI; Dr. Spudis is a Staff Scientist at LPI.)



DRAWINGS OF *ARTEMIS* COURTESY STEVE BAILEY, JSC NEW INITIATIVES OFFICE

JPL's design for the "common lunar lander," Artemis.

SUMMER INTERN

PROGRAM 1992

For the sixteenth year, the LPI offers selected undergraduates an opportunity to actively participate in lunar and planetary science at the Institute and the NASA Johnson Space Center. The 10-week program will be June 8 through August 14, 1992. Students interested in next year's LPI Summer Intern Program should contact Lebecca Simmons, 3600 Bay Area Blvd., Houston TX 77058-1113.

JULIA DOBZINSKAYA, St. Petersburg Technical University
Advisor: Tomasz F. Stepinski, Lunar and Planetary Institute

This project will investigate the hypothesis that the outburst mechanism of FU Orionis (Fuors) objects is driven by aperiodic magnetic fields originating in circumstellar disks surrounding young low-mass stars. Substantial evidence suggests that the outbursts of Fuors are caused by a rapid increase in mass accretion through a disk. What actually causes this increased accretion rate is not currently understood. It has been suggested that a dynamical evolution of some accretion disk, and thus an accretion rate, could be controlled by magnetic fields generated by a dynamo process within a disk itself. Because this process is a nonlinear phenomenon, dynamo-generated magnetic fields are likely to be intrinsically chaotic, rather than steady or periodic. Aperiodic magnetic fields would lead to aperiodic changes in a disk's angular momentum transport rate and thus to the aperiodic changes in accretion rate that we observe as Fuors events.

JEFFREY J. GILLIS, University of Massachusetts
Advisor: Paul Spudis, Lunar and Planetary Institute

The intern will learn the fundamental principles of planetary geological mapping and will participate in the compilation of a new lunar nearside geological map. The intern will collate maps that have already been made at a variety of scales and projections and transfer them to the new lunar shaded relief base, recently completed by the U.S. Geological Survey. The mapping will be extended to new areas in the lunar limb regions (i.e., between 50° and 100° E and W), mapping both stratigraphic units and structural features. This will give practical experience in photo-geological mapping, a detailed understanding of the stratigraphy and geological history of the Moon, and a thorough grounding in the rudiments and principles of historical geology applied to another planet.

KANDY S. JARVIS, Wright State University
Advisor: Faith Vilas, NASA Johnson Space Center

C-class asteroids probably underwent aqueous alteration during their history in the solar system. Spectral reflectance studies in the visible and near-infrared have identified absorption features similar to those seen in laboratory reflectance spectra of phyllosilicates. This project will study a large number of telescopic narrowband CCD reflectance spectra of asteroids, identifying and removing effects on the data, identifying trends within the data, and studying these trends in the context of solar system compositional formation.

IVETT A. LEYVA, Whitman College
Advisor: Stephen Clifford, Lunar and Planetary Institute

During the great Alaska Earthquake of 1964, water and sediment were ejected from shallow aquifers as far as 400 km from the earthquake's epicenter, with some eruptions rising over 30 m into the air. The martian cratering record provides evidence that the planet has experienced numerous seismic events of a similar, and often much greater, magnitude. Given this fact and the photogeologic evidence for abundant water in the early crust, we propose to investigate the response of a martian aquifer to a major seismic disturbance using a variety of numerical and analytical techniques. This study will improve our understanding of both the dynamic behavior of volatiles within the early martian crust and the geomorphologic evolution of the planet's surface.

TROY A. MARINO, Arizona State University
Advisors: Gordon McKay and Allan Treiman, NASA Johnson Space Center

In an earlier study we observed that REE partition coefficients for clinopyroxene increase as the wollastonite content of the pyroxene increases. There are two possible explanations: (1) The pyroxene could be a homogeneous phase, with the distribution coefficients increasing continuously as Ca "expands" the pyroxene structure, making it easier for the larger REE ions to enter the crystal lattice; or (2) The pyroxene could be a submicroscopic intergrowth of two phases, one with low Ca and REE partition coefficients, and one with high Ca and partition coefficients. In the latter case, the variations in Ca content and distribution coefficient values would simply result from different proportions of each pyroxene phase being sampled. We propose a high-resolution analytical transmission electron microscope study of the same pyroxenes analyzed with the electron microprobe at much lower spatial resolution in our earlier study to determine whether these pyroxenes are homogeneous or are instead mixtures of two discrete phases. Answering this question will make a very valuable contribution to our attempts to extrapolate partition coefficients to systems other than those for which they were measured.

GWENDOLYN C. MINER, Bryn Mawr College
Advisor: Arch Reid, Lunar and Planetary Institute

A major objective is to obtain high-quality petrographic and mineralogic data on unusual "igneous" inclusions in carbonaceous chondrites. The mineral and textural data should allow us to put some constraints on the physical conditions under which the inclusions formed, e.g., melting temperature and cooling rate. Comparison will be made with similar assemblages in terrestrial, lunar, and eucritic assemblages. A search will be made for evidence of the presence of "relict" phases, i.e., mineral phases that persisted as solids from any precursor assemblage. The overall objective is to understand the origin of these refractory inclusions and their relationship to the more abundant CAI inclusions in carbonaceous chondrites.

JOHN A. NORRIS, University of Georgia
Advisors: Lindsay Keller and David McKay, NASA Johnson Space Center

The compositions of impact glasses in lunar soils provide important information on the chemical fractionations that accompany impact events and the processes that affect the evolution of lunar soils. Our research indicates that vaporization and condensation are the major processes affecting the compositions of micrometer-sized glass spheres in lunar soils. Electron microscopy will be used to determine the compositions of submicrometer glasses from both highland and mare sites and from mature and immature soils. The main questions to be investigated include: How are the glass compositions and populations affected by impact into (chemically) different target materials? How does soil maturity affect the relative populations of compositional groups of glasses?

MARINER 10 PHOTO: FDS 00080 (118)

C. MICHELLE OLMSTEAD, Northern Arizona University
Advisor: Paul Schenk, Lunar and Planetary Institute

The analysis of impact crater dimensions on planetary bodies is perhaps the best means of determining how craters are structurally modified and how crater morphology depends on surface gravity and crustal composition. Some features of crater formation are central peaks and rimwall terraces, the occurrence and dimensions of which vary from planet to planet. The goal of this work is to fill gaps in the data record and to incorporate new results into a conceptual model of crater modification. Most important is measuring the heights and widths of central peaks on Mercury. Central peaks form as a result of rapid uplift of the crater floor by mechanisms that are not entirely understood. Mercury has a surface gravity between that of the Moon and those of Venus and Earth. Comparison of uplift measurements on these planets is important in understanding how surface gravity influences floor uplift. Measurements of peaks on Mars will also be attempted.

SHEILA B. SMITH, Baylor University
Advisor: Fred Hörz, NASA Johnson Space Center

Some 15 m^2 of thermal blanket materials were exposed for 5.7 years in low Earth orbit on the Long Duration Exposure Facility (LDEF). They display literally thousands of penetration holes caused by natural cosmic dust particles and man-made debris. A light gas gun will be used at velocities up to 7 km/s to reproduce such hypervelocity penetrations in teflon-analogue foils and in actual LDEF thermal blankets. The objective is to show the relationships between projectile size and resulting penetration hole size over a wide range of (experimental) foil thicknesses; such "scaled" experiments simulate the on-orbit condition of a single foil of fixed thickness being penetrated by projectiles of widely varying sizes and masses. The experimental results will therefore be useful to delineate the size-frequency distribution of hypervelocity particles in space.

ANTON VUORILEHTO, Helsinki University of Technology
Advisor: Deborah Domingue, Lunar and Planetary Institute

Photometric analysis can establish relative differences in surface structure among various regions of a planetary surface. The aim of this project will be the construction of a

NASA PHOTO P-21207C

photometric parameter map of Ganymede's surface using Hapke's model. In the process of constructing this map, a color ratio map will also be generated. Coupling these two maps to the cratering record and geomorphic maps may help to establish age and emplacement relationships among Ganymede's various terrains.

EGON T. WEBER, Texas A&M University
Advisors: A. Jurewicz and John Jones, NASA Johnson Space Center

Some meteorites have compositions similar to terrestrial basalts. Thus, primitive condensates from the early solar nebula must have been processed by partial melting and chemical differentiation to produce these basalts. By controlled experimental melting of carbonaceous chondrites, which are probably representative of these primitive materials, we have produced melts that are similar to either of two different basaltic meteorite groups, angrites or eucrites. This summer we would like to extend our previous partial melting experiments to include ordinary chondrites, specifically Lost City and St. Severin.

RUSSEL J. WHITE, Ohio State University
Advisor: A. Dolginov, Lunar and Planetary Institute

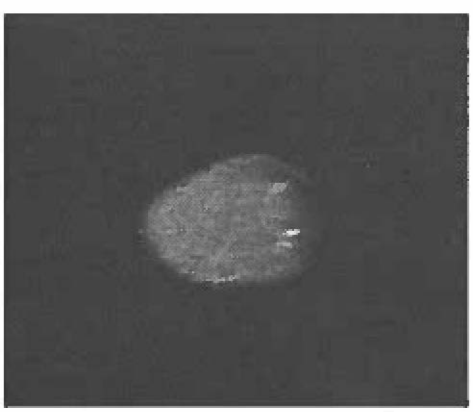
One of the problems in protoplanetary and intertellar cloud evolution is the thermal and charge balance of the dust component in those clouds. Even though grains constitute only about 1% of the cloud mass, they have a deciding influence on opacity and thus on the way the nebula evolves. Polarization of light passing through the nebula is also determined by scattering on the grains. Chemical reactions on the grain surface can lead to electron emission and charging of the grain. The project will involve (1) analyses of the existing data on the relative abundance of H and H_2 in interstellar clouds of various types; (2) calculation of the rate of H_2 formation using these data, assuming that the process takes place mainly on the grain's surface; (3) calculation of the thermal balance of the grain taking into account collisions with ambient gas atoms and possible chemical reactions on the surface; (4) calculation of the dust grain electric charge and value as dependent on the grain's chemical composition and conditions in the surrounding medium; and (5) calculation of the dust grain's angular velocity and magnetic moment values and the degree of angular momentum orientation in the magnetic field of the cloud.

MARK A. WIECZOREK, State University of New York at Buffalo
Advisors: Wendell W. Mendell and Faith Vilas, NASA Johnson Space Center

The intern will work on the development of computer software to display Apollo data on lunar surface temperatures and will assist in analysis of the data for application to planning future lunar science missions.

MICHAEL P. F. WOLFBAUER, Bemidji State University
Advisor: Petr Jakes, Lunar and Planetary Institute

Determination of the partition coefficient of a selected transition element (e.g., Ti) between metal and silicate phases will allow us to constrain the behavior of transition metals in the formation and composition of planetary cores. Pyroxene composition melted in a vertical furnace at 1 atm of controlled inert gas and temperatures above the liquidus will be analyzed by electron microprobe.



NASA PHOTO P-21223

LESLIE ZIMMERMAN, Dickinson College
Advisor: Renu Malhotra, Lunar and Planetary Institute

The irregular outer satellites of Jupiter move in elongated, highly inclined orbits. Recent observations indicate that these objects are physically similar to the Trojan asteroids. (The Trojans orbit the Sun at the same distance as Jupiter, only 60 degrees ahead in longitude.) The eight satellites form two clusters with four members each; one cluster orbits Jupiter in a prograde sense at a distance of about 11 million km, and the other orbits Jupiter in the retrograde sense at a distance of about 23 million km. Their great distance from Jupiter means that they are relatively weakly bound to the planet. The long-term stability of their orbits is not known. Using extensive numerical experiments, we will locate the regions of chaotic and regular orbits in the outer reaches of the Jovian system to discover under what circumstances Trojan family asteroids could "leak" into Jovicentric orbits, and vice versa.

CALENDAR 1992

1992 is International Space Year

A host of activities, events, and meetings around the world will focus on space science and exploration with a special emphasis on education. The year-long celebration is coordinated by the national space agencies of 29 countries, the United Nations, 9 international organizations, and many other groups, large and small. Some of the highlights are included in the *LPIB* Calendar. For a more complete list, refer to the special ISY insert in the January/February issues of *Ad Astra* or *Final Frontier* or contact the US-ISY Association, 600 Maryland Avenue NW, Suite 600, Washington DC 20024; phone: 202-863-1734; FAX: 202-863-5240.

MAY

30—June 4 **Space 92: International Conference on Engineering, Construction, and Operations in Space,** Denver, Colorado. Contact: Marie McGuinness, American Society of Civil Engineers. Phone: 212-705-7494.

JUNE

1-5 **Second LDEF Post Retrieval Symposium,** San Diego, California. Contact: Arlene Levine, Mail Stop 404, LDEF Science Office, NASA Langley Research Center, Hampton VA 23665-5225. Phone: 804-864-3318.

4-5 **Evolution of Earth's Surface,** Chicago, Illinois, Contact: Carmen Marti, University News and Information, University of Chicago, Room 200, 5801 S. Ellis Avenue, Chicago IL 60637-1473. Phone: 312-702-4195; FAX: 312-702-8324.

15-19 **Getting Comfortable Teaching with Space—Graduate Course,** Colorado Springs, Colorado. Contact: U.S. Space Foundation. Phone: 719-550-1000.

20-25 **Universe '92 at 104th Annual Meeting of the Astronomical Society of the Pacific,** Madison, Wisconsin. Contact: Meeting Department, A.S.P., 390 Ashton Avenue, San Francisco CA 94112. Phone: 415-337-1100.

29—July 1 **MSATT Workshop on the Evolution of the Martian Atmosphere,** Kona, Hawaii. Contact: Program Services Department, LPI, 3600 Bay Area Boulevard, Houston TX 77058-1113. Phone: 713-486-2166; FAX: 713-486-2160.

29—July 1 **International Symposium on Small Satellites, Systems, and Services,** Arcachon, France. Contact: Chantal Tailhades, Europa Organisation/PSL, 40, boulevard des Recollets 31400 Toulouse, France. Phone: 33-61-32-66-99; FAX: 33-61-32-66-00.

JUNE (CONTINUED)

29—July 7 **Science with the Hubble Space Telescope,** Bala Chia, Sardinia, Italy. Contact: Britt Sjoberg, Space Telescope European Coordinating Facility, K-Schwarzschild-Str. 2, D-W8046 Garching bei Munchen, Germany. Phone: 49-89-32006-291; FAX: 49-89-32006-480.
SPAN: ESO::BRITT
Internet: britt@eso.org
britt@dgaeso51.bitnet

JULY

13-16 **International Workshop on Variable Phenomena in Jovian Planetary Systems,** Annapolis, Maryland. Contact: Ted Kostiuk, NASA Goddard Space Flight Center, Code 693.1, Greenbelt MD 20771. Phone: 301-286-8431.

15-18 **IAU Colloquium 139, New Perspectives on Stellar Pulstion and Pulsating Variable Stars,** Victoria, B.C., Canada. Contact: James Nemec, Washington, State University, Pullman WA 99164-3113. Phone: 509-335-3136; FAX: 509-335-3136.

16-20 **International Aerospace Convention,** Huntsville, Alabama. Contact: Debbie Roderick, Aviation Space Education Association. Phone: 205-551-2230.

16-24 **Spaceweek 1992,** nationwide. Contact: Spaceweek National Headquarters. Phone: 713-333-3627.

19—Aug 8 **Remote Sensing and Global Climate Change,** Dundee, Scotland. Contact: Robin Vaughan, Department of Applied Physics and Electronic & Manufacturing Engineering, University of Dundee, Dundee DD1 4HN, Scotland. Phone: (0382) 23181 ext. 4557/4912; FAX: (0832) 202830; Telex: 93121 10826 DUG.

CALENDAR 1992

JULY (CONTINUED)

27-31 **55th Meteoritical Society Meeting,** Copenhagen, Denmark. Contact: Program Services Department, LPI, 3600 Bay Area Boulevard, Houston TX 77058-1113. Phone: 713-486-2166; FAX: 713-486-2160.

27 — Dec 24 **Planet Formation** research program, Santa Barbara, California. Contact: Jack Lissauer, Earth and Space Sciences, State University of New York, Stony Brook NY 11794. Phone: 516-632-8225.
JLISSAUER@SBCCMAIL.bitnet

AUGUST

2-14 **XVII Congress of the International Society for Photogrammetry and Remote Sensing (ISPRS),** Washington, DC. Contact: Lawrence W. Fritz, GE Aerospace, P.O. Box 8048-10A26, Philadelphia PA 19101. Phone: 215-531-3205; FAX: 215-962-3698; Telex:261745.

3-7 **Dispersal of Protoplanetary Disks,** Santa Barbara, California. Contact: Steve Ruden, Physics Department, University of California, Irvine CA 92717. Phone: 714-856-6669.
SRUDEN@UCI.bitnet

8-9 **International Symposium on the Exploration of the Sun,** Dnepropetrovsk, Ukraine. Contact: US-ISY Association, 600 Maryland Avenue SW, Suite 600, Washington DC 20024. Phone: 202-863-1734; FAX: 202-863-5240.

10-12 **International Colloquium: Magellan at Venus,** Pasadena, California. Contact: Program Services Department, LPI, 3600 Bay Area Boulevard, HoustonTX 77058-1113. Phone: 713-486-2150; FAX: 713-486-2160.

19-21 **Seventeenth Symposium on Antarctic Meteorites,** Tokyo, Japan. Contact: Keizo Yanai, National Institute of Polar Research, 9-10, Kaga 1-Chome, Itabashi-ku, Tokyo, Japan. Phone: 03-3962-4711 ext. 155; FAX: 03-3962-5711.

24 **Experimental Planetology and Cosmic Mineralogy** (special symposium at IGC), Kyoto, Japan. Contact: IGC-92 Office, P.O. Box 65, Tsukuba, Ibaraki 305, Japan. Phone: 81-298-54-3627; FAX: 81-298-54-3629; Telex: 3652511 GSJ J.

24 — Sept 29 **World Space Congress—Joint meeting of the International Astronautical Federation (IAF) and the Committee on Space Research (COSPAR),** Washington, DC. Contact: Mireille Gerard, AIAA, 370 L'Enfant Promenade SW, Washington DC 20024-2518. Phone: 202-646-7450; Information Hotline: 202-646-7451.

AUGUST (CONTINUED)

31 — Sept 2 **Large Meteorite Impacts and Planetary Evolution,** Sudbury, Canada. Contact: Program Services Department, LPI, 3600 Bay Area Boulevard, Houston TX 77058-1113. Phone: 713-486-2150; FAX: 713-486-2160.

31 — Sept 4 **Chapman Conference on Tectonics and Topography,** Snowbird, Utah. Contact: AGU Meetings, 2000 Florida Avenue NW, Washington DC 20009. Phone: 202-462-6903

SEPTEMBER

10-12 **MSATT Workshop on Chemical Weathering on Mars,** Cape Canaveral/Orlando, Florida. Contact: LPI-MSATT Chemical Weathering Workshop, LPI, 3600 Bay Area Boulevard, Houston TX 77058-1113.

14-16 **Planetesimal Dynamics,** Santa Barbara, California. Contact: Glen Stewart, LASP, Campus Box 392, University of Colorado, Boulder CO 80309. Phone: 303-492-3737.
GSTEWART@COLOLASP.bitnet

14-17 **4th International Colloquium on Atomic Spectra and Oscillator Strengths for Astrophysical and Laboratory Plasmas,** Gaithersburg, Maryland. Contact: Lori Phillips, National Institute of Standards and Technology, Gaithersburg MD 20899. Phone: 301-975-4513; FAX: 301-926-1630.

14-19 **Chapman Conference on Solar Wind Sources of Magnetospheric Ulf Waves,** Williamsburg, Virginia. Contact: AGU Meetings, 2000 Florida Avenue NW,Washington DC 20009. Phone: 202-462-6903.

15-19 **The Impact of Astrometry on Astrophysics and Geodynamics,** Shanghai, China. Contact: Ivan I. Mueller, Department of Geodetic Science and Surveying, Ohio State University, Columbus OH 43210-1247. Phone: 614-292-2269; FAX: 614-292-2957.

21-25 **International Symposium on Observational Cosmology,** Milano, Italy. Contact: Secretariat, Osservatorio Astronomico, Via Brera 28, 20121 Milano, Italy. Phone: (0)2-72023751; FAX: (0)2-72001600.
SPAN: 39216::OBS_COS
Internet: OBS_COS@ASTMIB.INFN.IT
PSI: PSI%23910085::OBS_COS

28-30 **International Symposium on Mission Technologies and Design of Planetary Mobile Vehicles,** Toulouse-Labege, France. Contact: Groupe Europa-40, boulevard des Recollets, 31400 Toulouse, France. Phone: (33) 61 32 66 99; FAX: (33) 61 32 66 00.

SEPTEMBER (CONTINUED)

30 —Oct 2 **International Symposium on Artificial Intelligence, Robotics, and Automation in Space (i-SAIRAS),** Toulouse-Labege, France. Contact: Groupe Europa - 40, boulevard des Recollets, 31400 Toulouse, France. Phone: (33) 61 32 66 99; FAX: (33) 61 32 66 00.

OCTOBER

8-9 **MSATT Workshop on Innovative Instrumentation for the *In Situ* Study of Atmosphere-Surface Interactions on Mars,** Mainz, Germany. Contact: Program Services Department, LPI, 3600 Bay Area Boulevard, Houston TX 77058-1113. Phone: 713-486-2158; FAX: 713-486-2160.

10-11 **Fourth International Conference on Laboratory Research for Planetary Atmospheres,** Munich, Germany. Contact: Kenneth Fox, University of Maryland, Department of Chemistry and Biochemistry, College Park MD 20741. Phone: 301-314-9124.

11-16 **24th Annual Meeting of the Division for Planetary Sciences of the American Astronomical Society,** Munich, Germany. Contact: Program Services Department, LPI, 3600 Bay Area Boulevard, Houston TX 77058-1113. Phone: 713-486-2150; FAX: 713-486-2160.

26-29 **Geological Society of America Annual Meeting,** Cincinnati, Ohio. Contact: Vanessa George, GSA, Box 9140, Boulder CO 80301. Phone: 303-447-2020.

NOVEMBER

13-15 **MSATT Workshop on the Polar Region of Mars: Geology, Glaciology, and Climate History,** Houston, Texas. Contact: Program Services Department, LPI, 3600 Bay Area Boulevard, Houston TX 77058-1113. Phone: 713-486-2177; FAX: 713-486-2160.

15-20 **Chapman Conference on the Lower Thermosphere and Upper Mesosphere,** Asilomar, California. Contact: AGU Meetings, 2000 Florida Avenue NW, Washington DC 20009. Phone 202-462-6903.

17-20 **Discovery Program Mission Concept Workshop,** San Juan Capistrano, California. Contact: Doug Nash, San Juan Institute, 31872 Camino Capistrano, San Juan Capistrano CA 92675. Phone: 714-240-2010; FAX: 714-240-0482.

DECEMBER

2-4 **LAPST Workshop on the Apollo 17 Landing Site,** Houston, Texas. Contact: Program Services Department, LPI, 3600 Bay Area Boulevard, Houston TX 77058-1113. Phone: 713-486-2150; FAX: 713-486-2160.

7-11 **American Geophysical Union, Fall Meeting,** San Francisco, California. Contact: AGU Meetings, 2000 Florida Avenue NW, Washington DC 20009. Phone: 202-462-6903.

8-10 **Planetary Systems: Formation, Evolution, and Detection—First International Conference,** Pasadena, California. Contact: Neil Nickle, Jet Propulsion Laboratory, 180-704, 4800 Oak Grove Drive, Pasadena CA 91109-8099. Phone: 818-354-8244. NASAMAIL: NNICKLE

BULLETIN AVAILABLE ONLINE

With this issue, the *Lunar and Planetary Information Bulletin* will be available on line as well as in print. We plan to treat this as an experiment in electronic publishing and hope to enlist readers with a pioneering spirit to help us learn firsthand some of the advantages and disadvantages of putting out information in this way. At least for now, a clear disadvantage is that we will not be able to publish the illustrations and photos that appear in the print copy. (And we welcome advice and counsel from readers who have experience in publishing illustrations electronically.) An option to download individual articles to your computer is being developed but is not available at press time. To access the *Bulletin* via the NASA Science Internet (NSI) or by direct dial:

On NSI/DECNET (SPAN), type SET HOST LPI.
On NSI/Internet, type TELNET LPI.JSC.NASA.GOV or TELNET 192.101.147.11.
To dial direct, call 713-244-2090 or 713-244-2091 to connect to 2400/1200/300 baud.

For all three methods of access, respond to USERNAME: LPI. No password is necessary. Choose *Lunar and Planetary Information Bulletin* from the main menu, then choose the issue from the second menu. If you have difficulty accessing the LPI computer, contact Kinpong Leung at 713-486-2165 (LPI::LEUNG on NSI/DECNET or leung@lpiipf.jsc.nasa.gov on NSI/Internet) or Lorraine Willett at 713-486-2194 (LLFISHER on NASAMAIL).

If you would like to actively participate in this experiment which may involve answering questionnaires or testing new features as they become available, please send your name, voice phone number, FAX number, and e-mail address to the *Bulletin* editor (see masthead on page 2 for mail and e-mail address). We will alert you when each issue comes on line.

MEETINGS

Online Abstracts

The LPI Publications Services Department is experimenting with putting abstracts on line prior to workshops and conferences as part of a database of information in planetary sciences. An option to download individual abstracts to your computer is being developed but is not available at press time. To access the abstracts via the NASA Science Internet (NSI) or by direct dial:

On NSI/DECNET (SPAN), type SET HOST LPI.
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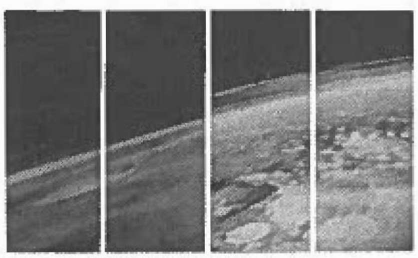
For all three methods of access, respond to USERNAME: LPI. No password is necessary. Choose Online Abstracts, then choose the name of the workshop or conference from the second menu. If you have difficulty accessing the LPI computer, contact Kinpong Leung at 713-486-2165 (LPI::LEUNG on NSI/DECNET or leung@lpiipf.jsc.nasa.gov on NSI/Internet) or Lorraine Willett at 713-486-2194 (LLFISHER on NASAMAIL).

Electronic Abstract Submission

To speed putting abstracts on line and to help cut the cost of abstract volume production, Publications Services is now encouraging as many authors as possible to submit abstracts electronically, by floppy disk or e-mail. If you have not received specific information in the meeting circular, please contact LPI Publications Services, 713-486-2164, for details on electronic submission.



MSATT Workshop on Evolution of the Martian Atmosphere, June 29–July 1, Kona, Hawaii.

This focused workshop on the evolution of the martian atmosphere will concentrate on putting different processes for sources and sinks into perspective and on long- and short-term atmosphere and climate evolution. Some goals are to organize and unify current understanding, encourage interdisciplinary investigation, and possibly list measurements and models that could further constrain the evolution scenario. Abstracts will be on line at LPI by May 25. Information: LPI Program Services, 713-486-2150.

55th Annual Meteoritical Society Meeting, July 27–31, Copenhagen.

More than 340 people responded to the first circular, so organizers expect to have a full program on all aspects of meteorite research. Medalists and invited speakers will cover a variety of topics, from chondrule formation and cratering to the 500th anniversary of the Ensisheim fall. One of the field trips offered will allow participants to visit the K/T exposure at Stevns Klint. Preregistration deadline is June 15. Abstracts will be on line at LPI by June 26. Information: LPI Program Services, 713-486-2150.

International Colloquium on Venus, August 10–12, Pasadena, California.

The meeting will focus on a comprehensive examination of our knowledge of Venus, identifying gaps in the data and suggesting strategies to fill them. Future exploration of Venus, both in the near term and over the coming decade, will also be discussed. The program will be organized around six topics: Atmosphere, Solar Wind Interaction, Impact Cratering/Surface Modification, Geochemistry/Volcanism, Tectonics/Interior Processes, and Future Exploration. Abstract deadline is May 29. Abstracts will be on line at LPI by July 3. Information: LPI Program Services, 713-486-2150.

Large Meteorite Impacts and Planetary Evolution, August 31–September 2, Sudbury, Ontario.

The three-day conference will deal with all aspects of impact mechanics, impact experiments, computer modeling of large impacts, remote sensing for crater studies on Earth and other planets, geochemical studies, field studies, and the role of impact on paleontological extinctions. Poster sessions will be included. Field trips will include pre- and post-conference visits to the Sudbury Structure and a post-conference excursion to Slate Islands. Abstracts will be on line at LPI by June 30. Information: Burkhard Dressler, 416-965-7046.

Second International Planetary Science Conference/24th DPS Meeting, October 12–16, Munich.

"International Space Year" is an excellent time for planetary scientists to share their latest results. The year will see Magellan at Venus, Galileo's Gaspra encounter, Ulysses encounter with Jupiter, the Giotto extended mission, and the start of Mars Observer. The usual rules for DPS meetings will apply. Only one contributed presentation per participant will be accepted. Abstract deadline is July 13. Abstracts will be on line at LPI by July 31. Information: LPI Program Services, 713-486-2150.

MSATT Workshop on Chemical Weathering on Mars, September 10–12, Cape Canaveral/Orlando.

The workshop will bring together scientists studying weathering processes and mineral transformations on surfaces of terrestrial planets to elucidate chemical interactions between the atmosphere and regolith of Mars and to assess the mineral inventory of its surface. A tour of the Kennedy Space Center is planned, possibly to observe final preparations for the launch of Mars Observer. Abstract deadline is June 15. Abstracts will be on line at LPI by July 24. Information: LPI Program Services, 713-486-2150.

LAPST Workshop on Apollo 17, December 2–4, Houston.

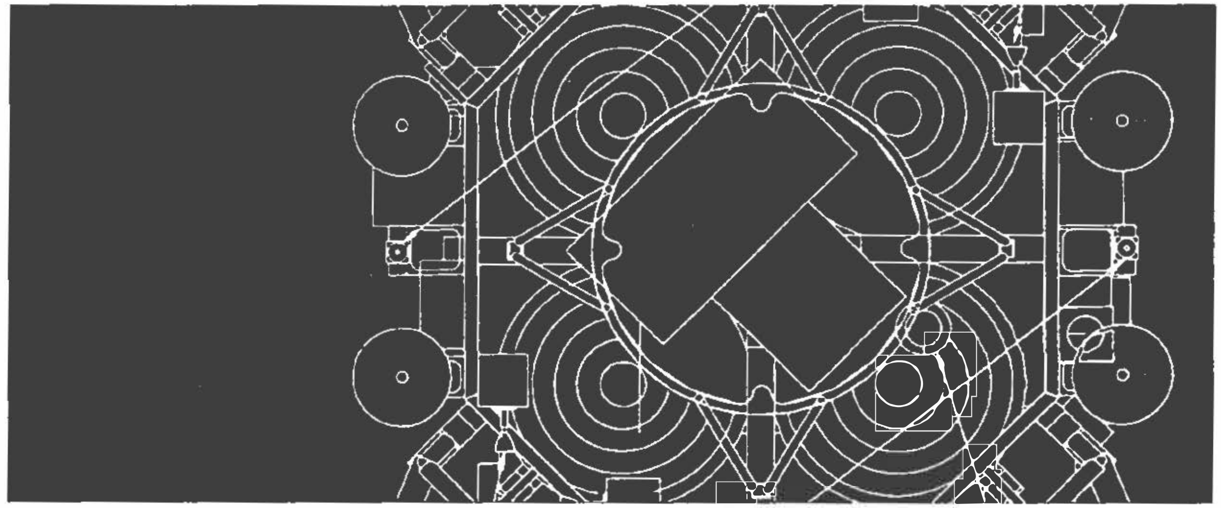
The Apollo 17 site was specifically chosen for its geological diversity; many aspects of lunar processes and history may be studied at the site. Among the topics to be covered are crustal formation and evolution, basin-forming processes, lunar volcanism and tectonism, and surface modification processes and regolith evolution: We also plan a special session dealing with the future exploration and utilization of the Taurus-Littrow site. We encourage participation by workers from diverse disciplines, including photogeology, petrology, geochemistry, geophysics, remote sensing, and resource utilization. Abstract deadline is October 1. Abstracts will be on line at LPI by November 2. Information: LPI Program Services, 713-486-2150.

LPSC XXIII Features Magellan Results

The 23rd Lunar and Planetary Science Conference drew 769 attendees from around the world. The emerging picture of Venus from the Magellan mapping mission was the subject of five different conference sessions. At the Venus Volcanism session, scientists honored William Quaide on his retirement from NASA. Poster sessions held at the new Lunar and Planetary Institute facility on Tuesday and Thursday evenings were especially lively and well attended (photo). A special session on Wednesday afternoon focused on educational outreach and academic opportunities in the planetary sciences and featured descriptions of some innovative programs already underway.

Nathan Bridges of the Department of Geology, Arizona State University, was chosen to receive the Stephen E. Dwornik Student Paper Award of the Planetary Geology Division of the Geological Society of America. His paper, "Aspect Ratios of Lava Domes on the Earth, Moon, and Venus" (N.T. Bridges and J.H. Fink, Arizona State University), was chosen from 50 oral and poster presentations evaluated by the panel of seven judges.

INSIDE



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