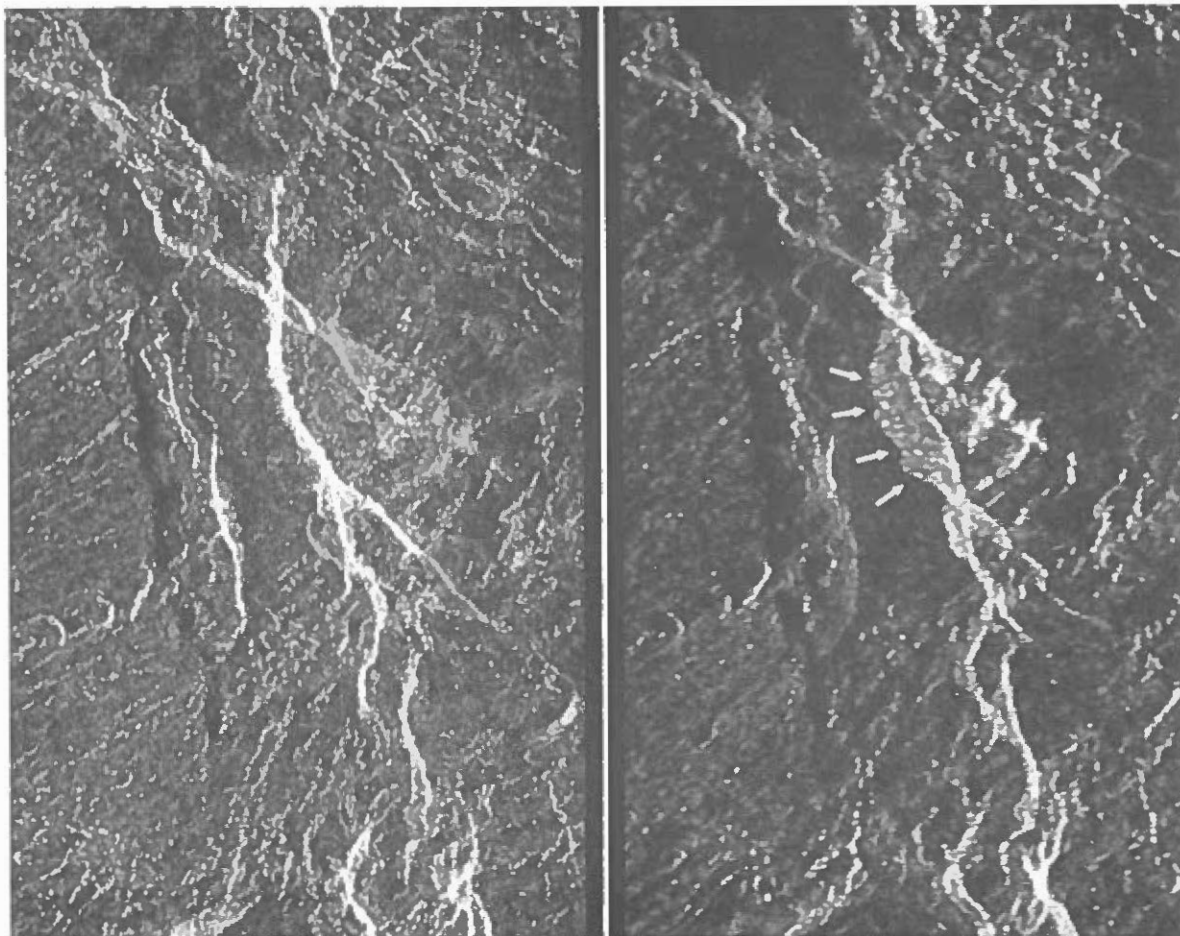


Lunar and Planetary Information

# BULLETIN

NOVEMBER 1991/NUMBER 61 • LUNAR AND PLANETARY INSTITUTE • UNIVERSITIES SPACE RESEARCH ASSOCIATION



NASA PHOTO NO. P-38975

## Landslide or “Layover Effect” on Venus?

The image on the upper left was taken in late November 1990 during Magellan's first trip around Venus. The image on the right was taken July 23 of the same steeply sloping valley in Aphrodite Terra. A radar bright patch to the west (left) of the bright fracture in the later image suggested to scientists that a landslide, possibly triggered by a Venusquake, had occurred. Exciting news indeed, for it would mean that Venus is still tectonically active. With more detailed analysis of geometric and radio-

metric data, researchers are more cautious and most now interpret the feature to be a “layover effect” caused by the different incidence angles of the radar during the two passes over the region.

It is important to remember that Magellan is not taking snapshots of Venus. Although the images may remind us of black and white photographs, they are pictures painted by the radar echoes received by the spacecraft's synthetic aperture radar (SAR) and require experienced interpretation. SAR

has the great advantage of being able to see through the dense clouds of Venus, and it is capable of mapping without illumination. Disadvantages of the technique are the extremely complex data processing necessary to make the signals into images. As with the above images, disentangling the precise “look geometry” (how the radar is oriented relative to the surface) is crucial to interpreting the image. This geometry varies within orbits and with latitude and means, for example, that just

because surfaces at different latitudes *look* different to the radar does not mean that they are.

In the image on the left, the radar was oriented at 44 degrees from the vertical (0 degrees, or directly "overhead") and was taking a somewhat "sideways" view relative to the slope of the linear north-south feature. In this orientation, the radar pings for the steep slope of the feature would be returned from the bottom of the

feature almost as quickly as from the top. The radar sees the feature as a wall. In the right image the radar had an incidence angle of 24 degrees—much more "overhead" in orientation. With this viewing geometry the echoes from the top of the feature are returned much more quickly and strongly creating the patch of radar brightness that was first thought to be a landslide. This is called the layover effect as it makes the feature seem to lay over itself.

In this and other interpretive puzzles, data from extended Magellan mission cycles will be needed to supplement the first map that Magellan has made of the surface of Venus. Stereo views, high resolution imagery, and gravity data will greatly improve the ability of researchers to interpret what they see. *Ø*

## Magellan Extended Mission Science Strategy

By R. Stephen Saunders  
Magellan Project Scientist,  
Jet Propulsion Laboratory

The Magellan extended mission strategy has been developed to maximize scientific return. Although science objectives can be prioritized in order of importance, constraints imposed by the Venus-Sun-Earth-spacecraft geometry, considerations of component lifetime, and loading of project resources must be carefully integrated into the planning process to ensure a more optimal implementation of these goals. Since these considerations have played a large role in the development of the extended mission science strategy, a brief discussion of them is in order.

### CONSTRAINTS

Most significantly, redundancy of two spacecraft components (tape recorder and X-band high-rate downlink telemetry exciter) critical to operation of the synthetic aperture radar (SAR) has been lost. Should either of the two remaining units fail, all SAR capability would be lost. Gravity data collection, however, would not be affected. Additionally, the spacecraft is experiencing a more severe thermal environment in the extended mission. To maintain spacecraft temperatures within acceptable limits, the spacecraft must spend a significant amount of its orbit in a "hide" (high-gain antenna to the Sun) attitude. When thermal constraints are high, mapping coverage is significantly reduced. The effect on gravity data collection is less severe. In the current orbit, Cycle 3 is predicted to experience minimal thermal constraints while Cycle 4 will be

highly constrained. Considerations of planetary and spacecraft geometry also play a large role. Gravity data can only be collected when periapsis is unocculted from Earth. This condition exists for approximately 60% of Cycle 3; however, periapsis is out of Earth occultation for all of Cycle 4 allowing 360 degrees of longitudinal coverage to be obtained. Finally, project resources are expected to be heavily loaded during Cycle 4 as preparations for aerobraking intensify. Thus the plan should seek to reduce operational complexity during this period.

Given that the primary mapping objectives have been largely accomplished, obtaining a high resolution gravity map now becomes the highest priority. Nevertheless, analysis of a series of special tests conducted in (the current) Cycle 2 has shown that there is significant science yet to be accomplished with the SAR. Test data collected using a stereo incidence angle has indicated that the stereo imagery obtainable by Magellan surpasses that of any other program. One full cycle of stereo coverage will more than double the value of the whole image dataset. Careful integration of these two important goals with the constraints discussed has led to the following science recommendations for extended mission operations in Cycles 3 and 4.

Global gravity coverage should be obtained in Cycle 4 beginning approximately September 15 when 360 degrees of longitudinal coverage of periapsis is geometrically possible. To enhance gravity resolution, periapsis should be lowered to 180 km. Imaging in Cycle 4 would be restricted to specific targets to continue the search for, or confirmation of, surface changes. Simplified operations in Cycle 4 (mostly gravity-only

sequences) would allow the flight team to prepare for circularization of the orbit via aerobraking. Cycle 3 should be devoted primarily to obtaining a stereo map of the planet, taking advantage of the minimal thermal constraints during this cycle to obtain maximum coverage. A limited amount of gravity data would be collected (1 in 8 orbits) over Artemis Chasma.

### CYCLE 3 OBJECTIVES

In Cycle 2, tests were performed to investigate new SAR modes: high-resolution SAR (60-m vs. 120-m azimuth resolution); stereo, using an alternate lower incidence angle; and polarimetry.

Used in the detailed planning of Cycle 3, the test results show that the stereo images add a significant quantitative aspect to the interpretability of the images. The stereo data can be used to generate topographic maps at the resolution of the image data and a height uncertainty of 30 meters. With a large dataset, a small fraction of the stereo

*continued on page 15*

The *Lunar and Planetary Information Bulletin* is published quarterly by the Lunar and Planetary Institute, P.O. Box 58407, Houston TX 77258

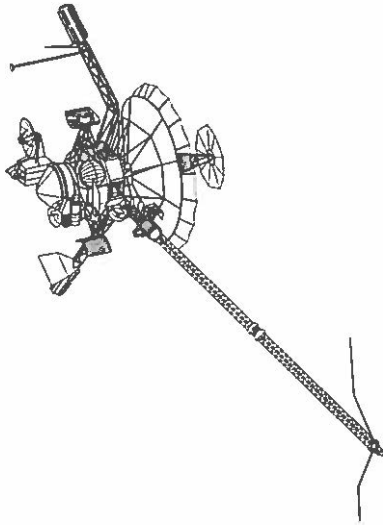
Pam Thompson, Editor

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Please send articles or announcements to:  
P. Thompson, P.O. Box 58407, Houston TX 77258.

Phone: 713-486-2175, FAX: 713-486-2162  
E-Mail: SPAN LPI::THOMPSON

# NEWS FROM SPACE



## GALILEO ENCOUNTERS GASpra; ANTENNA REMAINS STUCK

**G**alileo passed within 1000 miles of the 11-mile-long asteroid, Gaspra, on October 29 to record about 150 photos of the body. Data from the encounter will not be returned to Earth until the spacecraft makes its second Earth flyby in November 1992 because the troublesome high-gain antenna needed to transmit the images remains only partially deployed. Galileo's low-gain antenna can transmit the recorded data when it is nearer Earth.

Engineers tried a third, unsuccessful "cold soak" in mid August, hoping to free the umbrella-like antenna; another attempt is planned for December, when Galileo is even farther from the Sun. Their current model of the problem is that pins on 3 of the 18 umbrella ribs are stuck in V-grooves on the antenna tower. Lubricant used on the pins may have worn away during several cross-country voyages the spacecraft made by truck while awaiting launch.

Meanwhile, scientists studying data from Galileo's February 1990 flyby of Venus are becoming more confident that there are lightning storms in that planet's atmosphere. The science team used the spacecraft's plasma wave instrument to detect electromagnetic equivalents of thunderclaps, most probably generated by lightning bolts deep in the atmosphere. The cause of lightning storms has not been determined but may involve charged dust or other particles.

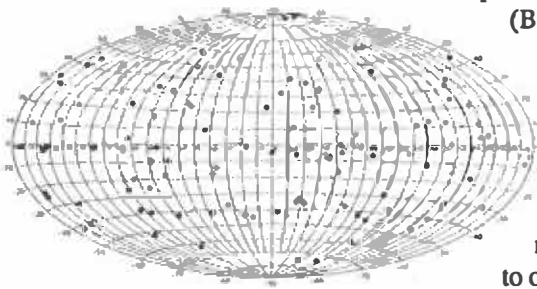
## RESULTS FROM GRO MAY REVISE THEORIES OF GAMMA RAY ORIGINS

**R**elease of early results from the Gamma Ray Observatory included the announcement that the spacecraft has been renamed the Compton Observatory in honor of Arthur Holly Compton, Nobel-prize-winning American physicist. The most startling preliminary result has come from the Burst and Transient Source Experiment

(BATSE), whose eight detectors have picked up gamma ray bursts at the rate of nearly one per day since the observatory was launched in April. Prior to the mission, scientists expected to see these brief, intense bursts of gamma radiation clustered along the plane of the Milky Way where electron-positron annihilations associated with neutron stars in the region might account for the flashes. Instead, the Compton Observatory has found that the gamma ray bursts are distributed evenly across the sky. Researchers do not know yet whether they originate from some new class of object, invisible at other wavelengths and very close to our solar system, or from almost unimaginably powerful gamma ray sources from far outside our galaxy.

The Energetic Gamma Ray Experiment Telescope (EGRET) has detected "the most distant, and by far, most luminous gamma ray source ever seen," says Principal Investigator Dr. Carl Fichtel. The source has been identified with the variable quasar 3C279 in the constellation Virgo, about seven billion light years from Earth. The quasar is presently emitting a large flux of gamma rays; each photon has an energy greater than 100 million electron volts. Gamma radiation from this source is about 1000 times the energy emitted by our galaxy at *all* wavelengths. "Quasar 3C279 is a variable quasar, meaning that its intensity changes over time," Fichtel said, explaining why two previous, smaller gamma ray missions failed to detect it. "Between 1982 and 1991, this quasar has gone from being undetectable to being one of the brightest objects in the gamma ray sky. Because of its large distance, this observation is dramatic confirmation of the dynamic nature of the gamma ray sky and an example of the most energetic processes in nature."

BATSE - GRO  
117 Burst Locations - 9/14/91  
Galactic Coordinates



G. FISHMAN, NASA

# NEWS FROM SPACE

NASA PHOTO: S48-05-024

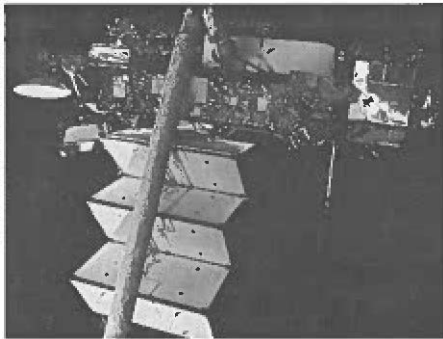
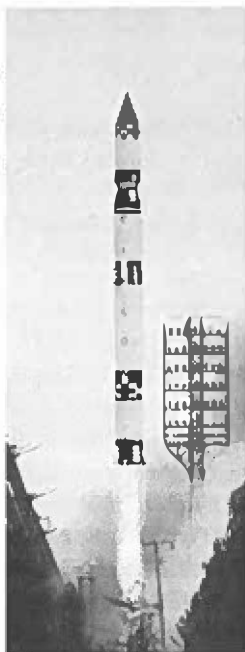
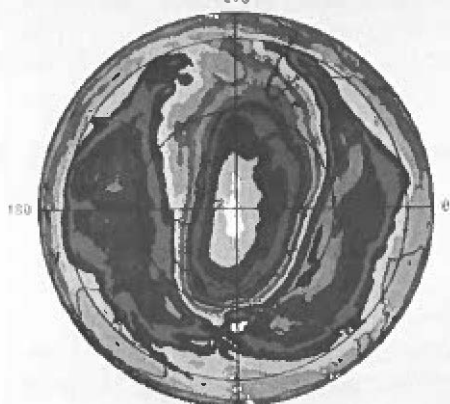


PHOTO: S. DUNNETTE, NASA



OCTOBER 6, 1991



SOUTH POLAR PLOT

## DISCOVERY RELEASES UARS TO BEGIN ENVIRONMENTAL MISSION

The 7.5-ton Upper Atmosphere Research Satellite (UARS), developed at Goddard Space Flight Center and built by GE AstroSpace, was deployed by the Shuttle *Discovery* at 11:23 p.m. CDT on September 15. Although it has been under development since 1985, NASA scientists and engineers consider UARS the first major element of the new Mission to Planet Earth because it will provide a global-scale study of Earth, gathering comprehensive data on interactions of chemistry, wind, and sunlight in the upper levels of the atmosphere from about 9 to 75 miles altitude. The first data were obtained from the spacecraft's Microwave Limb Sounder, one of nine instruments aboard. The satellite's orbit, 363 miles high at a 57-degree inclination, provides extensive geographic coverage. Preliminary data are already providing scientists with a three-dimensional view of the developing ozone hole over the Antarctic—a prime focus of the project. Another mission goal is for UARS to monitor atmospheric interactions over the northern hemisphere, where land-ocean interactions with the atmosphere are most complex, for two consecutive winters. UARS is managed by Goddard Space Flight Center for NASA's Office of Space Science and Applications.

## ANOTHER TOMS LAUNCHED BY SOVIET CYCLONE ROCKET

The first flight of a NASA ozone instrument on a Soviet spacecraft began August 15 when a Total Ozone Mapping Spectrometer (TOMS), flown on a Meteor-3 weather satellite, was launched aboard a Cyclone rocket also provided by the Soviet Union. The Meteor-3/TOMS two-year mission will continue to monitor global ozone levels by measuring the total ozone content in the atmosphere. Since the first TOMS was launched aboard NASA's Nimbus-7 satellite in 1978, it has provided reliable, high-resolution daily mapping of global total ozone. The new TOMS is virtually identical to the original. An early mission target will be to observe formation of the Antarctic ozone hole as it forms in early fall. Launched from the Plesetsk Cosmodrome, the project was conceived under the 1987 U.S.-U.S.S.R. agreement on "Cooperation in the Exploration and Use of Outer Space for Peaceful Purposes."

## AND NOT A MOMENT TOO SOON...

Ozone levels in the Antarctic have reached the lowest values ever observed, according to preliminary data from the Total Ozone Mapping Spectrometer (TOMS) on NASA's Nimbus-7 satellite. Measurements of less than 120 Dobson units have been made with a low value of 110 (plus or minus 6) observed on October 6. "The minimum ozone on October 6, 1991, is the lowest we have ever seen with the TOMS instrument in its 13-year record of data," said Goddard scientist Arlin Krueger. "Although the data are preliminary, we expect the final results will confirm this conclusion."

This is the fourth severe ozone hole since 1986 and the third consecutive year that severe ozone depletion has developed over the Antarctic. Research has linked man-made chlorine compounds and other chemicals to ozone depletion, but the extreme magnitude 1991 minimum cannot necessarily be attributed solely to chemical processes, according to Jack A. Kaye, head of NASA Headquarters' Atmospheric Chemistry Modeling and Analysis Program. Meteorological processes can cause temporary small fluctuations inside a chemically produced ozone hole.

## AXAF MIRRORS SUCCESSFULLY TESTED AT MARSHALL

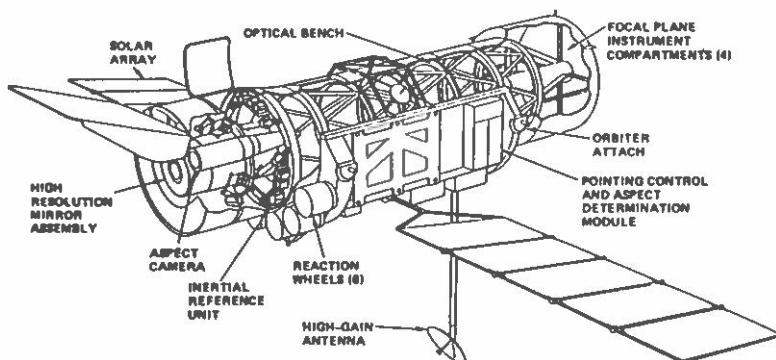
The two largest mirrors for NASA's Advanced X-ray Astrophysics Facility (AXAF) have been successfully tested in the new X-ray Calibration Facility at Marshall Space Flight Center. "We're excited about the results," said Dr. Len Fisk, Associate Administrator for the Office of Space Science and Applications, NASA Headquarters.

"We've met our goals. The mirrors were completed by June, and tests were successfully completed in September. The entire government and contractor team should be congratulated on meeting this challenge."

AXAF will be the third of NASA's four Great Observatories and is scheduled for launch in 1998. It will be used to study stellar structure and evolution, large-scale galactic phenomena, active galaxies, galaxy clusters, quasars, and cosmology.

The mirrors, almost 48 inches in diameter, are the largest ever made to collect X-rays in space. Angular resolution is approximately 0.23 arcsec when the effects of testing at 1 g are corrected for. Even without correc-

tion, the resolution achieved meets the specification of 0.5 arcsec. The instrument should achieve resolutions at least 10 times better than any X-ray telescope previously flown. The mirror set is the outermost of six concentric pairs that will form the High Resolution Mirror Assembly for AXAF. When complete, the entire assembly will be returned to Marshall for final calibration testing together with the scientific instruments planned for the X-ray facility.



## EARLY RESULTS FROM SLS-1 MISSION SHOW CONFIRMATIONS, SURPRISES



NASA PHOTO: S40-17-06

Preliminary results from the Spacelab Life Sciences-1 mission confirmed the expectations of some researchers and confounded those of others. Cardiovascular and renal system experiments showed that many of the changes caused by fluid shift to the upper body actually occur on the launch pad and prior to orbital insertion—much earlier than previously thought. Consistent with predictions, white blood cell responsiveness, which helps the body fight infection, decreased because the lymphocytes are unable to cluster normally in microgravity; an *in vitro* experiment showed that adding tiny glass beads or microcarriers promoted cell interaction, reducing the suppression of lymphocyte activity.

An unexpected finding is that lung function may not be gravity dependent. In 1 g, (heavier) blood flow is greater in the lower lung, while (lighter) air flow is greater in the upper lung. Researchers had assumed that in the absence of gravity tugging on the lungs, their shape would change and the flow of air and blood would be more evenly distributed (which would be more efficient). But a pulmonary function experiment revealed no significant differences in lung function inflight.

Examination of the space jellyfish has thus far shown normal statolith development (organs comparable to the otoliths of the inner ear in humans) and normal swimming behavior.

In postflight studies, a 10% decrease in blood volume in returning astronauts was noted as well as a decrease in cardiac pump capacity of about 25%. All the effects of microgravity appear to be reversible in days to weeks postflight. Researchers expect the length of exposure to microgravity to influence the time of recovery on return to 1 g.



October 29, 1991—  
The front facade of the  
new facility that will  
house the Lunar and  
Planetary Institute.



The Lunar and Planetary Institute:

# 3rd Decade and Beyond

By David C. Black

*The Lunar Science Institute* opened its doors for business in the renovated West Mansion almost exactly 22 years ago, October 27, 1969. Formal dedication of the new home for the Institute occurred January 4, 1970. (Historical note: the Institute was formally established in October 1968.) Those 22 years have seen tremendous advances and successes in the planetary program, and they have been witness to events that placed the very existence of planetary science in this country at risk.

During that time the charter of the Institute was broadened to include all of the planets in the solar system, and the name of the Institute was changed to reflect this expansion.

As most of you are aware, the Institute is about to embark on a new chapter in its history, a chapter in which we leave the surroundings that so many of you have come to associate with the Institute and move to a newly constructed facility that is located some three miles from the current site (see map below). At the present time, plans call for completion of construction in mid December, with the formal move taking place late in December. There was no groundbreaking ceremony for the new facility; it was too wet here this past spring to plan on a day, so it is our intent to have a "house-warming" in January of 1992. The real baptism of the facility will of course occur in that March madness known as LPSC. While the new Institute building is farther from our colleagues at JSC (less than three minutes more by car) than is the current site, this move will not change our relationship with JSC in anyway. Visiting Scientists will have the same access to the facilities and the people at JSC that they have come to expect over the years, and our colleagues at JSC will continue to use the Institute as a home away from home.

The new Institute will be approximately 48,000 square feet, roughly twice the size of all three of the buildings combined at the current site. We will have a Berkner Room and a Hess Room, both of which will be larger than their namesakes, and the Berkner Room can be divided into six smaller rooms as needed for meetings and panel work. There will also be a 190-seat auditorium that will be extremely useful for workshops and other special events. The McGetchin name will also carry on in the new building as the stained glass window from McGetchin Hall has been removed and will be mounted in the scientific staff commons room.

The move came about because our lease with Rice University on the mansion and its associated property expired roughly two years ago, and Rice plans to sell the property. I am asked frequently who will purchase the property and what will happen to the mansion. At the present time there is no new owner, but Rice is negotiating with some prospective buyers. I am assured that Rice will do everything it can to protect the mansion for the future in any arrangement it makes to sell the property.

The third decade of the Institute's existence promises to be as varied and as exciting as the first two decades. While there are always concerns that we do not have enough missions to conduct a vigorous planetary science program, the fact is that progress continues to be made on a number of fronts. The Institute will continue to work with the university scientific community and with NASA to assure that the ongoing program

## Transition Information

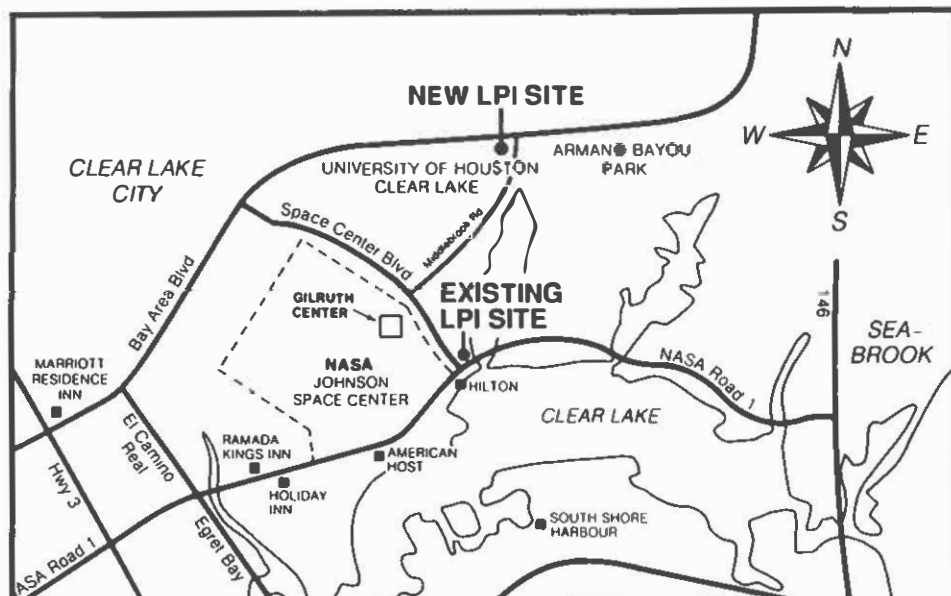
**THE PROJECTED TIME FOR THE MOVE** to the new LPI building is during the week between Christmas and the New Year.

**VOICE TELEPHONE NUMBERS** for scientists and staff will remain the same after the move, i.e., 713-486-Individual extension.

**THE LPI COMPUTER SYSTEM** will be down on Dec. 26-27 for the move. The new modem numbers to call into the LPI computers will be 713-244-2090, 244-2091, and 244-2092 (2400/1200/300 baud). The old dial-in numbers will be discontinued Dec. 25.

**THE MAILING ADDRESS** of the LPI from now through the transition to the new building is Lunar and Planetary Institute, P.O. Box 58407, Houston TX 77258.

**LPSC ABSTRACT SUBMISSIONS:** Abstracts sent by regular mail should be mailed to the LPI Publications Services Department at the P.O. Box 58407 address given above. However, many authors submit abstracts by overnight delivery service. Please note that ONLY U.S. Postal Service Express Mail can be delivered to a Post Office Box address; commercial overnight delivery services CAN NOT be delivered to a P.O. Box. The new street address for LPI will be 3600 Bay Area Boulevard, Houston TX 77058. However, because of the potential delays in moving, we cannot be certain of mail delivery to that address during the week of the abstract deadline. Please plan accordingly.



*Map shows location of the new site compared to the existing site of LPI. The new facility will still be conveniently close to the Johnson Space Center and area hotels.*

# Almost Finished...



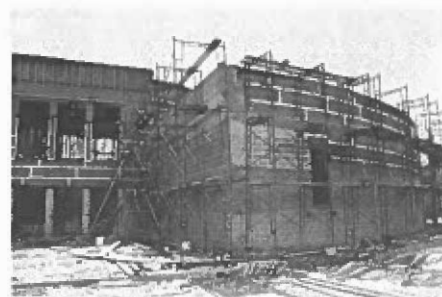
May 1, 1991—Groundbreaking.



July 18, 1991—"Great Room" scaffolding almost completed.



August 26, 1991—Brick construction begins.

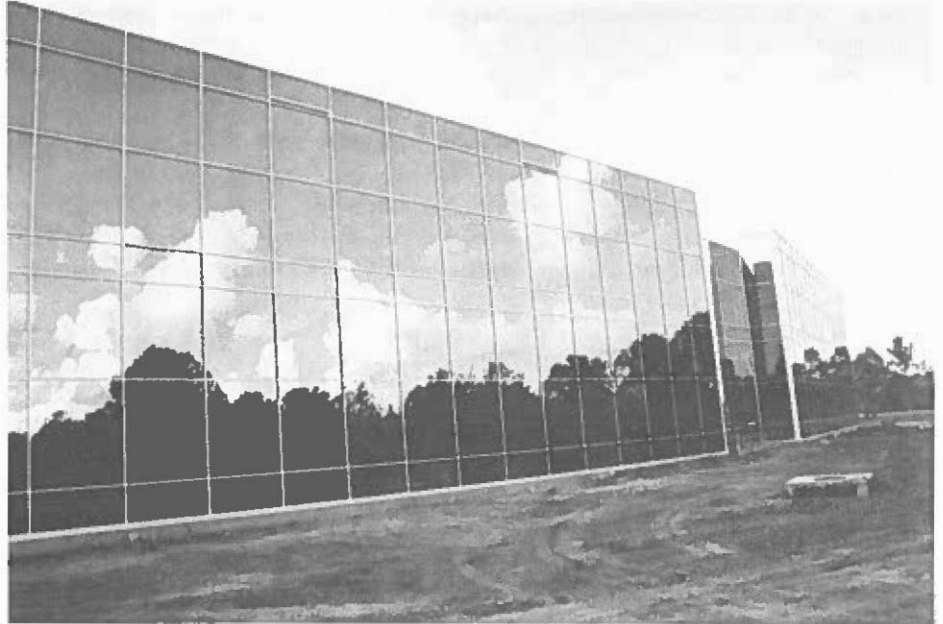


September 24, 1991—Auditorium construction.

is healthy and, perhaps more importantly from the perspective of the role of the Institute, that new ideas are being developed and examined to assure a strong future for the program.

An exciting aspect of this next decade involves bringing together with the Institute in the new facility two other Houston-area programs of the Universities Space Research Association. These are the Division of Space Life Sciences and the Division of Educational Programs. Their presence with the Institute affords a unique combination of communities and skills that are involved in the Mission From Planet Earth (a.k.a. the Space Exploration Initiative). The synergy that could evolve from this mix of activities is rich with promise.

(Dr. Black is Director of LPI.) Ø



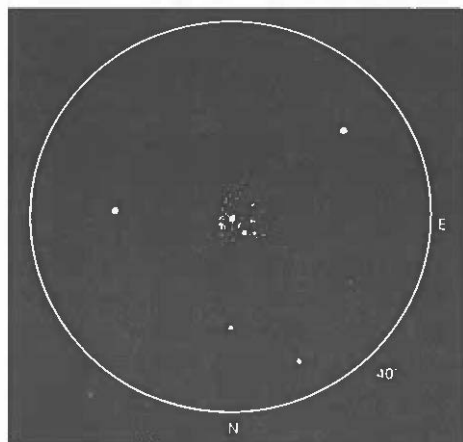
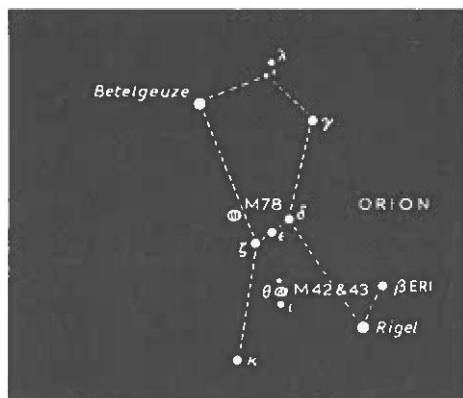
October 29, 1991 — (Above) The rear of the building is sheathed in glass. (Below) The entire length of the new structure is shown from a distance; meeting facilities are on the right.



ALL PHOTOS: D. RUEB, LPI

# NEW IN PRINT

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



*M 78 (NGC 2068): sky map location and telescope view.*

Drawings from MESSIER'S NEBULAE & STAR CLUSTERS. Copyright © 1991 by Kenneth Glyn Jones. Cambridge University Press, Great Britain. Reprinted with permission of the publisher.

## A REVIEW

### MESSIER'S NEBULAE & STAR CLUSTERS

By Kenneth Glyn Jones

Cambridge University Press, Cambridge, Great Britain 1991 427 pp.

Black and white illustrations. Hardcover, \$49.50.

Practical Astronomy Handbooks series, Volume 2.

I already had a book on the Messier objects when I obtained this book through the Astronomy Book Club. The older book, *The Messier Album* by Mallas and Kreimer, had frustrated me in that it failed to guide me to all the Messier nebulae. In all honesty, I can't blame the *Album* for my lack of discipline or Houston's impossible seeing conditions, but the book did lack beginner-level instructions for finding these elusive objects. I was pleased to find that this new publication (actually 1968 but reprinted in 1991) is much more friendly to the novice observer. In particular, the sky maps, constellation diagrams, and drawings of the objects are excellent. Each object is illustrated with a sky map with constellation outlines of the region of the sky near the object. Next to the map is an "eyepiece view" drawing of what the object looks like through a small telescope.

Text includes the descriptions made by the original discoverers (Messier, Halley, Webb) as well as locating and observing tips. The appendixes include photographs of all 110 objects as well as seasonal maps and Epoch 2000 coordinates.

The book is not perfect, however. The introductory text is formal and slightly out of date. The description of telescopes is likewise dated (1968). The orientation is "British," but not insufferable. The text contains Epoch 1950 coordinates, understandable in the 1968 publication, but less satisfactory in a 1991 reprint. This book will probably see a lot of use, which is the best review a book can get. I wish it was a "field guide," spiral bound with laminated pages, and I wish the maps were a little bigger, but on the whole, it is the better of the two Messier books in my library.

—Ed Malewitz

(Mr. Malewitz is an experienced amateur astronomer.)



## NEW FROM THE ASTRONOMICAL SOCIETY OF THE PACIFIC

### VIDEO ON MAPPING THE GALAXIES

A new videotape showing and explaining the surprising new maps of the large-scale structure of the universe that astronomers are constructing is now available from the A.S.P. The eight-minute video is narrated by one of the project's directors, Dr. Margaret Geller, of the Harvard-Smithsonian Center for Astrophysics, where the film was produced. The video focuses on a dramatic computer-animated tour of the deep "slices" through the universe astronomers have mapped and the remarkable soap-bubble-like structures (with filaments of galaxies surrounding great voids) that they have found. The VHS format video is accompanied by a nontechnical article about the mapping project by Dr. Geller and an introductory bibliography on the origin and structure of the universe. \$32.95 from A.S.P., Galaxies Tape Order Dept., 390 Ashton Avenue, San Francisco CA 94112.



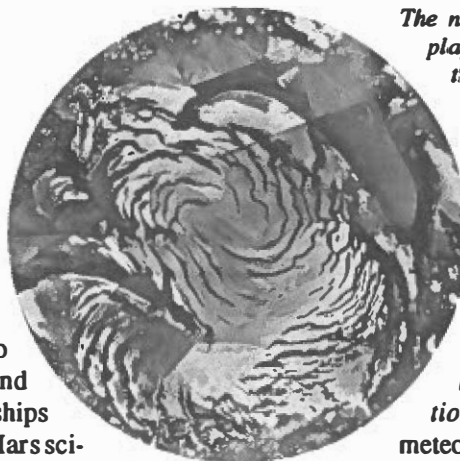
# SUMMARY: WORKSHOP ON THE MARTIAN SURFACE AND ATMOSPHERE THROUGH TIME

By Ben Schuraytz

**T**he NASA-sponsored MSATT Study Project, now in full swing, convened its first major meeting with the Workshop on the Martian Surface and Atmosphere Through Time, held at the University of Colorado in Boulder on September 23-25, 1991. The workshop, co-sponsored by the Lunar and Planetary Institute and the Laboratory for Atmospheric and Space Physics (LASP) at the University of Colorado, brought together an international group of 125 scientists to discuss a variety of issues relevant to the goals of the MSATT Program. The workshop program committee included co-convenors Robert Haberle, MSATT Steering Committee Chairman (NASA Ames Research Center) and Bruce Jakosky (University of Colorado) and committee members Amos Banin (NASA Ames Research Center and Hebrew University), Benjamin Schuraytz (Lunar and Planetary

Institute), and Kenneth Tanaka (U.S. Geological Survey, Flagstaff).

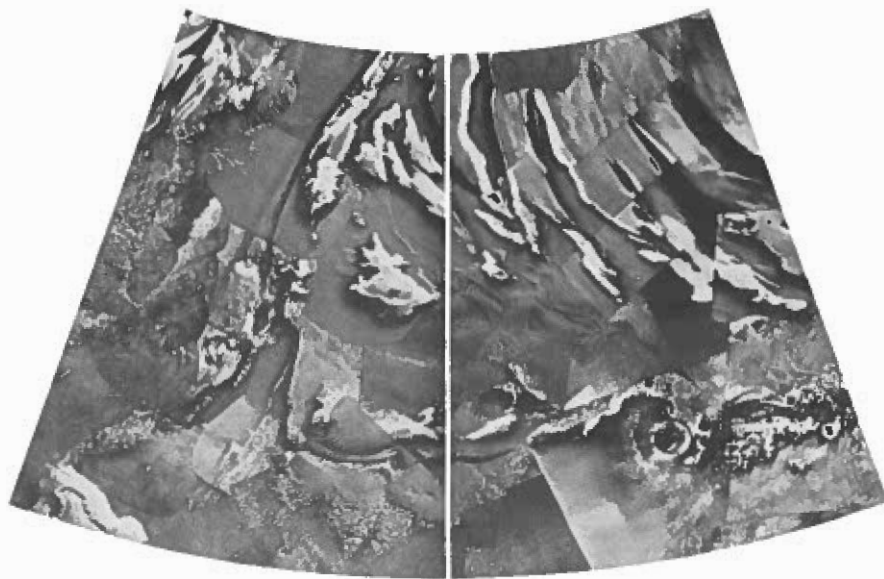
The purpose of the workshop was to begin to explore and define the relationships among aspects of Mars science involving evolution of the surface, atmosphere, upper atmosphere, volatiles, and climate. Specific topics addressed in the 88 contributed abstracts included: (1) *current nature of the surface* with respect to physical properties and photometric observations and interpretations; (2) *history of geological processes* comprising water and ice-related geomorphology, impact cratering, and volcanism; (3) *geochemistry and mineralogy of the surface* with emphasis on compositional and spectroscopic studies and weathering



*The north residual polar ice cap plays a major role in controlling the amount of water vapor in the martian atmosphere.*

processes; (4) *present atmosphere* focusing on structure and dynamics, volatile and dust distribution, and upper atmosphere; (5) *long-term volatile evolution* based on volatiles in SNC meteorites and atmospheric evolution processes; (6) *climate history and volatile cycles* in relation to early climate and the polar caps, ground ice, and regolith; and (7) *future mission concepts*. Because of the broad scope and interdisciplinary nature of these areas of research, a format was chosen to provide both a review of the current state of knowledge and outstanding questions pertaining to these topics and to allow maximum interaction and discussion in a dynamic workshop atmosphere. Each topic was the subject of a half-day session introduced by two invited presentations. These were followed by sessions devoted to poster presentations of contributed papers and then by a period of formal discussion, often lively and controversial, of those topics and issues.

The first session of the workshop led off with presentations by Ronald Greeley (Arizona State University) and Steven Lee (University of Colorado Boulder) regarding consideration of what processes are currently active on the martian surface. Kenneth Tanaka (U.S. Geological Survey, Flagstaff) discussed long-term geologic processes with a view toward understanding the hydrologic history of Mars. In a presentation on oceans and ice-related geological evolution that sparked much discussion, Victor Baker (University of Arizona) stated that concepts of an ancient northern ocean and polar glaciation are inferences based on geologic features rather



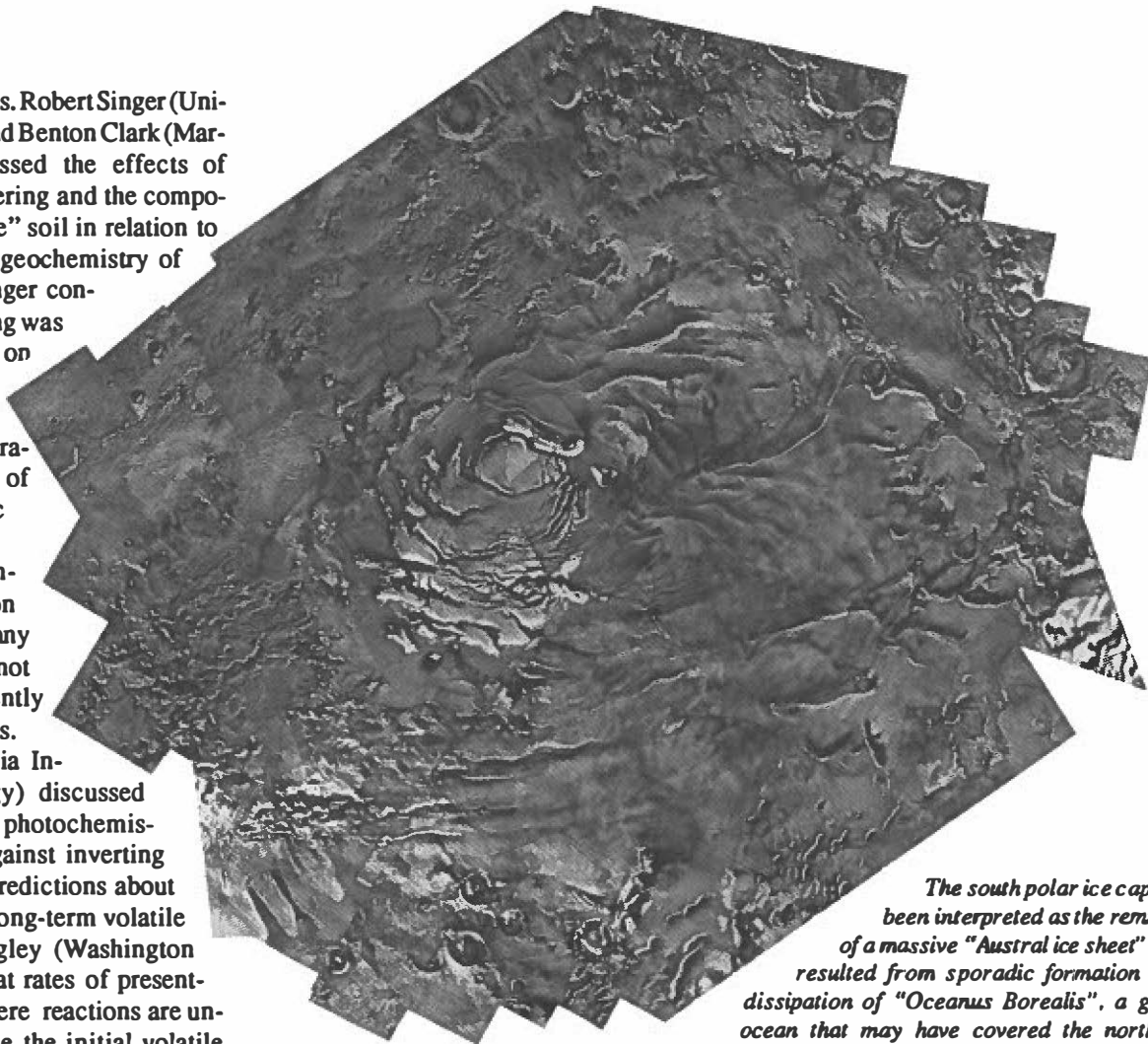
*Dune fields and perennial ice in the vicinity of Borealis Chasma attest to the variety of gradation processes that have shaped the martian surface over time.*

than model predictions. Robert Singer (University of Arizona) and Benton Clark (Martin Marietta) discussed the effects of alteration and weathering and the composition of a "candidate" soil in relation to the mineralogy and geochemistry of the surface, with Singer concluding that something was different in the past on the martian surface.

Richard Zurek (Jet Propulsion Laboratory), in a discussion of current atmospheric properties, noted that much of our current understanding is based on model simulations, many aspects of which cannot be validated by currently available observations.

Yuk Yung (California Institute of Technology) discussed current atmospheric photochemistry, but cautioned against inverting the results to make predictions about the past. Regarding long-term volatile evolution, Bruce Fegley (Washington University) noted that rates of present-day surface-atmosphere reactions are unknown and that while the initial volatile composition of Mars may be obtained through the study of meteorites, the initial volatile inventory is more difficult to estimate. Also concerned with long-term volatile evolution, Janet Luhmann (University of California, Los Angeles) noted that atmospheric escape to space is an unavoidable consequence for small planets with carbon dioxide atmospheres. In a discussion of short- and long-term climate change, James Pollack (NASA Ames Research Center) explained that the current climate is tied to the seasonal cycle of carbon dioxide, which in turn is intimately coupled with the seasonal cycles of water and dust as well as atmospheric dynamics. Pollack also discussed evidence for and against a warm, wet climate early in martian history. In the final presentation of the workshop, Aaron Zent (NASA Ames Research Center) discussed the interaction of carbon dioxide and water between the atmosphere, the polar caps, and the regolith, noting that an outstanding question concerns the structure of the regolith.

The quality and scope of both invited and contributed presentations, as well as



*The south polar ice cap has been interpreted as the remnant of a massive "Austral ice sheet" that resulted from sporadic formation and dissipation of "Oceanus Borealis", a great ocean that may have covered the northern plains of Mars.*

## "ATMOSPHERIC ESCAPE TO SPACE IS AN UNAVOIDABLE CONSEQUENCE FOR SMALL PLANETS WITH CARBON DIOXIDE ATMOSPHERES"

the formal and informal discussions that ensued, suggest that the workshop was highly successful, and attests to the keen interest on the part of the international science community in the goals of the MSATT Program. A more detailed summary of the presentations and discussions and a compilation of the contributed abstracts is soon to be published as an LPI Technical Report. In addition, arrangements have been made to publish manuscripts resulting from the workshop in a special section of *JGR-Planets*. The deadline for submission to this issue is December 31, 1991. You need not have been a participant at the Boulder workshop to

contribute provided your manuscript is related to the general MSATT theme. For further information regarding this special issue, contact Robert M. Haberle, MSATT Steering Committee Chairman, NASA Ames Research Center, MS 245-3, Moffett Field CA 94035. Phone: 415-604-5491; FAX: 415-604-6779.

E-mail (SPAN) GAL::HABERLE

*(Dr. Schuraytz is a staff scientist at the Lunar and Planetary Institute.)* ☉

# Minirover Tested on Marslike Terrain

Scientists and engineers at NASA's Jet Propulsion Laboratory in Pasadena, California successfully tested a small robotic vehicle in rough terrain very similar to the two Viking landing sites on Mars. The test of the minirover, Rocky III, in the Avawatz Mountains south of Death Valley on September 11 demonstrated one of several low-cost approaches to future Mars exploration.

Minirovers and the even smaller microrovers provide NASA planners with a new class of low-cost planetary exploration options, said Roger Bedard, manager of Rover Technologies at JPL. Microrovers weigh less than 11 pounds; minirovers are larger, up to about 52 pounds, the weight of Rocky III.

The rovers will carry cameras to examine the surface and to scan the horizon of Mars. They will also carry micromachined sensors to test the atmosphere and soil, spectrometers to gather geologic information and seismometers to detect crustal motion.

Dr. Matthew Golombek, principal science advisor on the project, said the terrain used in the test has the rock size and distribution of the Viking 2 site that featured large boulders strewn across a gravel surface; Rocky II successfully traversed the rough terrain in two tests. The rover also successfully negotiated a lava field in the Mojave Desert. "It was at least a starting point," Golombek said. "We are certain there are basalt flows on Mars. We are testing this rover for an unmanned sample-return mission."

Don Bickler, an engineer and a designer of the rover, said the group also tested the "rover's configuration, the suspension geometry, the ratios of levers and the wheel diameters. We wanted to see if it would confirm the tests we made in the laboratory; to see if in the natural environment the thing would perform as the lab tests said it would. And it did."



NASA PHOTO NO. JPL 17004 BC

*Rocky III, a prototype for a robotic planetary exploration vehicle, demonstrates ability to go over rough terrain and pick up rock or soil samples with its manipulator arm. Rocky is radio controlled and carries a video camera for real-time transmission. Rocky III is a 56-pound prototype for a much lighter robotic rover that would be sent to the Moon or Mars in future NASA sample return missions. Rocky III was designed and built at the Jet Propulsion Laboratory.*

The next generation of micro- and minirovers now being designed will include microsensors to allow the machines to measure some qualities of their environment. Because of their small size and light weight, the vehicles would be relatively inexpensive to launch to the Moon or Mars, according to Bedard.

"A new era of space exploration is made possible by advances in miniaturization technology and in distributed communications," said Dr. Giulio Varsi, manager of JPL's Space Automation and Robotics Program. "I believe these advances will make possible less expensive missions and broader participation of people." Ø

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continued from page 2

coverage would be used initially to generate digital terrain maps. The most typical application is in geological studies, in which the fine structure of the terrain is essential to understanding the geometric relationships among geologic structures. Investigators would use an optical stereoscope to study the data. The conclusion of expert analysis is that the Magellan stereo meets or surpasses our expectations and is the best radar stereo ever obtained by any program.

The stereo mode incidence angle has the additional advantage that the geometry is not radically different from that of Cycle 1. Data from the two cycles can be used to search for surface changes with a 16-month time base. Also, Cycle 3 data can be used to fill small gaps in the map without requiring a full upload of mostly redundant data.

The high-resolution images were also analyzed. It is felt that this imaging mode would be most useful in a circular orbit where the range resolution can be improved by a higher incidence angle.

Consequently, the Magellan Project Science Group (PSG) recommended that Cycle 3 should be devoted principally to stereo mapping, using an alternate incidence-angle profile essentially the same as the one used for the test orbits. Approximately 60% of the Cycle 1 coverage should be mapped to give 60% of the planet in stereo and greatly enhance the value of the Magellan dataset. A demonstration sample of gravity data should be obtained in Cycle 3. The PSG recommends acquiring it over Artemis Chasma, a large feature of particular geological and geophysical interest. In addition, the PSG recommends collection of high-resolution altimetry and performance of a specular solar reflection radiometer experiment.

## CYCLE 4 OBJECTIVES

Early in Cycle 4 periapsis should be lowered to 180 km and 360 degrees of continuous gravity data should be collected. It is required that SAR sequences be possible on a limited basis to allow targeting of areas where surface changes have been predicted or seen. The flight team would use Cycle 4 to prepare for aerobraking as the gravity sequences should reduce the load on them.



NASA PHOTO NO. P-38828

*An 84-mile segment of a remarkable 4200 mile channel in the Venusian plains. Several hundred kilometers longer than the Nile, Earth's longest river, it is the longest known channel in the solar system.*

Prior to Cycle 4, tracking for gravity data cannot provide 360 degrees of longitudinal coverage at periapsis. We expect to take advantage of this time before Cycle 4 to get the most out of the imaging. To get the best gravity coverage with the least risk to the spacecraft or other competing objectives of imaging and altimetry, the PSG recommends obtaining the gravity map before attempting to circularize the orbit. It is fully recognized that a circular orbit provides superior gravity data. Another consideration is that analysis and planning and software development for circularization could not be completed before Cycle 5. Given these constraints the strategy for Cycles 3 and 4 was developed.

## AEROBRAKING AND CIRCULAR OPERATIONS

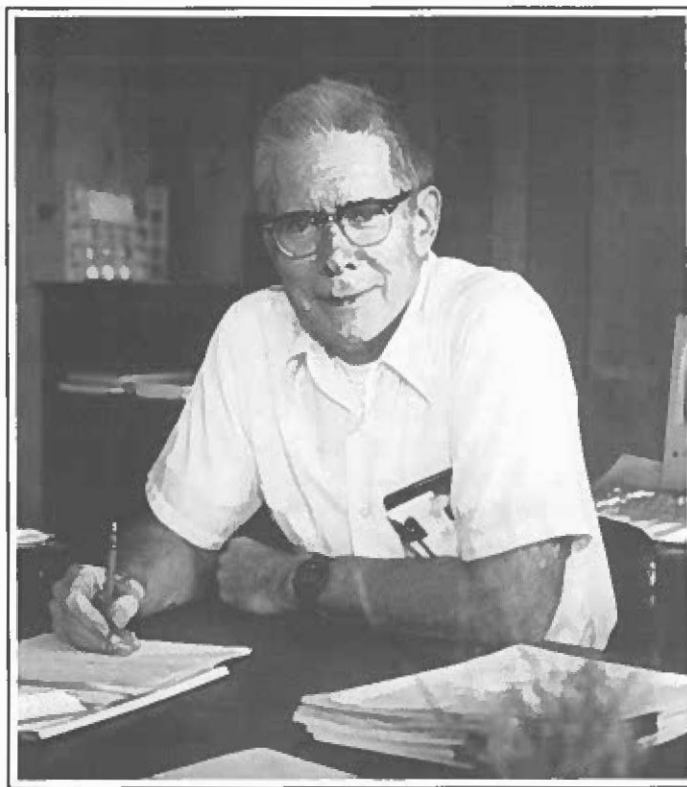
A near-circular orbit at about 200 km would provide a major improvement in our ability to construct geophysical models of Venus. Such a dataset would be equivalent to gravity resolution expected from a Lunar Orbiter or Mars Observer and would thus provide a basis for comparative planetology studies. Circular orbit gives the same resolution at all latitudes, so many important regions such as the Atalanta Basin or Ishtar

Terra could be studied and compared to the equatorial highlands of Venus. The science recommendation for aerobraking should not be interpreted to place restrictions on the time required or the degree of circularity. As much time as is needed should be allocated to the process of circularization.

Gravity science is the first priority for circular operations. Consequently the final orbit should be as low as possible since gravity sensitivity and resolution are proportional to the square of the range. Our preference would be a 200-250-km orbit.

SAR imaging also benefits from circular orbit. Contiguous coverage with constant incidence angles can be obtained. A factor of 4 improvement in linear resolution can be achieved in the polar regions, a 16-times improvement in resolution elements per area.

Stereo imaging in circular orbit will also be much more precise and of higher resolution. Interferometry may be a bonus benefit in this orbit but much analysis needs to be done to determine its feasibility. At present quantitative stereo radar grammaetry appears to achieve the resolution of interferometry and at lower cost with existing techniques. However, breakthroughs in computing speed and algorithms could quickly change this picture.  $\phi$



## Remembering Harlan J. Smith

*a*s we stood on the catwalk of McDonald Observatory's 82-inch reflector in 1967, Harlan Smith pointed out the Southern Cross just rising above the southern horizon, talked about the volcanics responsible for the Davis Mountains around us, and discussed human exploration of the Moon and Mars. It was one of those simple, yet special experiences that a first-year graduate student never forgets. Harlan was a teacher, a communicator, a researcher, and a dreamer with tireless energy and optimism. What I learned from him didn't only come from the classroom. It came from his unfailing enthusiasm about astronomy and planetary exploration.

Dr. Smith (never could get used to calling him Harlan) was unafraid of new ideas or approaches, which probably explains why he didn't flunk me when I used beer to hypersensitize photographic plates that night (it worked, by the way). The concept of combining geology and astronomy made sense to him and he sent me solo to a pre-Apollo Gordon Research Conference and other workshops where I met my future mentors and associates. Although our professional paths diverged with time, we could always talk, joke, or debate about bold new concepts whenever our paths crossed, just as if we were on that Observatory catwalk in 1967.

Harlan Smith passed away on the evening of October 17, 1991 from kidney cancer. Born in Wheeling, West Virginia, he received his doctorate in Astronomy from Harvard University in 1955. Harlan leaves behind a legacy as past Chairman of the Department of Astronomy of the University of Texas at Austin, past Director of McDonald Observatory for 26 years, and creator of *Stardate* (the two-minute radio spots heard daily by about ten million people in the U.S. and Canada). Most recently he had championed the next generation of telescopes, the "Eye of Texas" telescope, and the Moon as the ultimate deep-space observatory site. He recently received NASA's prestigious Distinguished Public Service Medal as testimony to his contributions. He is survived by his wife Joan and four children. But his vision survives through his numerous students, friends, accomplishments, and, of course, dreams.

—Peter H. Schultz

*(Dr. Schultz, currently a professor at Brown University specializing in planetary studies and Director of the Northeast Planetary Data Center, was a graduate student of Dr. Smith at the University of Texas at Austin.)* ☺

## ASTEROID NAMED FOR LPI's JONES

Pam Jones, who heads the Program Services Department at LPI, has been honored by having an asteroid named for her. From the *Minor Planet Circular 18648*: (4852) Pamjones = 1977 JD Discovered 1977 May 15 by N.S. Chernykh at the Crimean Astrophysical Observatory. Named in honor of Pamela Ann Jones, of the Lunar and Planetary Institute, Houston, in appreciation of her organization of many conferences in planetary sciences, particularly two international conferences held in June-July 1991, "Asteroids, Comets, Meteors 1991" in Flagstaff and "Near-Earth Asteroids" in San Juan Capistrano.



PAMELA ANN JONES

Pamjones is in an orbit with a semimajor axis of 2.3040056 AU, an eccentricity of 0.1023863, an inclination of 6.77402 degrees and a period of 3.50 years. The asteroid has an absolute magnitude of 13.7 and a phase factor of 0.15 magnitudes/degree and is from a region of the asteroid belt dominated by S types (ordinary chondrites) but could also be a C type (carbonaceous chondrite).

Ms. Jones, who joined the Institute staff in 1975, has been involved in the organization of over 200 meetings in lunar and planetary science. "It is a great honor, both for the LPI and for me, to have the Institute's science meetings and their contribution to the science community recognized in such an unusual and enduring way," she said. "I am deeply grateful to Dr. Nicolai Chernykh for providing this very special commemorative in my name." ☺

## LPI SUMMER INTERN PROGRAM IN PLANETARY SCIENCE

For the 16th year, the Lunar and Planetary Institute offers selected undergraduates an opportunity to participate actively in lunar and planetary science at the Institute and the NASA Johnson Space Center. The program is designed to expose students in planetary and terrestrial studies to an actual research environment to help them examine and focus their career goals and to encourage their development as planetary scientists.

College undergraduates with at least 50 semester-hours credit who are interested in a career in the physical sciences are eligible. Spring semester graduates in the current year are considered eligible. Relevant disciplines include the geo-

sciences, physics, chemistry, engineering, computer science, and mathematics.

Typical projects in past years have included studies in formation of the planets and solar system, lunar resource utilization, cosmic dust and lunar sample characterization, meteorites and their origins, properties of planetary surfaces and atmospheres, volcanism, geophysical data analysis and modeling, geochemistry, petrology, processing of remote sensing data and images, photogeology, stratigraphy, tectonic processes, impact cratering, and spectroscopic observation of planetary surfaces. Each project is directed by an LPI or JSC scientist.

The ten-week program will be June 8 through August 14, 1992. Notification of selection will be made by March 12, 1992. Interested students should contact LPI Summer Intern Program, P.O. Box 58407, Houston TX 77258, Attention: Ms. Lebecca Simmons. ☺

## 23rd LUNAR AND PLANETARY SCIENCE CONFERENCE

The 23rd LPSC will be held in Houston at the NASA Johnson Space Center, March 16-20, 1992. Some conference events, including the Sunday night reception and registration, will take place at the new Lunar and Planetary Institute facility at 3600 Bay Area Boulevard.



The Magellan spacecraft is providing a global view of Venus and significant new data on volcanism, tectonism, impact cratering, and surface modification processes have been gathered. A special session on Magellan will focus on the most recent results in analyses of Magellan and related data and comparisons to Earth and other planets.

The December 1990 Galileo lunar flyby provided the first spacecraft digital multispectral data for the western limb and some of the farside. The Galileo special lunar session will focus on regional studies of mare basalts, basin formation and evolution, and crustal heterogeneity using all data types including Earth-based data, Apollo orbital data, and the recent Galileo data. Details of the second Galileo lunar encounter (December, 1992) and future exploration goals will be discussed.

The Hal Masursky Lecture, a special public session with invited talks in planetary geology and geophysics, will commemorate the late Hal Masursky, a longtime leader and friend in planetary geology.

Please contact the LPI Program Services Department (713-486-2166) for further information about the Conference. Contact the LPI Publications Services Department (713-486-2143) for information about abstract submission and Proceedings publication. ☺

# CALENDAR 1991-92

## DECEMBER 1991

**3-5** **Space Business Opportunities II: Space Systems and Technology Initiatives, American Astronautical Society Conference and 38th Annual Meeting**, Los Angeles, California. Contact: Ruth Hayden, 4727 Gardner Avenue, Everett WA 98203. Phone: 206-353-0794.

**6-8** **Workshop on the Physics and Chemistry of Magma Oceans from 1 bar to 4 Mbar**, Burlingame, California. Contact: Program Services Department, LPI, 3303 NASA Road 1, Houston TX 77058-4399. Phone: 713-486-2166; FAX: 713-486-2162.

**9-13** **American Geophysical Union, Fall Meeting**, San Francisco, California. Contact: AGU Meetings, 2000 Florida Avenue NW, Washington DC 20009. Phone: 202-462-6903.

## JANUARY 1992

**6-10** **Neptune and Triton, An international Meeting**, Tucson, Arizona. Contact: Dale Cruikshank, MS 245-6, NASA Ames Research Center, Moffett Field CA 94035. Phone: 415-604-4244; FAX: 415-604-6779.

**12-16** **179th National Meeting, American Astronomical Society**, Atlanta, Georgia. Contact: Diana Alexander, 2000 Florida Avenue NW, Suite 300, Washington DC 20009. Phone: 202-328-2010; FAX: 202-234-2560.

**13-15** **Mountain Belts on Venus and Earth**, San Juan Capistrano, California. Contact: Program Services Department, LPI, P.O. Box 58407, Houston TX 77258. Phone: 713-486-2150; FAX: 713-486-2162.

## FEBRUARY

**10-13** **International Space Year Conference on Earth and Space Science Information Systems**, Pasadena, California. Contact: Arthur Zygierbaum, MS 180-70, Jet Propulsion Laboratory, 4800 Oak Grove Drive, Pasadena CA 91109. FAX: 818-354-8333. NASAMAIL: AZYGIELBAUM  
Internet: aiz@ewok.jpl.nasa.gov

## MARCH

**1-5** **4th International Symposium on Experimental Methods for Microgravity Materials Science Research**, San Diego, California. Contact: Dr. Robert Schiffman, Symposium Chairman, 1960 Saunders

## MARCH (CONTINUED)

Road, Riverwoods IL 60015. Phone/FAX: 708-940-7417.

**2-6** **IAU Symposium 154 Infrared Solar Physics 1  $\mu$ m to 1 mm**, Tucson, Arizona. Contact: Douglas Rabin, National Solar Observatory, P.O. Box 26732, Tucson AZ 85726-6732. Phone: 602-325-9331; FAX: 602-325-9278.  
SPAN: 5355::rabin  
Internet: rabin@noao.edu

**16-20** **23rd Lunar and Planetary Science Conference**, Houston, Texas. Contact: Program Services Department, LPI, P.O. Box 58407, Houston TX 77258. Phone: 713-486-2166; FAX: 713-486-2160.

**17-20** **Recent Advances in High Energy Astronomy**, Toulouse, France. Contact: Pierre Mandrou, 9 Av. du Colonel Roche, 31027 Toulouse France. Phone: 33-61.55.66.88; FAX: 33-61.55.67.01; Telex: 531729 UNSPAT Toulouse.  
SPAN: 17449::RAMON

**23-26** **Space Commerce 92**, Montreux, Switzerland. Contact: (in North America) George Suter, Access Management Corporation, 7 Woodlawn Green, Suite 212, Charlotte NC 28217. Phone: 704-525-7030; FAX: 704-527-3768; Telex: 9102401552 access cha. (outside North America) Norman Neve, Permanent Secretariat, Space Commerce 90, P.O. Box 97, CH-1820 Montreux, Switzerland. Phone: 41 21 963 23 54; FAX: 41 21 963 78 95; Telex: 453 222 mtch ch.

**23-27** **AGU Chapman Conference on Climate, Volcanism, and Global Change**, Hilo, Hawaii. Contact: Stephen Self, Department of Geology and Geophysics, University of Hawaii at Manoa, Honolulu HI 96822; or Richard P. Turco, Department of Atmospheric Sciences, University of California at Los Angeles, Los Angeles CA 90024-1565.

## APRIL

**6-7** **Joint Workshop on New Technologies for Lunar Resource Assessment**, Santa Fe, New Mexico. Contact: Program Services Department, LPI, P.O. Box 58407, Houston TX 77258. Phone: 713-486-2166; FAX: 713-486-2160.

**6-10** **Scientific Instrumentation in Space Programs: International Course in Space Technology**, Toulouse, France. Contact: C. Salmon, CNES. Phone: 33-61-27-34-72; FAX: 33-61-28-13-27. C. Tailhades, Europa. Phone: 33-61-32-66-99; FAX: 33-61-32-66-00.

JUNE	AUGUST (CONTINUED)
<p><b>29</b> <b>MSATT Workshop on the Evolution of the Martian Atmosphere</b>, Kona, Hawaii. Contact: Program Services Department, LPI, P.O. Box 58407, Houston TX 77258. Phone: 713-486-2166; FAX: 713-486-2160.</p> <p>— July <b>1</b></p> <p><b>29</b> <b>International Symposium on Small Satellites, Systems, and Services</b>, 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.</p> <p>— July <b>1</b></p> <p><b>29</b> <b>Science with the Hubble Space Telescope</b>, 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.</p> <p>— July <b>7</b></p> <p>SPAN: ESO::BRITT Internet: britt@eso.org</p>	<p><b>10-12</b> <b>International Colloquium on Venus</b>, Pasadena, California. Contact: Program Services Department, LPI, P.O. Box 58407, Houston TX 77258. Phone: 713-486-2150; FAX: 713-486-2160.</p> <p><b>24</b> <b>29th International Geological Congress</b>, Kyoto, Japan. Contact: Secretary General, 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.</p> <p>— Sept <b>3</b></p> <p><b>27</b> <b>The World Space Congress</b>, Washington, DC. Contact: American Institute of Aeronautics and Astronautics, 370 L'Enfant Promenade, SW, Washington DC 20024-2518. Phone: 202-646-7400; FAX: 202-646-7508; Telex: 204792 AIAA UR.</p> <p>— Sept <b>7</b></p>
AUGUST	SEPTEMBER
<p><b>2-14</b> <b>XVII Congress of the International Society for Photogrammetry and Remote Sensing (ISPRS)</b>, 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.</p>	<p><b>21-25</b> <b>International Symposium on Observational Cosmology</b>, Milano, Italy. Contact: Secretariat, Osservatorio Astronomico, Via Brera 28, 20121 Milano, Italy. Phone: (0)2-72023751; FAX: (0)2-72001600.</p> <p>SPAN: 39216::OBS_COS Internet: obs_cos@astmib.infn.it PSI: PSI%23910085::OBS_COS</p>

**T**he international symposium on Missions, Technologies, and Design of Planetary Mobile Vehicles is planned for September 28-30, 1992, in Toulouse, France, and will assess various programs and studies of planetary mobile vehicles; included will be discussions among scientists, engineers, and planetary scientists. The symposium will be organized around four themes: Mission Definitions and Requirements; Mission Analysis and System Architecture; Vehicle Technologies and Design; and Robotics Functions (onboard and on Earth).

Each theme will be covered in several sessions of invited and contributed papers. A final round table will review the four themes and discuss to what extent the mission needs and requirements correspond with technical possibilities.

Following the symposium, participants can visit the space industry and robotics research laboratories in Toulouse associ-

## International Symposium: *Missions, Technologies, and Design of Planetary Mobile Vehicles*

ated with the third International Space Artificial Intelligence, Robotics and Automation in Space (ISAIRAS) Conference, which is to be held in Toulouse from September 30-October 2, 1992.

The working languages will be French and English, with two-way simultaneous translation at the plenary sessions. Russian translation will also be available. Each paper will be given in about 20 minutes with facilities for showing slides, films, and transparencies.

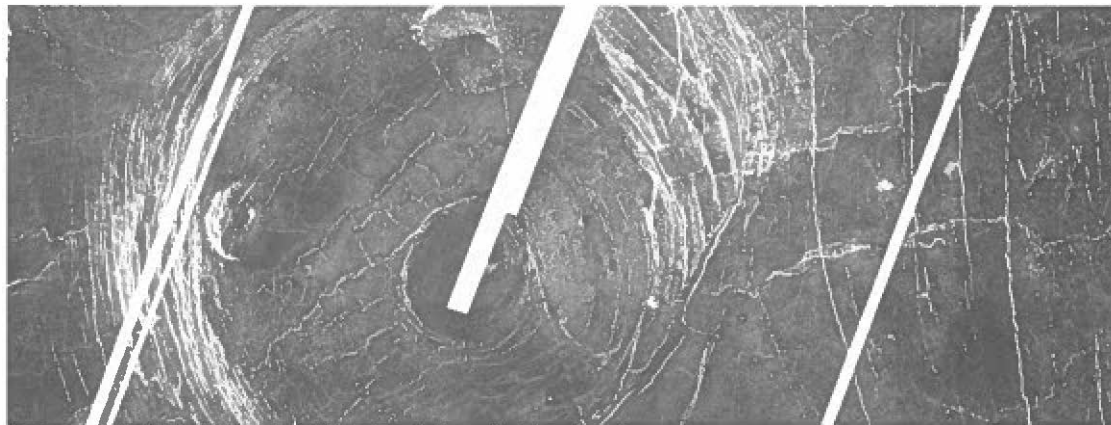
Those who wish to present a paper on one of the symposium themes should send

a typed 300-word summary in English before December 30, 1991 to Mr. Denis Moura, RA/RE/SU/AS, Centre National d'Etudes Spatiales, 18 Avenue E. Belin-31055 Toulouse Cedex-France, (FAX: 33-61-22-03).

Authors selected by the Scientific Committee will be informed before the end of February 1992 and will be given precise instructions for writing papers and summaries at that time. The symposium is sponsored by space agencies and other institutions of Canada, Europe, France, Japan, and the United States. ☉

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**MAXIMIZING MAGELLAN . . . SEE PAGE 2**



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