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Gamma Ray Observatory page 4

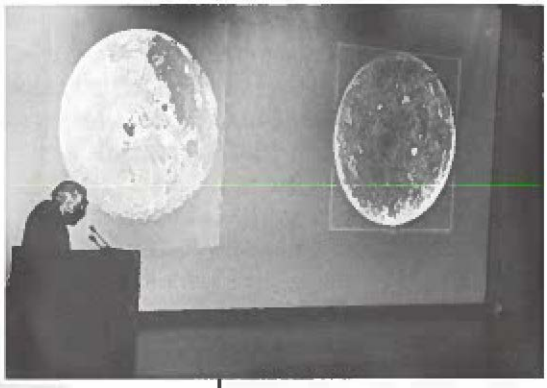
A wealth of new data from the Magellan and Galileo planetary missions contributed a feeling of excitement and revitalization to the 22nd Lunar and Planetary Science Conference held at the Johnson Space Center in Houston, March 18-22.

22nd LPSC HIGHLIGHTS

During the week tbe 777 registrants could choose from 36 technical sessions in addition to poster sessions and special events. In all, 422 oral reports were given, 169 posters were displayed, and an additional 201 reports appeared in print only.

Abstracts of all presentations are available in *Lunar and Planetary Science XXII* (see order form in this issue).

NASA Night on Monday evening featured a panel discussion of "Science, Exploration and the New NASA" with JSC Director Aaron Cohen, Martin Marietta Chief Scientist Noel Hinners, JPL Director Ed Stone, and Len Fisk, Assistant Administrator for NASA's Office of Space Science and Applications. Each of the panelists suggested ways in which the planetary community might establish and communicate its goals in the context of the Space Exploration Initiative and recent recommendations of the Augustine report. As Dr. Fisk summarized, "What we need, in simple terms, is an incremental program of high science value, which is perceived to be clever in its approach, which adjusts to various funding levels, and is part of an overall exploration strategy."



Dr. Jim Head displayed lunar images from Galileo.

"Venus, Earth and Moon: New Views from Magellan and Galileo" was the title of a Wednesday evening session chaired by Drs. Doug Blanchard and David Black. Dr. Wes Huntress, Director, Solar System Exploration Division, speculated on the Moon's influence on our rather rapid development as space explorers. Had the Moon not been so close to Earth, so palpably another world—not just another distant point of light—perhaps the urge to explore our solar system and beyond would never have arisen. Dr. Steve Saunders presented many of the newest images returned by Magellan, remarking that they were some of the most beautiful pictures returned from any of the planetary missions, and that some of the features they reveal have been seen nowhere else in the solar system thus far. Dr. Jim Head showed recent images from the Galileo Earth-Moon flyby last December and explained how the new lunar spectral data is combined with Apollo sample information to give scientists the first fairly detailed map of surface composition on the lunar farside.

Dr. Len Fisk spoke at NASA Night panel.

The influx of new data and the promise of much more to come as Magellan and Galileo continue their missions should make the next LPSC equally exhilarating.

see **LPSC XXII** page 2

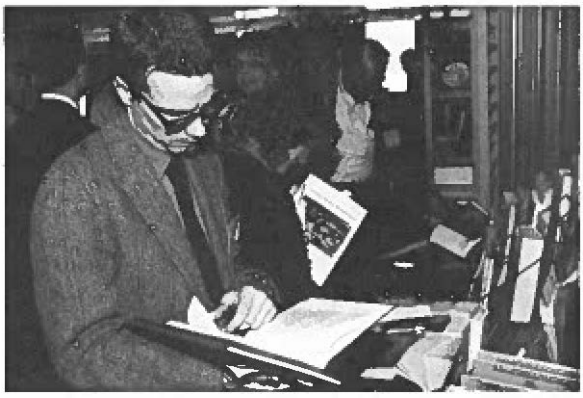
from LPSC XXII page 1

Poster sessions sparked discussion throughout the week.

1ST ANNUAL LPSC BEST STUDENT PAPER AWARD ANNOUNCED

Ms. Laurinda Chamberlain, student at Caltech, Pasadena, California has won the first annual Lunar and Planetary Science Conference Best Student Paper Award for her presentation, "Experimental Determination of the Free Energy of Formation of $MgAl_2O_4$ Spinel: An Important Constraint on Solar System Processes." Drs. A. Basu, R. Harvey, F. Horz, W. McKinnon, and H. Newsom judged 34 entrants at LPSC 22 and awarded honorable mention to Mr. Jim S. Alexopoulos, Washington University, St. Louis; Mr. Erich M. Fischer, Brown University, Providence; and Ms. Laurie L. Watson, Caltech, Pasadena.

The $500 award is made possible through a donor committed to excellence in planetary geosciences in the U.S. and is to provide encouragement and recognition to outstanding future scientists. It is administered through the Planetary Geology Division of the Geological Society of America, one of the LPSC sponsors.



The Combined Publishers Exhibit featured 73 books and journals from 13 publishers and societies.

The competition is open to U.S. citizens enrolled as students in the field of planetary geosciences.

Competitors must be senior author of the abstract and the paper must be presented orally at the conference. The judges base their decision on the scientific content and clarity of the abstract and on the effectiveness of the oral presentation. Entry forms for LPSC 23 will be included in the First Announcement of the conference. ∅

Ms. Fran Waranius—longtime editor of the Bulletin.

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Ms. Fran Waranius, Editor
Ms. Pam Thompson, Editor

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E-Mail: SPAN LPI::THOMPSON

CHANGING TIMES. . . AN EDITORIAL

Some of you may remember the first issue of the Lunar Science Information Bulletin in 1974. It was typed, copied on a Xerox, and mailed out to about 500 people. It began when Jim Head was interim director at the Institute. He felt the members of the lunar science community needed a way to communicate with one another. Dave Criswell was the editor of issue no. 1 and I helped him. From issue no. 2, I became the editor and have continued to be (with the exception of the February 1991 issue which was so well done by Pam Thompson).

Work in the library is increasing. More and more people have found us. With the ever-growing interest in lunar bases and Mars missions, use of the literature is on the up-swing. Combined with our move to a new facility and the implementing of new on-line systems this means there is much more work to be done in the library that requires my attention.

Thus, it has been decided to transfer the editorship of the LPIB to Pam Thompson. If you have any news items that you wish to have included in the LPIB, please send them to her. If you need to get in touch with her, Pam's phone number is 713-486-2175, e-mail LPI::THOMPSON. Rest assured that anything that comes in to me will be forwarded to Pam posthaste.

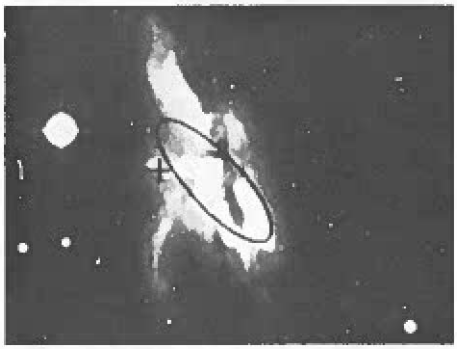
I have enjoyed working on the Bulletin. It has been very satisfying to see it grow to its present size and format with a circulation over 4000. I am sure you will show Pam the same cooperative spirit when she calls upon you for articles, book reviews, and news that you have given to me. ∅

Ye olde editor. . . Fran

NEWS FROM SPACE

NASA MARKS THE FIRST DECADE OF SHUTTLE FLIGHTS

The Space Shuttle *Columbia* inaugurated an era of winged flight into space on April 12, 1981, with Commander John Young and Pilot Robert Crippen aboard. They were the first astronauts to land their spacecraft on a runway instead of splashing down in an ocean. The first decade of shuttle flight has seen many triumphs, from on-orbit repair of satellites to launching of the first two Great Observatories, and a tragedy, the loss of the *Challenger* and her crew. To mark *Columbia's* tenth anniversary, we cite some achievements of the shuttle fleet in its first decade of operation: days in orbit: 225.07; orbits: 3572; statute miles flown: 94,300,612; pounds flown to orbit (minus orbiter): 1,055,421; payload deployed: 533,898 lbs; crew flown: 199; EVA man-hours: 136.66; man-hours in orbit: 28,688.

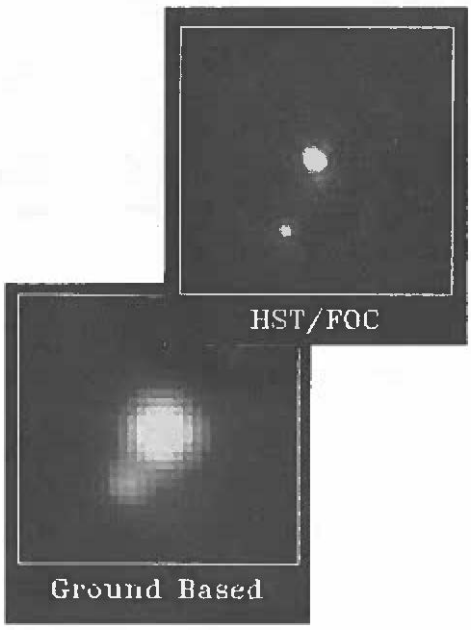


ULTRAMASSIVE DARK CORE IN NGC 6240?

Astronomers using the Hawaii Imaging Fabry-Perot Interferometer have made the first complete kinematic map of the luminous infrared galaxy NGC 6240. Reporting in *The Astrophysical Journal*, April 10, 1991, Drs. J. Bland-Hawthorn (Rice University), A. S. Wilson (University of Maryland), and R. B. Tully (University of Hawaii) describe a galactic collision of two disks. The first has a fairly common appearance (ellipse in photo at left), but the patterns and speeds of rotating gases in disk 2 seem to imply an extremely massive object invisible in radio, millimeter, infrared, or X-ray wavelengths at the core (cross in photo). If the dark core is a black hole, it would be equivalent to 100 billion solar masses, which is 10 to 100 times as massive as the largest black hole believed to exist (at the center of the Andromeda galaxy). This is 100 times larger than the upper limit on the size of black holes predicted by some cosmological theorists. Another possibility is that the core is a rekindling quasar that is beginning to swallow matter from the galactic collision. The researchers hope to use the Great Observatories to discover what the nature of this dark core is.

HUBBLE TAKES A CLOSER LOOK AT PLUTO/CHARON SYSTEM

The Hubble Space Telescope (HST) has resolved Pluto and its moon, Charon, for the first time. This HST image, taken with the Faint Object Camera, is compared with the best groundbased image taken with the Canada-France-Hawaii telescope in Hawaii. The Hubble image clearly resolves the separation between the two icy worlds. When observed, Charon was near its maximum apparent distance from Pluto (about 0.9 arc second). Additional images will allow analysis of brightness variations of the two bodies that will give scientists clues about their surfaces and atmospheres. Orbital parameters of the system can be analyzed to give much better estimates of the density and mass of each body.

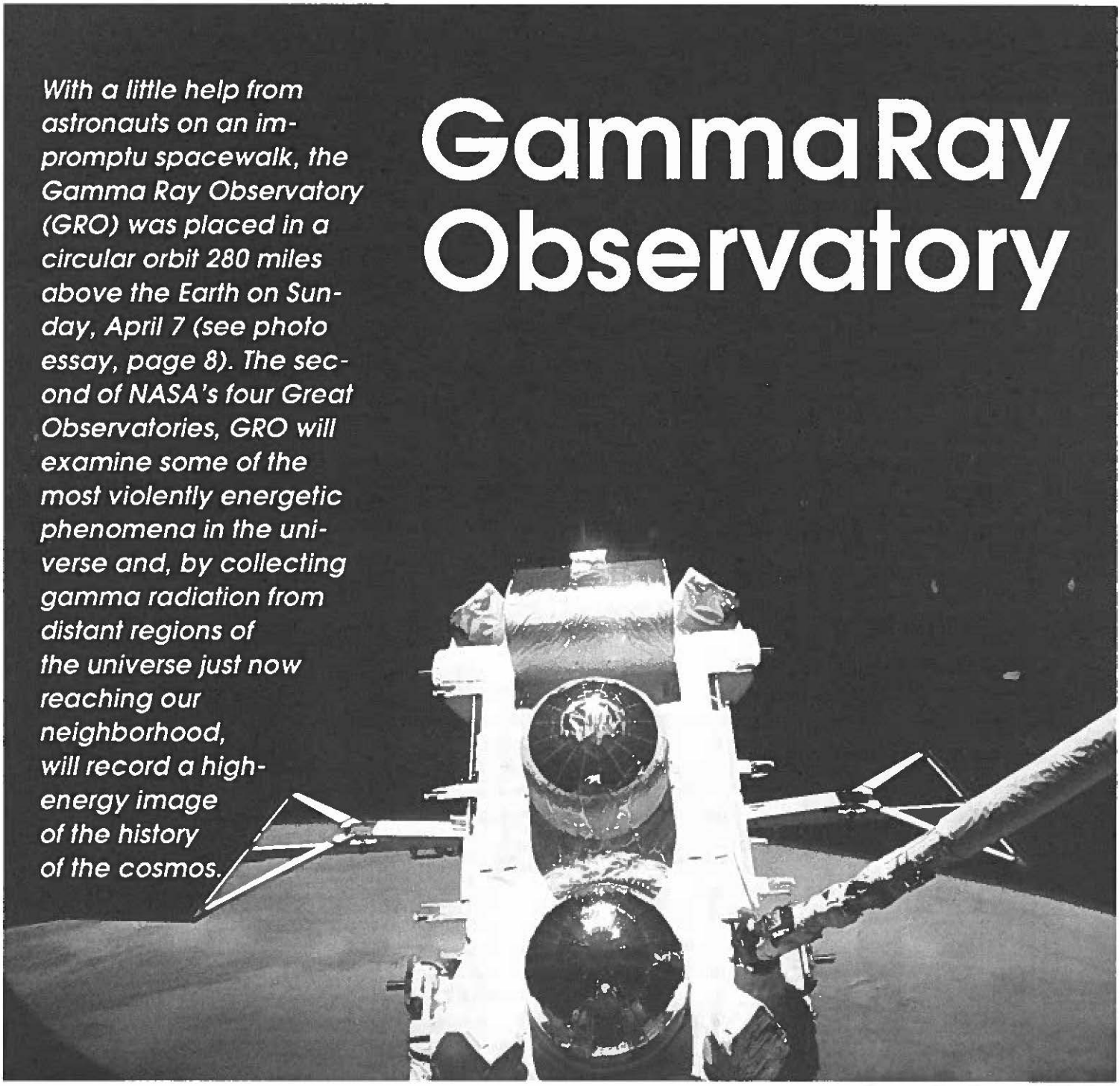


GALILEO'S HIGH-GAIN ANTENNA FAILS TO UNFURL

Engineers at Jet Propulsion Laboratory commanded Galileo's high-gain antenna to deploy on April 11, but indications from the craft's spin rate and deployment limit switches are that the antenna is only partly unfurled. The high-gain antenna, which will be crucial to attaining the necessary signal strength to send high-speed scientific data from Jupiter, deploys like an umbrella and employs gold-plated molybdenum wire mesh as the umbrella "fabric." The deployment problem may be because the mesh has caught on something or because double-sided tape used on the ribs has stuck together. Controllers are planning strategies to attempt to free the antenna in the near future. The flyby of asteroid Gaspra in October can be accomplished without the high-gain antenna if necessary.

Gamma Ray Observatory

With a little help from astronauts on an impromptu spacewalk, the Gamma Ray Observatory (GRO) was placed in a circular orbit 280 miles above the Earth on Sunday, April 7 (see photo essay, page 8). The second of NASA's four Great Observatories, GRO will examine some of the most violently energetic phenomena in the universe and, by collecting gamma radiation from distant regions of the universe just now reaching our neighborhood, will record a high-energy image of the history of the cosmos.



NASA PHOTO NO. [illegible]

The first Great Observatory, the Hubble Space Telescope, is already at work covering the visible portion of the electromagnetic spectrum from the near infrared to the near ultraviolet. In 1998, the Advanced X-ray Astrophysics Facility (AXAF) will be launched aboard the shuttle to provide high-resolution imaging and spectroscopy in the X-ray region. AXAF will be followed by the Space Infrared Telescope Facility (SIRTF) that will observe in the infrared band. Operations of all four observatories will be coordinated to provide coverage of nearly the entire electromagnetic spectrum, providing the most complete, detailed picture of the universe astronomers have ever seen.

Under development since the early 80s, the GRO will operate for two to six years and possibly longer since its design includes refuelable hydrazine thrusters for

attitude control and orbit maintenance. It is also the first large observer craft that can be guided through reentry from the ground. Its four instruments are the largest and most sensitive ever built and, together, will gather data from our own galaxy and beyond in the highest energy (gamma-ray) portion of the spectrum. Gamma ray energies range from thousands to billions of electron volts (eV); visible light, by comparison, is about 3 eV. Such extremely high energies and their lack of charge allow gamma rays to penetrate much interstellar matter intact, bringing us information about some of the most distant, violent objects and processes in the universe. Some of these phenomena apparently emit only in the gamma-ray region and have not been observed at other wavelengths. GRO will focus on such exotic objects as pulsars, quasars, neutron stars, and black holes and will provide clues about the evolution of the universe and processes that produce and transfer astonishing amounts of energy. The greatly increased sensitivity of its instruments may even detect classes of objects never seen before.

GRO is a NASA cooperative program with scientific flight hardware furnished by the Federal Republic of Germany, the Netherlands, and the European Space Agency and with scientific support from the United Kingdom.

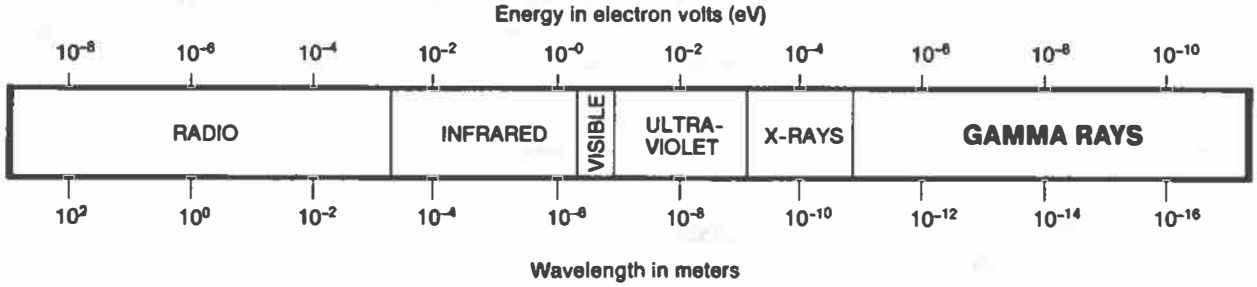
In general, the larger the detector, the better the gamma-ray map

INSTRUMENTS

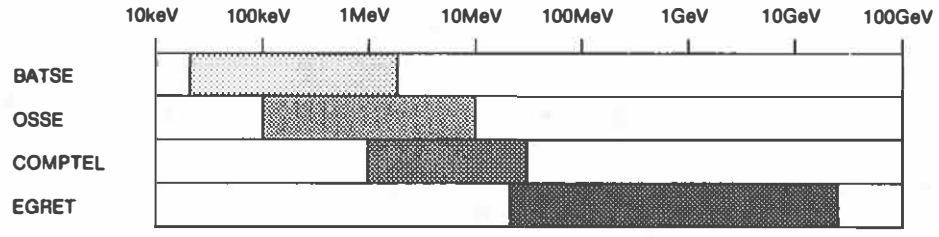
Because they are largely absorbed by the extensive atmosphere, gamma rays rarely arrive at the Earth's surface and must be studied by space-borne instruments. Because their extremely high energies penetrate most materials, gamma rays cannot be collected and focused on a surface (as the Hubble Space Telescope does with visible radiation); rather, they are detected indirectly by their interaction with certain liquid or crystal materials. Collisions with the atoms of these materials cause brief flashes of light (scintillations) that can describe the intensity and, in some configurations, the trajectory of the gamma rays. Spark chambers are also used to detect the paths and energies of subatomic particles triggered by a gamma ray passing near the nucleus of an atom of detector material, a technique commonly used in particle accelerators on Earth. The GRO instruments employ both techniques, and each has a mechanism (an anticoincidence system) for distinguishing gamma rays from the more numerous, charged particles known as cosmic rays.

In general, the larger the detector, the better the gamma-ray map, since size directly determines how many gamma-ray "hits" can be collected in a practical observing period. The GRO instruments are the largest yet flown—three of the four are about the size of a subcompact car—and should prove 10 to 20 times more sensitive than previous detectors. Each is designed for an observing mission in a particular portion of the gamma-ray spectrum and can be pointed independently of the other instruments on the platform. Together, they span the entire range of gamma radiation and will give us the most complete picture of the gamma-ray universe ever.

The Electromagnetic Spectrum



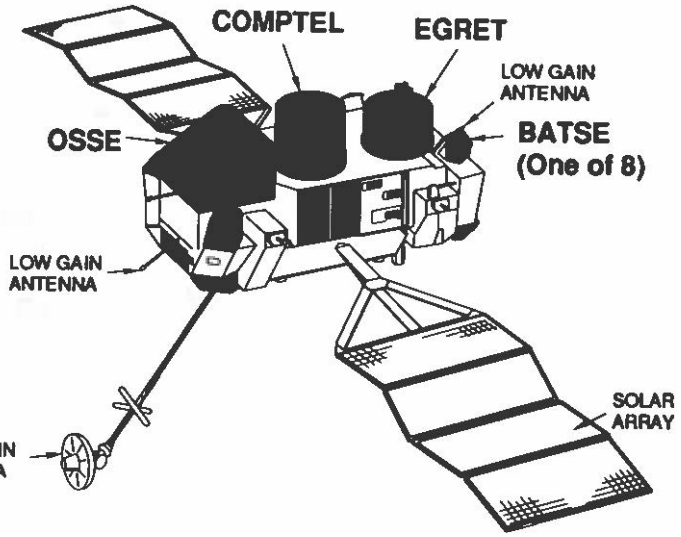
GRO INSTRUMENTS

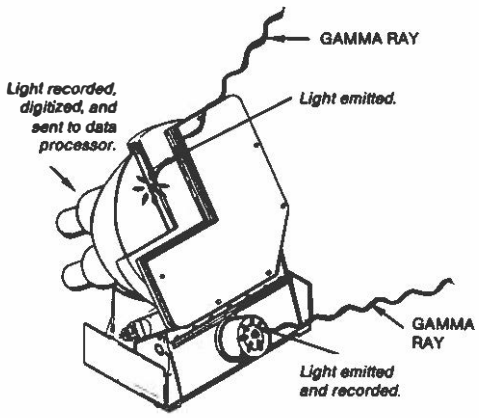


GRO energy range

GRO INSTRUMENT CHARACTERISTICS

	OSSE	*COMPTEL*	*EGRET*	*BATSE*
Energy range (millions of eV)	0.10 to 10.0	1.0 to 30.0	20 to 30,000	0.03 to 1.9
Field of view	3.8 × 11.4°	60°	30°	2/3 sky
Best positional accuracy	10 arc min.	8.5 arc min.	5-10 arc min.	1°
Mass (kg)	1,810	1,460	1,815	976
Size (meters)	1.6 × 1.8 × 2.1	2.8 × 1.8	2.2 × 1.6	0.7 × 0.6 × 0.7
Power (watts)	192	206	190	182





BATSE

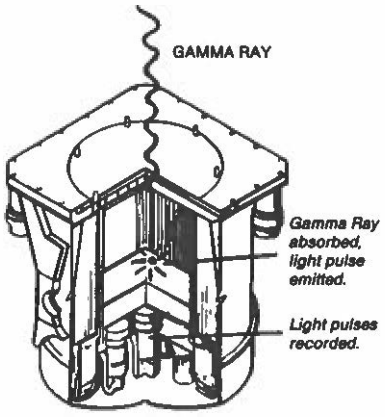
The Burst and Transient Source experiment (BATSE) will look for the mysterious, transient bursts of gamma rays first detected by a Vela satellite in 1967. The bursts last only a few seconds, but emit more gamma radiation than all other sources combined. BATSE is designed to be most sensitive to lower-energy gamma radiation, from 20 to 600 thousand electron volts (eV), where the bursters have been observed, and can detect variations in gamma-ray brightness lasting only milliseconds; when a burst or other transient event is detected, it can signal the other GRO instruments to take a look at the same region of the sky.

Eight identical sodium iodide scintillation detectors are mounted on the upper and lower corners of the GRO platform to give BATSE the widest possible coverage (about two-thirds of the sky) in its search. A small, secondary scintillator with a photomultiplier in each module helps determine the energies of individual photons more precisely. Among other events BATSE is well suited to study are solar flares that will be observed during the current solar maximum cycle.

OSSE

The Oriented Scintillation Spectrometer Experiment (OSSE) is designed to observe discrete sources of gamma rays that form spectral emission lines in the 100,000 to 10 million eV range. These emission lines are the signatures of radioactive elements that are believed to be formed by stellar explosions such as supernovae. The elements are the building blocks of our universe, including living things.

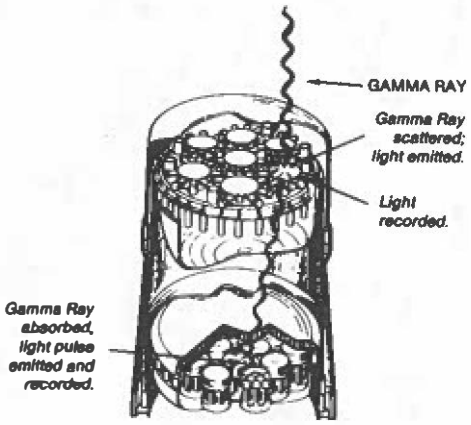
OSSE consists of four sodium iodide scintillator detectors that will make very precise measurements of photon energies. They are designed to work together to pinpoint gamma-ray sources more precisely than ever, and each detector can tilt in a 192-degree arc to point on and off of a source to evaluate the background radiation in its neighborhood and subtract it from the target's emission. OSSE's field of view is 3.8 by 11.4 degrees and it can point to targets of opportunity without disturbing the observing activities of the other GRO instruments. Supernova 1987A that appeared in the Large Magellenic Cloud in that year should prove a fascinating target for observation.

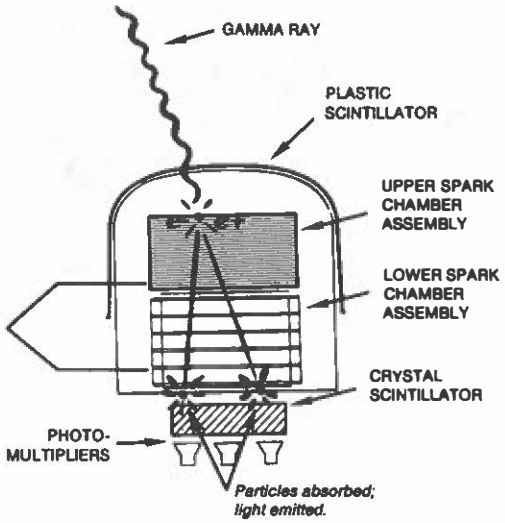


COMPTEL

The Imaging Compton Telescope (COMPTEL) will scan the sky at the energy range between 1 and 30 million eV to image large galactic structures that have been difficult to detect with earlier instruments. Its immense size and 60-degree field of view will enable it to map the diffuse gamma radiation emanating from the center of our galaxy as well as point sources such as neutron stars and other galaxies.

COMPTEL uses a two-stage detector in which the incoming photon ricochets off an electron in the upper detector and is deflected into a lower sodium iodide detector that measures the energy lost in collision and records the strike points at both the lower and upper detectors to calculate the trajectory of the original gamma ray. Using this technique based on Compton scattering (the results of the photon-electron collision), the COMPTEL is expected to be 20 times more sensitive than previous measurements in this energy range and to achieve resolution of a few degrees. It will complement and extend into higher energies the observations of OSSE and should provide the most detailed look at large galactic and extragalactic structures we have seen.



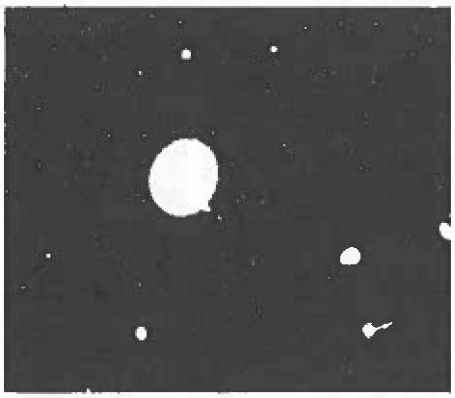


EGRET

The Energetic Gamma-Ray Experiment (EGRET) will detect high and ultra-high-energy gamma-ray sources from about 20 million to 30 billion eV in its whole-sky survey. The instrument has a 30-degree field of view and is 10 to 20 times larger than previous high-energy gamma-ray telescopes; its sensitivity, also 10 to 20 times greater than earlier instruments, will allow it to detect much fainter sources than have been seen before.

EGRET uses a spark chamber detection system similar to those used in high-energy particle physics on Earth. A gamma ray entering the upper spark chamber disrupts an atom in a tantalum foil, producing an electron and its antiparticle, a positron. The pair zip through the inert gas enclosing the chamber, ionizing it along their paths, and are absorbed by a massive 900-pound sodium iodide crystal that measures their energies. If the EGRET's anticoincidence system does not register a charged hit (indicating a cosmic rather than a gamma ray), the instrument applies high voltage to the chambers, creating sparks along the ionized particle wakes. These illuminated paths can be used to determine the trajectory of the gamma ray that triggered them and, with the energy measurement from the NaI crystal, its energy.

An important task for EGRET is the study of pulsars that will be coordinated with Earth-based radio measurements (since pulsars have been seen to emit at both radio and gamma-ray frequencies). Other targets will include molecular clouds, black holes, quasistellar objects or quasars, neutron stars, supernovae, normal galaxies, and active galaxies (those that shine brightest in nonvisible energy ranges).



M87 Galaxy

A NEW MAP OF THE UNIVERSE

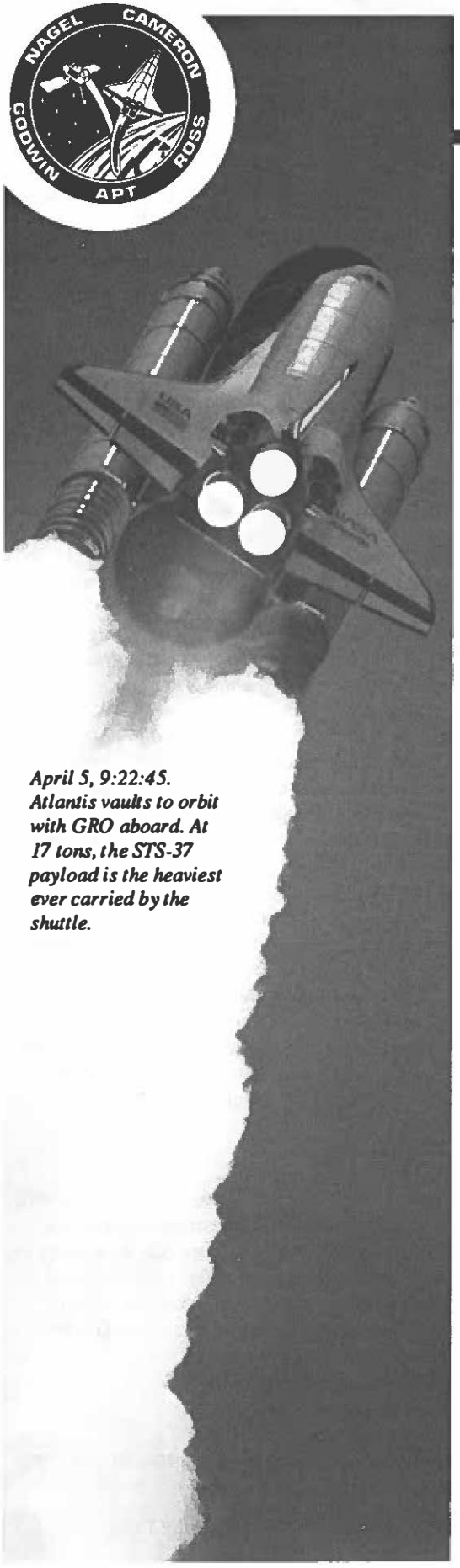
When GRO completes its scheduled 15-month, whole-sky survey, astronomers will have a new map of the gamma ray universe. Just as the GRO's instruments together cover the entire gamma-ray spectrum, the Observatory itself will provide its overlay on the picture of the universe being gathered by Hubble and eventually, by AXAF and SIRTF. Taken together, these maps will cover the cosmos across the entire electromagnetic spectrum and provide us with a picture unimaginable as the Great Observatories begin their missions. —P.T.

FOR FURTHER READING

The Gamma Ray Observatory, NASA NP-124, National Aeronautics and Space Administration, Washington, DC, 1990.

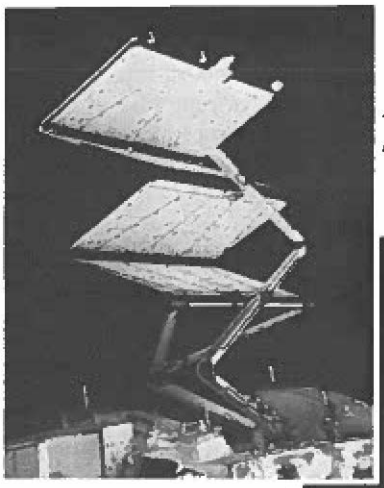
Kniffen, D. A. The Gamma Ray Observatory, *Sky and Telescope*, May 1991.

STS-37 . . .

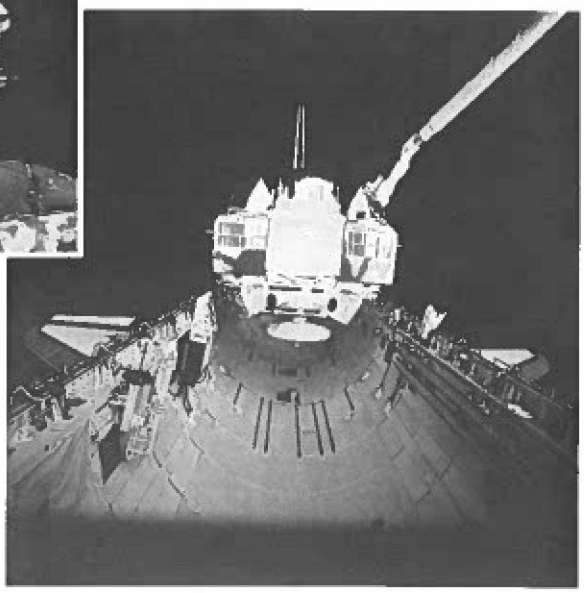


April 5, 9:22:45. Atlantis vaults to orbit with GRO aboard. At 17 tons, the STS-37 payload is the heaviest ever carried by the shuttle.

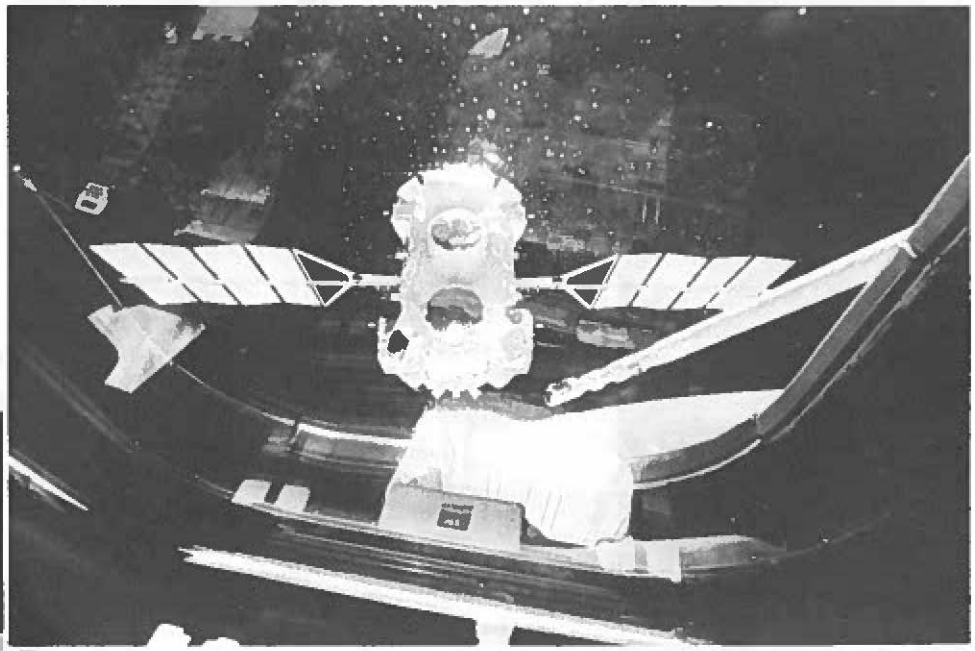
April 7. "It's free, it's free!" Misssion Specialists Jerry Ross (pictured) and Jay Apt perform an unexpected EVA to deploy the high-gain antenna on GRO that refused to budge on command from the ground. Ross "just kind of shook on the side of the boom" and the antenna released. At 5:38 on flight day 3, Mission Specialist Linda Godwin released the observatory from the remote manipulator arm.



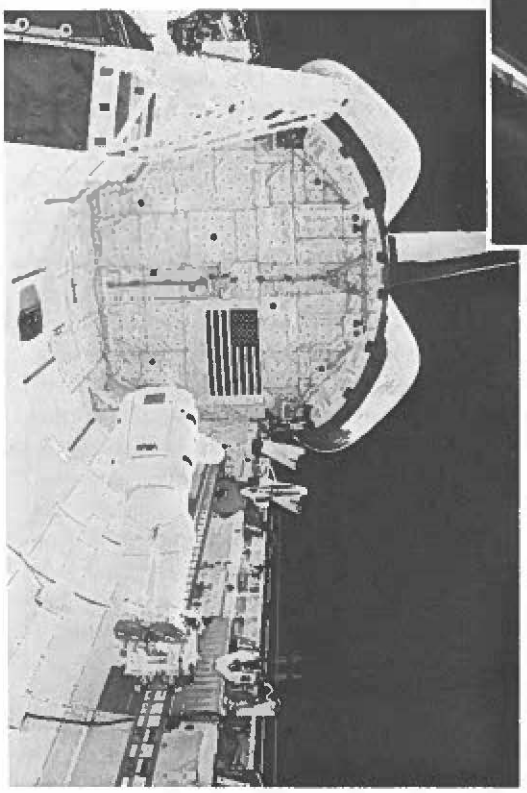
April 7. GRO solar panel deployment.



April 7. The GRO is grappled by Mission Specialist Godwin using the remote manipulator arm and lifted from the payload bay for checkout.



April 7. Release! Atlantis moves gingerly away from the Gamma Ray Observatory after the remote manipulator arm has freed it to orbit 280 miles above Earth.



April 8. Mission Specialist Apt pilots a cart to move along a beam in Atlantis' cargo bay as part of the testing of equipment that will aid crews aboard Space Station Freedom.

April 5. The shuttle's view of Kuwait is almost completely obscured by smoke from hundreds of oil wells burning out of control, a legacy of the Iraqi army driven from Kuwait in February.

. . . mission accomplished

April 11. Atlantis touches down at Edwards Air Force Base in the Mojave Desert. The mission was extended a day because of high winds at Edwards on the originally planned landing day. Wheel stop occurred at 6:56:26 PDT, marking the completion of a very successful mission.

NEW IN PRINT

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

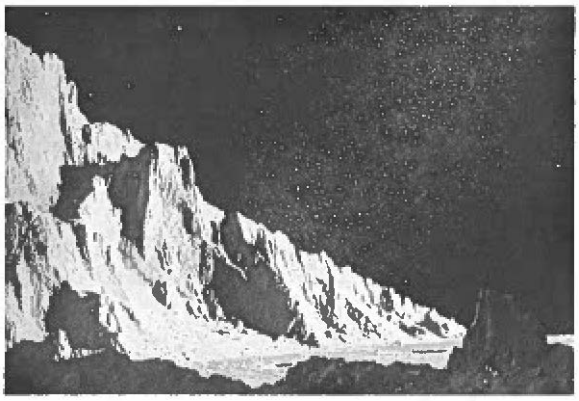
VLADIMIR DZHANIBEKOV
PORTRAIT OF GAGARIN

A REVIEW

IN THE STREAM OF STARS: THE SOVIET/AMERICAN SPACE ART BOOK
Edited by William K. Hartmann, Andrei Sokolov, Ron Miller, and Vitaly Myagkov
with An Historical Perspective by Ray Bradbury
Workman Publishing Co., New York, 1990 183 pp.
Color illustrations. Hardcover, $29.95; Softcover, $19.95

In the Stream of Stars presents a fascinating and varied collection of space art, the results of ongoing collaboration between members of the U.S.-based International Association of Astronomical Artists and the Soviet Union of Artists. The two groups have been conducting joint field trips, meetings, and exhibitions since 1987 and this compilation of images demonstrates just how rich and rewarding the experience has been.

The artwork is well reproduced in full color on a generous 11 by 10 inch format and is accompanied by eight brief articles that offer additional perspectives on the subject matter. What is immediately apparent from the images alone is that this volume captures a particular moment in the history of space art when traditions in the West and the East meet each other for the first time. Western, especially American, artists have been developing the line of heroic landscape painting begun in the last century and best exemplified by Thomas Moran and others, who often accompanied the great geological survey expeditions in the American West. Expansive and also meticulous in detail, the images are quite realistic and emotionally cool. Human presence is unimportant to nonexistent. In the Soviet work, the human being is the focus—man's relationship to the cosmos is explored in detail using complex symbolism and expressionistic technique to create emotion-charged images. Portraiture in the heroic tradition is a genre of space art not often seen in the West but the cosmonaut-hero figure is seen repeatedly in the Soviet examples.



CHESLEY BONESTELL (1949)
THE STRAIGHT WALL

An article by Ron Miller traces the history of space art (with many illustrations from early in the century). Alexei Leonov, the first spacewalker, and Alan Bean, lunar astronaut, describe their unique experiences as artist/astronauts in space and on the Moon. Vitaly Myagkov describes the blossoming of space art in the U.S.S.R. in the era of glasnost and Robert Schulman contributes a look at the now-revitalized NASA Space Art Program. Scientist/artist William Hartmann makes a clear case for the value of "exploring by paintbrush" and Andrei Sokolov emphasizes the pyschological needs that cosmological themes in art supply.

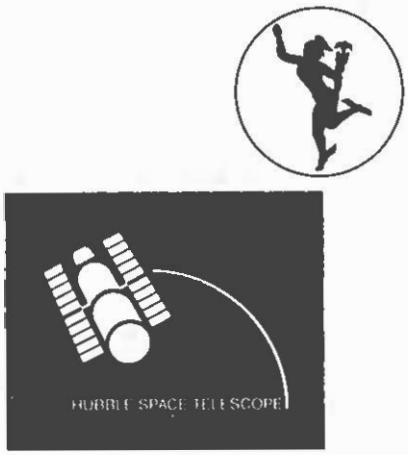
GEORGII POPLAVSKI
FLOWERS TO THE PLANET

This is a remarkable book (at a very reasonable price) that makes this reader eager for the next edition to see how the two traditions in space art are cross-fertilizing one another. We also hope the authors will include dimensions, dates, and media for the images as they do not in this volume. Capsule biographies of all the artists represented are given at the end. Editor Hartmann suggests asking your bookseller to order the hardcover edition if you prefer it to the softcover most often stocked in stores. —P.T.

ALAN BEAN
FAST TIMES ON THE OCEAN OF STORMS

LGI TECHNICAL REPORT

The Lunar Geotechnical Institute announces publication of Technical Report 90-03. The report may be ordered free from LGI as "Mining on the Moon," Proceedings of a Technical Session at the 1990 Annual Meeting, Society for Mining, Metallurgy, and Explorations, Inc., Salt Lake City, TR90-03. Order from LGI, P.O. Box 5056, Lakeland FL 33807-5056. Phone: 813-646-1842; FAX: 813-644-5920.



NEW FROM THE ASTRONOMICAL SOCIETY OF THE PACIFIC

HUBBLE SPACE TELESCOPE SLIDE SET

Among the 25 slides in this set are some of the first magnificent color images taken in late 1990 with the HST's two cameras. They include Saturn and its rings; the clearest picture ever taken of Pluto and Charon; the faint ring of matter around Supernova 1987A ejected over the 10,000 years before the star exploded; and the "Einstein Cross," an illusion created by the gravity of a nearby galaxy bending the light of a distant quasar into four distinct images. Assembled with the assistance of Dr. Eric Chaisson and Ray Villard of the Space Telescope Science Institute, the set includes a 40-page booklet of nontechnical background information including a report on the mirror problem and its proposed solution, captions for each slide, summaries of the HST instruments, and a glossary and reading list. $29.50 from A.S.P., HST Slide Order Dept., 390 Ashton Ave., San Francisco CA 94112.

POWERS OF TEN VIDEO

Powers of Ten is a famous 9-minute film that is a narrated journey into the depths of space, where each stop propels us ten times farther outward until we reach the realm of the clusters of galaxies. We return to Earth to take a similar trip into the microscopic world until reaching the atomic nucleus. The tape, in VHS format, also includes an earlier version of the film that features clocks that compare Earth time and ship time as the voyage approaches the speed of light and an introduction by Gregory Peck to the work of film-makers Charles and Ray Eames. A reading list of the best introductory books in many branches of astronomy is included. $42.95 from A.S.P., Powers of Ten Orders, 390 Ashton Ave., San Francisco CA 94112.

GALAXIES AND NEBULAE SLIDE SET

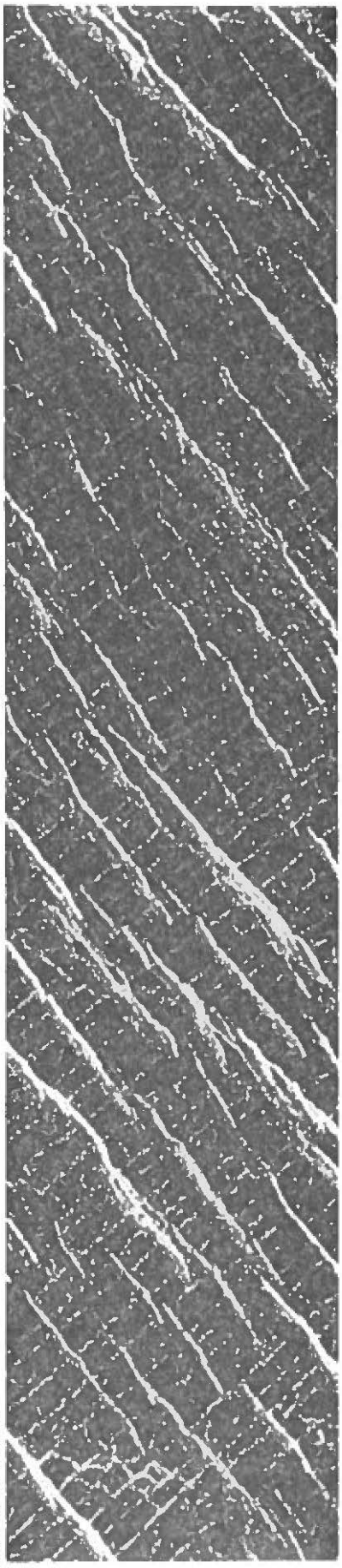
Fifteen color slides of nebulae and galaxies photographed with the large Anglo-Australian Telescope is available from A.S.P. Taken by noted astronomical photographer David Malin, the slides have been processed to bring out the colors and details of these dramatic celestial objects. They include new images of Trifid, Rosette, and Eta Carinae nebulae and examples of glowing gas and dust clouds in our galaxy as well as a nearby dwarf galaxy and the active galaxies Centaurus A and Virgo A. A booklet of captions and background information is included. $23.95 from A.S.P., Malin Slide Orders, 390 Ashton Ave., San Francisco CA 94112.

A REVIEW

PLANETARY MATERIALS AND RESOURCE UTILIZATION: A VIDEOTAPE LECTURE SERIES

The Department of Geological Engineering, Geology, and Geophysics and the Department of Metallurgical and Materials Engineering, Michigan Technological University, has produced a set of 15 videotapes based on a series of lectures constituting a course on "Planetary Materials and Resource Utilization."

(continued on page 14)



Venus Unveiled

On April 4, NASA's Jet Propulsion Laboratory announced that Magellan completed its primary goal of mapping 70% of Venus more than a month before the end of the first 243-day mapping cycle. (One complete rotation of Venus beneath the orbiting satellite takes 243 days.) Project Manager Tony Spear said that because of the quality of the images and the excitement they have generated in the scientific community, an extended mission for a second 243-day mapping cycle has been approved by NASA and will begin May 16. By the end of the first cycle, Magellan will have mapped 84% of the surface.

As scientists begin the unprecedented task of mapping this Earth-sized planet, they describe a geologically active surface with widespread volcanism, tectonic deformations, mountain belts and a number of impact craters that indicate a relatively young surface age of a few hundred million years. There is evidence of several types of lava flows and lava rivers hundreds of miles long. Ejecta from meteorite impacts appears to have been flung as far as 600 miles from craters and there are dark traces that seem to suggest wind activity at the surface.

We present some of the striking and beautiful images of Venus's surface as Magellan completes its first observing cycle. In future issues of the Bulletin we will feature interpretation of some of the distinct terrain units as the spacecraft embarks on the second mapping cycle. The first objective of the extended mission is to image the remaining 16% of the planet including the south pole which has never been imaged before. Other surface features will be mapped from a different viewing angle to yield a new perspective, and image comparisons from one mapping cycle to the next will be made to look for active surface processes.

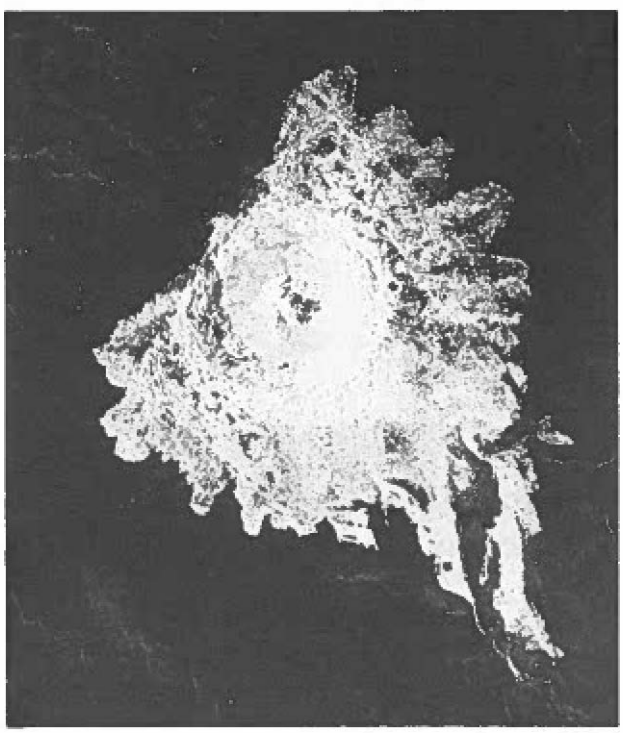
Beginning in mid-November, every fourth orbit will be dedicated to acquiring gravity data. Instead of mapping the surface on those orbits, Magellan's high-gain antenna will point toward Earth, slight changes in the radio signal caused by the variable tug from Venus will help indicate local gravity variations on the planet—an important clue to processes in the interior.

Finally, near the end of the mission, engineers may try to aerobrake Magellan into a circular orbit where it could return global, high-resolution gravity and image data. Aerobraking, or using the planet's upper atmosphere to slow the spacecraft and change its orbit is an untried concept and the maneuver would be a valuable engineering demonstration for future missions of many types.

JPL-P36699 MGN 16

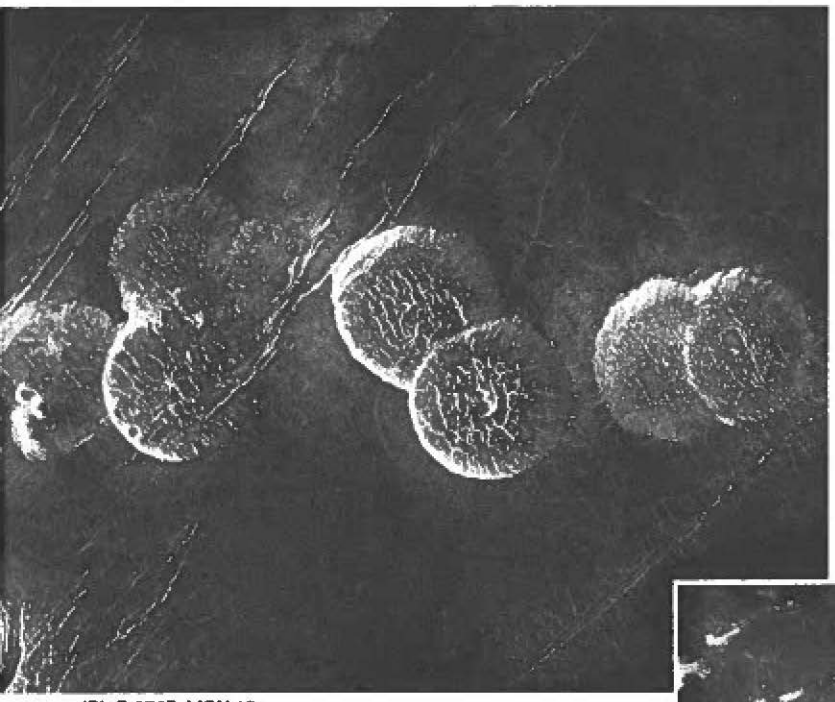
A mosaic of part of the Lakshmi region at 30 N, 333.3 E located on the low rise separating Sedna Planitia and Guinivere Planitia and to the west of Eistla Regio. The two sets of lineations, one faint and one bright, appear to intersect at 90-degree angles. It is not clear if they represent faults or fractures. In other regions the bright lineations are associated with volcanic features. This sort of terrain has not been seen before on Venus or any other planet.

Magellan Has Mapped 70% of the Planet



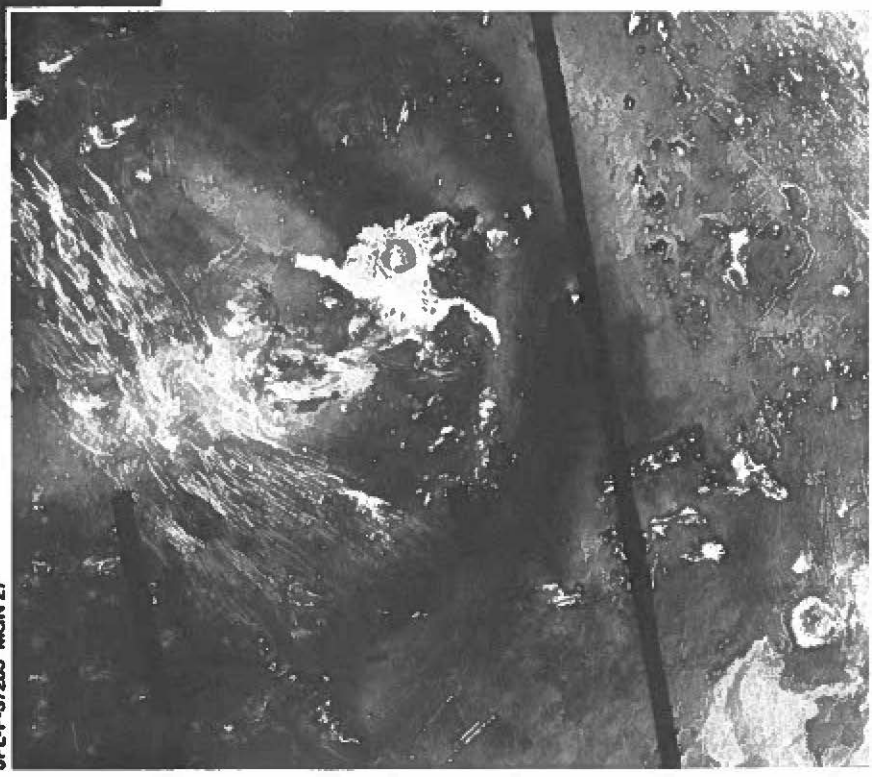
P-37128

(Right) Impact crater Aurelia, about 20 miles in diameter, 20.3 N, 331.8 E surrounded by radar-bright (thus rough) ejecta. Asymmetric ejecta patterns such as this are seen surprisingly often on Venus.



JPL-P-3725 MGN 16

(Left) At the eastern edge of Alpha Regio, 30 S, 11.8 E, we see seven circular domes about 15 miles in diameter. They may be formed by upwelling of extremely viscous lava from vents on the very flat ground. The fracture patterns on their surfaces may be caused by cooling of the outer layer of lava which is then stretched and cracked by subsequent intrusion of new lava.



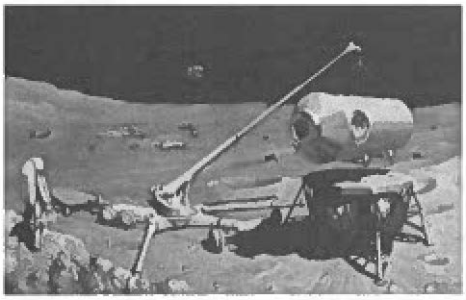
JPL-P-37265 MGN 27

(Right) This mosaic, at 25 S, 345 E in the northern Lavinia region, features a 24-mile diameter impact crater with two lava flows at the southern rim. The radar-brightness of the ejecta and flows indicates that both are extremely rough and might have formed at about the same time (at impact). The abundance of visible windstreaks suggests there is sediment that can be moved by the wind in this region. The bright linear features are a ridge belt apparently crossed by thin dark windstreaks that follow the topography.

NEW IN PRINT

PLANETARY MATERIALS *continued from page 11*

This course was organized as a senior/graduate-level course and given in the spring of 1989. The success of the course was largely due to 13 visiting speakers from NASA, USGS, universities, and private companies. Each gave one or two classroom lectures in their field of speciality. It is these lectures that were captured on videotape and are being offered by the University so that others may use one or all of the tapes to inaugurate a similar course.



P. RAWLINGS

The tapes integrate current scientific knowledge of nonterrestrial materials with potential engineering solutions that will ultimately lead to self-sufficient and sustained lunar/martian bases. Topics range from a general discussion of the Moon and Mars to the technical aspects of materials processing and microgravity manufacturing.

The set of 15 videotapes could provide a core around which a course on twenty-first century space activities could be organized; however, each tape does stand alone. These are tapes of the actual classroom lectures showing the instructor and zeroing in on the audio-visuals used during the class.

The tapes are expensive: $100 each or $1000 for all 15. However, it would be quite difficult to bring together a suite of guest lecturers for this cost. It should also be remembered that the world of planetary science and particularly resource utilization is changing rapidly so that in some cases the tapes could be dated in just a few terms.

The tapes may be ordered from Michigan Technological University, Public Services and Professional Development, 1400 Townsend Drive, Houghton MI 49931-1295. Contact Martha Banks, Coordinator, Video Marketing, 906-487-2585.

P. RAWLINGS

An article describing the course has been published. See Rose, W.I. et al., "New Interdisciplinary Engineering Design Course in Planetary Materials and Resource Utilization," Proceedings of Space '90 v.2, 1413-1422, ASCE, 1990. —F.W.

MTU OFFERS SHORT COURSE IN PLANETARY MATERIALS

Michigan Technological University is offering a 10-day, 3-credit course that will be an interdisciplinary introduction to concepts envisioned for twenty-first century space activities. The intensive course will integrate current scientific knowledge on non-terrestrial materials with potential engineering solutions for future self-sufficient space activities such as a lunar or martian base. Titled Planetary Materials and Resource Utilization, the course will cover topics in three categories. Nonterrestrial Geological Resources will cover lunar mineralogy, petrology, surface conditions and remote sensing; Utilization of Non-terrestrial Resources will cover geotechnical and mining topics, lunar power systems, and lunar materials processing systems; and Utilization of Non-terrestrial Conditions will cover low gravity and high vacuum materials processing in space. No specific prerequisites other than senior or graduate level are required. The course will be held at MTU in Houghton, Michigan, August 12-24. For more information, contact Coordinator, Professional Development Program, MTU, 1400 Townsend Drive, Houghton MI 49931. Phone: 906-487-2585; FAX: 906-487-2468.

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SUMMER INTERN

PROGRAM 1991

The Summer Intern Program, entering its 15th year at the Lunar and Planetary Institute, is designed to introduce undergraduate students to the research environment. The 1991 program will begin on June 10 for a ten-week period with a roster of 13 students. From such diverse areas as Japan and Finland to the Gulf shores, and from Hawaii to New Jersey, these young people will carry out individual research projects under the direction of a scientist-advisor, culminating in a mini-conference to report the results of the summer's labor. Throughout the summer, frequent lectures and seminars by scientists in a variety of space science programs offer additional opportunity to learn about many aspects of planetary science. The scientific organizers are Dr. Stephen Clifford, LPI, and Dr. Michael Zolensky, NASA Johnson Space Center.

If you are interested in participating in the 1992 program, send your name and address to the Program Services Department, Summer Intern Program, LPI, 3303 NASA Road 1, Houston TX 77058-4399. You will receive application information in November 1991.

The 1991 interns, their advisors, and projects are:

JOSE MANUEL AGUIRRE Jr., University of California at Berkeley
Advisor: Virgil L. Sharpton, Lunar and Planetary Institute

Marquez Dome is a 22-km diameter well-preserved impact structure located in Leon County, Texas. The impact occurred in poorly consolidated strata of the Paleocene Calvert Bluff Formation. Recently, headward erosion has revealed the central peak of this partly buried structure, and possible impact deposits have been located along the banks of the Navasota River, which cuts the western flank of the structure. The project will involve field work and petrography to document impact units, including fall-back breccia and ejecta. Seismic data will be used to constrain outcrop localities. In addition, quarries located some 30 miles northeast of the structure will be examined.

Shatter cone structure from Marquez Dome impact.

IRENE ANTONENKO, University of Toronto
Advisor: David McKay, NASA Johnson Space Center

Meteorite impacts on the lunar surface drive a number of processes including the reduction of FeO to metallic iron in minerals or glasses. The details of this process are not well understood but may point to an effective way to produce oxygen at a lunar outpost. The project will consist of using the scanning electron microscope to study samples in which the iron bound up in minerals and glass has been partially reduced to metallic iron. These samples will include actual lunar material and synthetic material that has been reduced in a gas mixing furnace at the Johnson Space Center under controlled reducing conditions.

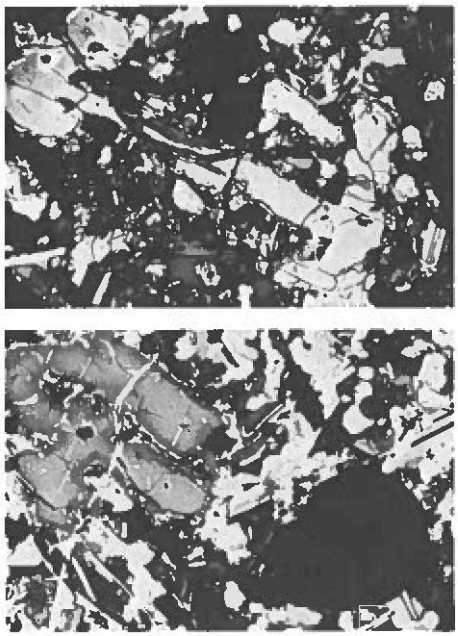
GREGORY JOHN HANSON, Middlebury College
Advisor: Deborah Domingue, Lunar and Planetary Institute

Studying the structural and scattering properties of a planetary regolith on a regional scale can provide insights into the geologic processes at work on the surface of a planet. This project will involve a study of the average properties of the regolith on the leading and trailing hemispheres of Jupiter's moon Ganymede to better understand brightness variations between them. Measurements of brightness variations with viewing geometry taken from telescopic observations will be combined with measurements taken from Voyager images to construct a solar phase curve. This data will be modeled using Hapke's theory to obtain limits on porosity, roughness, and single-particle scattering functions.

ERIN CATHERINE HATCH, Centenary College of Louisiana
Advisor: Faith Vilas, NASA Johnson Space Center

Primitive asteroids in the solar system (C, P, D class and associated subclasses) are believed to have undergone less thermal processing than differentiated (S-class) asteroids (the majority of the main-belt and near-Earth population). C-class asteroids (and subclasses) represent a large percentage of the solar system minor bodies that have undergone aqueous alteration. Different products of aqueous alteration exist at

different heliocentric distances, driven by the temperature and initial composition at these locations. 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.



Photomicrographs of Apollo 15 olivine-normative mare basalt.

PAUL D. JOHNSON, University of Hawaii at Manoa
Advisors: Benjamin C. Schuraytz and Graham Ryder, Lunar and Planetary Institute

Textures of the Apollo 15 olivine-normative mare basalts are not easily reconciled with the simple crystal fractionation model inferred from their chemistry. The problem will be approached by detailed petrographic study of the samples to quantify their phenocryst assemblages. This research project will explore the use of computer-aided image processing to obtain precise modal analyses for the basalts. The goal of this study is to integrate these data with existing chemical analyses into a comprehensive petrogenetic model.

ELISSA KOENIG, Princeton University
Advisor: T. A. Sullivan, NASA Johnson Space Center

The focus of this project is theoretical analyses and experiments to transport soil at partial gravity. Pneumatic conveyance of bulk soil could replace complex dump trucks for soil transport. This concept might even extend to using pneumatic mining in a closed environment. Gas classification could replace screening for size separation. The final products will include a theoretical analysis of the behavior of pneumatic systems at 1/6-*g*, the design of equipment to study these effects, laboratory studies using different density material to gain insight into partial-*g* effects, and finally, partial-*g* flights on the KC-135 to explore the operation of the unit under actual 1/6-*g* conditions.

KATALIN KRIVIAN, Hillsborough Community College, Dale Mabry Campus
Advisors: Michael Zolensky, Douglas Ming, and D. C. Golden, NASA Johnson Space Center

Development of new procedures permitting the characterization of the phyllosilicates (clay minerals) in chondritic meteorites and interplanetary dust will be the focus of this project. Mineralogical identifications using electron beam instruments have been severely hampered by the tendency of phyllosilicates to be rendered amorphous and unrecognizable through heating and radiation effects of the beam. The new techniques will be through chemical means. In the first phase of the project specific liquid amines will be applied to a variety of standard phyllosilicates expected to be encountered in extraterrestrial samples to develop specific formulas for stabilization of phyllosilicates. Research procedures we develop will be applied to the characterization of the carbonaceous chondrite meteorites Orgueil and Murchison.

441B02

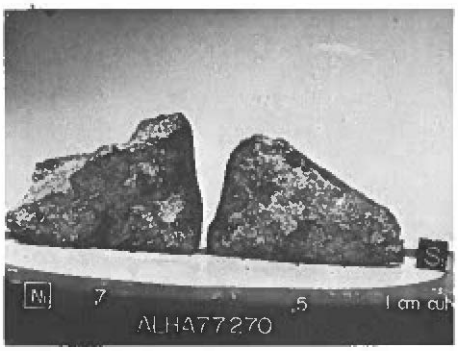
Are the dark streaks on this martian talus slope weathered debris, water-carried sediment, or signs of scarring from recent landslides?

DAVID WILLIAM LEVERINGTON, University of Ottawa
Advisor: Steven Williams, Lunar and Planetary Institute

Dark streaks on some martian talus slopes have been interpreted as weathered debris of inhomogeneities in the slope material, as material that has been modified and transported downslope due to water released as a spring, and as scars of relatively recent landslides. If the latter interpretation is correct, then the presence and quantity of the streaks can be used to demonstrate the presence of relatively nonweathered bedrock (a desirable target for remote sensing) and to constrain the rate of talus development. The project will involve examination of Viking Orbiter photographs to identify all the dark talus streaks and use that data to look for correlations of the streaks with geography, terrain type, latitude, surface cover, and elevation to help resolve the question of the origin and evolution of the streaks and determine their utility in finding bedrock and constraining slope evolution models.

CHRISTOPHER STEPHEN SPARGUR, Iowa State University
Advisor: James L. Gooding, NASA Johnson Space Center

More than 10,000 meteorites, with terrestrial residence ages of 10^4 to 10^6 years, have been recovered from Antarctica since 1969. Accumulated effects of terrestrial weathering in the specimens require that investigators proceed cautiously in analyzing



How weathered is this meteorite after residing in Antarctica for 500,000 years? Development of a numerical scale for estimating degrees of "rustiness" will help meteorite scientists select the best samples for cosmochemical analyses.

the meteorites for cosmochemical information. Differential scanning calorimetry (DSC) will be applied to chemically analyzed samples from the Antarctic meteorite collection to (1) identify the thermal-analytical signatures of weathering products and (2) evaluate measurable parameters (e.g., peak intensities or ratios) that can be used as "weatherometer" indices. In addition, petrography of meteorite thin sections will be used to compare visual indices of weathering with those derived by DSC. These studies will focus initially on ordinary chondrites although applicability to carbonaceous chondrites and to achondrites will also be examined.

DOUGLAS R. STEWART, Vassar College
Advisor: Everett K. Gibson Jr., NASA Johnson Space Center

This project involves the study of trapped atmospheric gases in Archean sediments. Unaltered Archean sediments of ages ranging from 3.5 billion years to the termination of the Archean will be analyzed for their trapped atmospheric gases using stepped combustion and/or vacuum extraction techniques. The released gases will be purified and analyzed for their carbon and oxygen isotopic compositions. The study will examine approximately 12 sediments of different ages to show changes during the interval of enhanced oxygen production during the Earth's early history, especially during changes in the Earth's early atmosphere.

KOICHI TAKATORI, University of Tokyo
Advisors: Lindsay Keller, David McKay, and Michael Zolensky, NASA Johnson Space Center

For most studies of interplanetary dust particles, the larger particles (>10 or 20 micrometers) in the NASA collection are the ones cataloged and most requested for detailed studies. The smallest particles have for the most part been neglected. Samples of particle sizes (<0.4 micrometers, 0.4–1 micrometers, and 1–5 micrometers) are in the Johnson Space Center collection still on the nucleopore filters. This project will consist of analyzing some of these particles, transferring the data to a database for processing and plotting, and finally interpreting the data. Data analysis may reveal different populations of particles including chondritic particles, ablation products from meteorites, exhaust products from rockets, reentering orbital debris particles, terrestrial volcanic ash, industrial smoke particles, and unusual types of extraterrestrial materials.

KEITH C. VANDEN HEUVEL, Saint Norbert College
Advisor: Andrew Potter, NASA Johnson Space Center

Both the Moon and Mercury have a very thin atmosphere, so thin as to be equivalent to the best vacuum we can get in the laboratory. Optical spectrometers aboard the Mariner 10 spacecraft measured remotely some of the gases in the atmosphere of Mercury in 1974. Mass spectrometers, carried to the Moon by the Apollo lander, measured the atmosphere during lunar night. These measurements were incomplete one-time events. It has been discovered that sodium and potassium vapor can be observed in the atmospheres of both Mercury and the Moon with groundbased telescopes. A large body of data for the Moon and Mercury has been collected and more is on the way from a synoptic observation program of Mercury at the Kitt Peak National Observatory. The project will involve analysis of the Mercury data to attempt to establish a correlation between the planetary distribution of sodium and potassium vapor and solar activity and analysis of the Moon data to understand how the lunar atmosphere is produced and how it changes with time.

HARRI VANHALA, University of Oulu
Advisor: Tomasz F. Stepinski, Lunar and Planetary Institute

The project on magnetic fields in the solar nebula involves numerical calculations to determine where in the primordial solar nebula magnetic fields are likely to exist for relatively long periods of time. The existence of such fields is interesting because the Lorentz stress associated with them could become a major factor in the structure and dynamical balance of the nebula. The project will concentrate on the issue of how sensitive the structure of nebular magnetic field is to the features of a particular solar nebula model.

The Twenty-second Lunar and Planetary Science Conference was the largest in history. Many of the long-time members of the community remarked upon the number of young researchers that were present at the Conference. Their presence, their fresh perspectives on problems, indicate that planetary science is a subject of considerable interest to the young as well as the "old."

The Lunar and Planetary Institute has been a fixture in planetary science for more than two decades. It has grown and evolved with the discipline itself. In some cases the Institute's evolution has followed that of the communities that it serves, and in some cases the Institute has been at the forefront, working in concert with members of the planetary science community, shaping the evolution of planetary science.

One function that the Institute has provided over the years is that of a "safe haven" for visiting scientists. During visits, which may be for a few days or for prolonged periods, these scientists can use facilities at the Johnson Space Center or at the Institute to conduct their research. As such it affords the community a home away from home.

As most readers of the Bulletin are aware, the Institute's lease on the current site for the Institute, the West Mansion and its associated grounds, expired in 1989. Rice University has kindly provided an opportunity to the Institute to continue to lease the West Mansion until we are able to move to a new site.

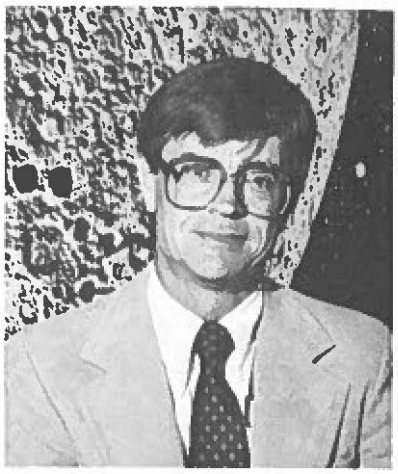


PHOTO: D. RUEB, LPI

Dr. David C. Black, Director, LPI

BREAKING GROUND FOR THE FUTURE

Through the efforts and support of NASA, both Headquarters and the Johnson Space Center, a new site has been located. One week after the 22nd LPSC, bonds to finance the purchase of the land and the construction of the new Institute were put on the market. They sold within a few hours of issuance, and the construction of the new Institute began almost immediately.

The new Institute facility and the land will be owned by Universities Space Research Association, the parent organization for the Institute. This is extremely important as it will provide a strong and stable foundation for the Institute to continue its interaction with the scientific community and NASA.

I mentioned the support of NASA, and it is important to stress that the support went beyond that of the science organizations within the agency. Support was also provided by the manned program side of NASA, and none of this would have happened without the dedicated and highly constructive efforts of individuals in the contracts and procurement side of NASA. The importance of the Institute over the years in providing the scientific community access to and interaction with manned programs, such as Apollo, is recognized and appreciated.

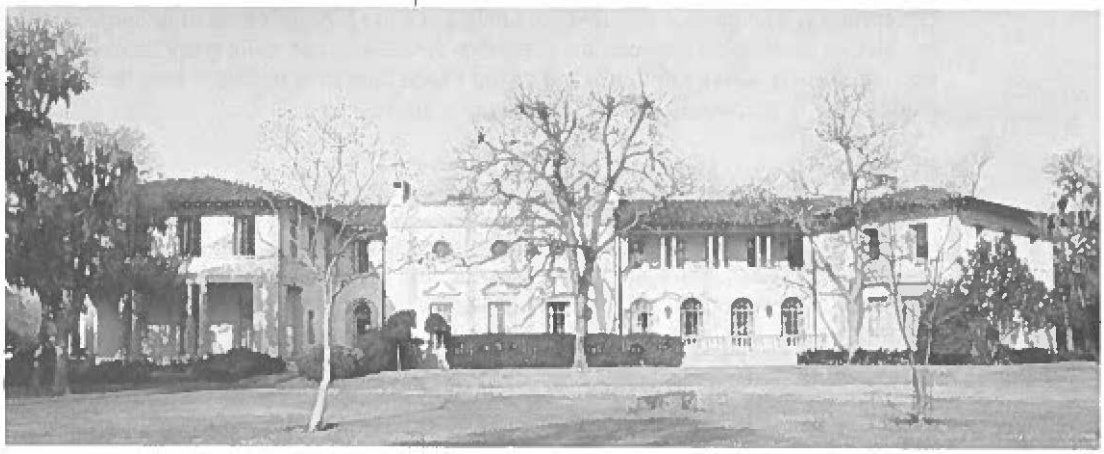


PHOTO: D. RUEB, LPI

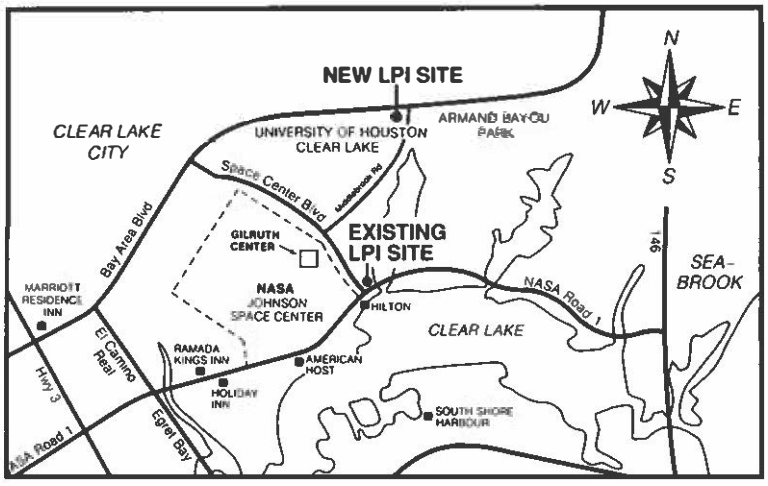
The West Mansion, built in 1928, has housed the Lunar and Planetary Institute since 1969.

RENDERING: GREGG JONES, 1991, COURTESY KIRKSEY-MEYERS ARCHITECTS

The new site is located at the intersection of Bay Area Boulevard and Middlebrook Road (see map). It is a nine-acre plot, and the only contiguous neighbor is the University of Houston Clear Lake. While the new facility will not possess the old world charm that the West Mansion has, those of you who have spent much time at the Institute in recent years will attest to the fact that while the Mansion may have been a fine home, it did not really lend itself to many of the functions that the Institute performs, such as panel reviews and workshops. In addition, the upkeep and operational costs associated with the current site were just beginning to increase in a significant manner (the building was renovated over twenty years ago).

At present, the Institute plans to move into the new facility around the end of the calendar year. At that time we intend to have a dedication ceremony.

The abundance of young faces at the Conference this year, the exciting results from the Magellan mission, and the anticipation of Galileo bodes well for the future of planetary science. On behalf of all the employees at the Institute, I want to thank those of you who have expressed your support for the Institute and its role as a link between NASA and the research community. We all look forward to another twenty-plus years of exciting activity. —*David C. Black*



(Top) Artist's rendering of LPI's new facility. At present, the Institute is scheduled to relocate to the new building at the end of 1991. (Above) 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.

CALENDAR 1991

MAY

22-27 **Space: A Call for Action; 10th Annual International Space Development Conference,** San Antonio, Texas. Contact: Carol Luckhardt Redfield, Southwest Research Institute, 6220 Culebra Road, San Antonio TX 78228-0510. Phone: 512-522-3823 or 679-7625.

27-29 **Joint Annual Meeting of Geological Association of Canada, Mineralogical Association of Canada, and Society of Economic Geologists,** Toronto, Canada. Contact: Jeff J. Fawcett, Department of Geology, University of Toronto, 22 Russell Street, Room 1066B, Toronto, Ontario, Canada M5S 3B1. Phone: 416-978-6588; FAX: 416-978-3938.

28 —June 1 **American Geophysical Union, Spring Meeting,** Baltimore, Maryland. Contact: AGU, 2000 Florida Avenue NW, Washington DC 20009. Phone: 202-462-6900.

JUNE

5-7 **Sixteenth Symposium on Antarctic Meteorites,** Tokyo, Japan. Contact: Keizo Yanai, Department of Antarctic Meteorites, National Institute of Polar Research, 9-10, Kaga 1-chrome, Itabashi-ku, Tokyo 173, Japan. Phone: 03-3962-4711, extension 155; FAX: 03-3962-5711.

10 —Aug 8 **LPI Summer Intern Program.** Contact: Lebecca Simmons, Summer Intern Program, LPI, 3303 NASA Road 1, Houston TX 77058-4399. Phone: 713-486-2166.

21-27 **103rd Annual Astronomical Society of the Pacific Meeting,** University of Wyoming, Laramie, Wyoming. Contact: Wyoming Meeting Info, A.S.P., 390 Ashton Avenue, San Francisco CA 94112. Phone: 415-337-1100.

24-28 **Asteroids, Comets, Meteors, 1991,** Flagstaff, Arizona, Contact: Pam Jones, ACM '91, Program Services Dept., LPI, 3303 NASA Road 1, Houston TX 77058-4399. Phone: 713-486-2150; FAX: 713-486-2162.

30 —July 3 **International Conference on Near-Earth Asteroids,** San Juan Capistrano, California. Contact: Dr. Clark R. Chapman, Chairman, NEA Conference, Planetary Science Institute, 2421 E. 6th Street, Tucson AZ 85719.

JULY

1-5 **Workshop on Hypervelocity Impacts in Space,** Canterbury, United Kingdom. Contact: Professor J. A. M. McDonnell, Unit for Space Sciences, University of Kent at Canterbury, Kent CT2 7NR, UK. Phone 44-227-459616.

11 Total eclipse of the Sun visible from Hawaii and Mexico.

21-26 **54th Meteoritical Society Meeting,** Monterrey, California. Contact: Dr. Peter Englert, San Jose State University, School of Science, Nuclear Science Facility, One Washington Square, San Jose CA 95192-0163. Phone: 408-924-4820.

23 —Aug 1 **International Astronomical Union XXI General Assembly,** Buenos Aires, Argentina. Contact: IAU Secretariat 98bis, bd Arago, 75014 Paris, France.

AUGUST

5-6 **Stellar Populations of Galaxies, IAU Symposium No. 149,** Angra dos Reis, Brazil. Contact: Dr. B. Barbuy, Dept. de Astronomia, Instituto Astronomico e Geofisico/USP, Caixa Postal 30627, Sao Paulo 01051 Brazil.

9-14 **Students for the Exploration and Development of Space (SEDS) International Conference,** Albuquerque, New Mexico. Contact: Brian Y. Vanden Bosch, SEDS, Box 92 SUB, University of New Mexico, Albuquerque NM 87131. Phone: 505-277-4845; FAX: 505-277-0813.

27-30 **Second International Symposium on Power from Space,** Paris, France. Contact: SPS 91, Societe des Electriciens et des Electroniciens, 48 rue de la Procession, 75724 Paris Cedex 15, France. Phone: 33 1 45 67 07 70; FAX: 33 1 40 65 92 29.

SEPTEMBER

2-4 **Planetary Radio Emissions III,** Graz, Austria. Contact: Helmut O. Rucker, Space Research Institute, Halbarthgasse 1, A8010 GRAZ, Austria.

16-20 **8th International Conference on Modern Trends in Activation Analysis (MTAA 8),** Vienna, Austria. Contact: Eva Haberl, MTAA 8, c/o Atominstitut, Schuttelstrasse 115, A-1020 Wien, Austria.

23-25 **Workshop on the Martian Surface and Atmosphere Through Time (MSATT),** Boulder, Colorado. Contact: Program Services Department, LPI, 3303 NASA Road 1, Houston TX 77058-4399. Phone: 713-486-2166; FAX: 713-486-2162.

SEPTEMBER (CONTINUED)

30 — Oct 2 **Comets and the Origins and Evolution of Life,** University of Wisconsin-Eau Claire. Contact: Paul J. Thomas, Department of Physics and Astronomy, University of Wisconsin, Eau Claire WI 54702-4004. Phone: 715-836-5046; FAX: 715-836-2380.

OCTOBER

1-3 **Desktop Publishing in Astronomy and Space Sciences,** Strasbourg, France. Contact: Dr. Andre Heck, Observatoire Astronomique, 11, rue de l'Universite, F-67000 Strasbourg, France. Phone: 33-88.35.82.22; FAX: 33-88.25.01.60; Telex: 890506 starobs f.

5-10 **Twenty-eighth Annual Meeting of Clay Minerals Society,** Houston, Texas. Contact: D. R. Pevear, Exxon Production Res., P. O. Box 2189, Houston TX 77001. Phone: 713-529-8909.

21-24 **Geological Society of America Annual Meeting,** San Diego, California. Contact: R. Gordon Gastil, Department of Geological Sciences, San Diego State University, San Diego CA 92182.

22-23 **Third Annual Conference: Earth Observations and Global Change Decision Making: A National Partnership,** National Press Club, Washington, DC.

OCTOBER (CONTINUED)

Contact: Dr. Robert H. Rogers, ERIM, Box 8618, Ann Arbor MI 48107-8618. Phone: 313-994-1200, extension 3234; FAX: 313-994-5123.

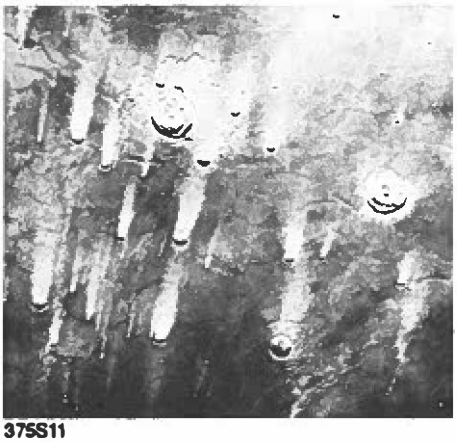
NOVEMBER

4-8 **23rd Annual Meeting of the Division for Planetary Sciences of the American Astronomical Society,** Palo Alto, California. Contact: Christopher P. McKay, Space Sciences Division, NASA Ames Research Center, Moffett Field CA 94035. Phone: 415-694-5499.

DECEMBER

6-8 **Workshop on the Physics and Chemistry of Magma Oceans from 1 Bar to 4 MBar,** San Francisco area, 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.



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MSATT WORKSHOP SCHEDULED

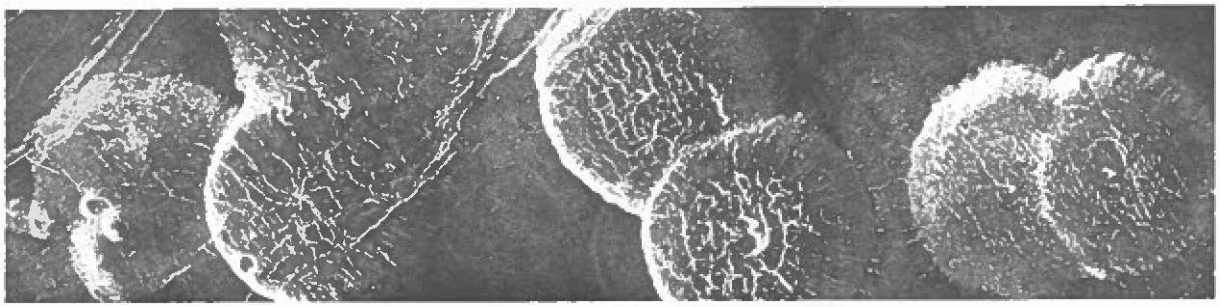
The lead-off workshop for the three-year study project, Martian Surface and Atmosphere Through Time (MSATT), will be held September 23-25 in Boulder, Colorado. The purpose of the workshop will be to explore the relationships and evolution of the surface, atmosphere, upper atmosphere, volatiles, and climate of Mars. Sessions will begin with invited talks that will be review, tutorial, or inflammatory in nature. All contributed papers will be posters. Much of the meeting will be devoted to discussion periods on topics such as (1) the present state of the surface and atmosphere and ongoing processes, (2) geochemistry and mineralogy of the surface at present or past epochs, (3) history of processes that affect interactions between surface and atmosphere, and (4) evolution of the atmosphere and volatile system as a whole.

The workshop is sponsored by the Lunar and Planetary Institute and the MSATT Study Group and will be hosted by the Laboratory for Atmospheric and Space Physics, University of Colorado. Co-conveners are Bob Haberle, NASA Ames Research Center and Bruce Jakosky, University of Colorado, Boulder. Two-page abstracts are due at LPI on July 26.

MSATT is the third in the series of focused, NASA-sponsored LPI study projects of the Mars Data Analysis Program. It follows Mars: Evolution of its Climate and Atmosphere (MECA) and Mars: Evolution of Volcanism, Tectonics, and Volatiles (MEVTV). For more information, contact LPI Program Services at 713-486-2166.

*U.S.GOVERNMENT PRINTING OFFICE:1991-561-057/20137

INSIDE



NEW VENUS IMAGES FROM MAGELLAN, PAGES 12-13

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