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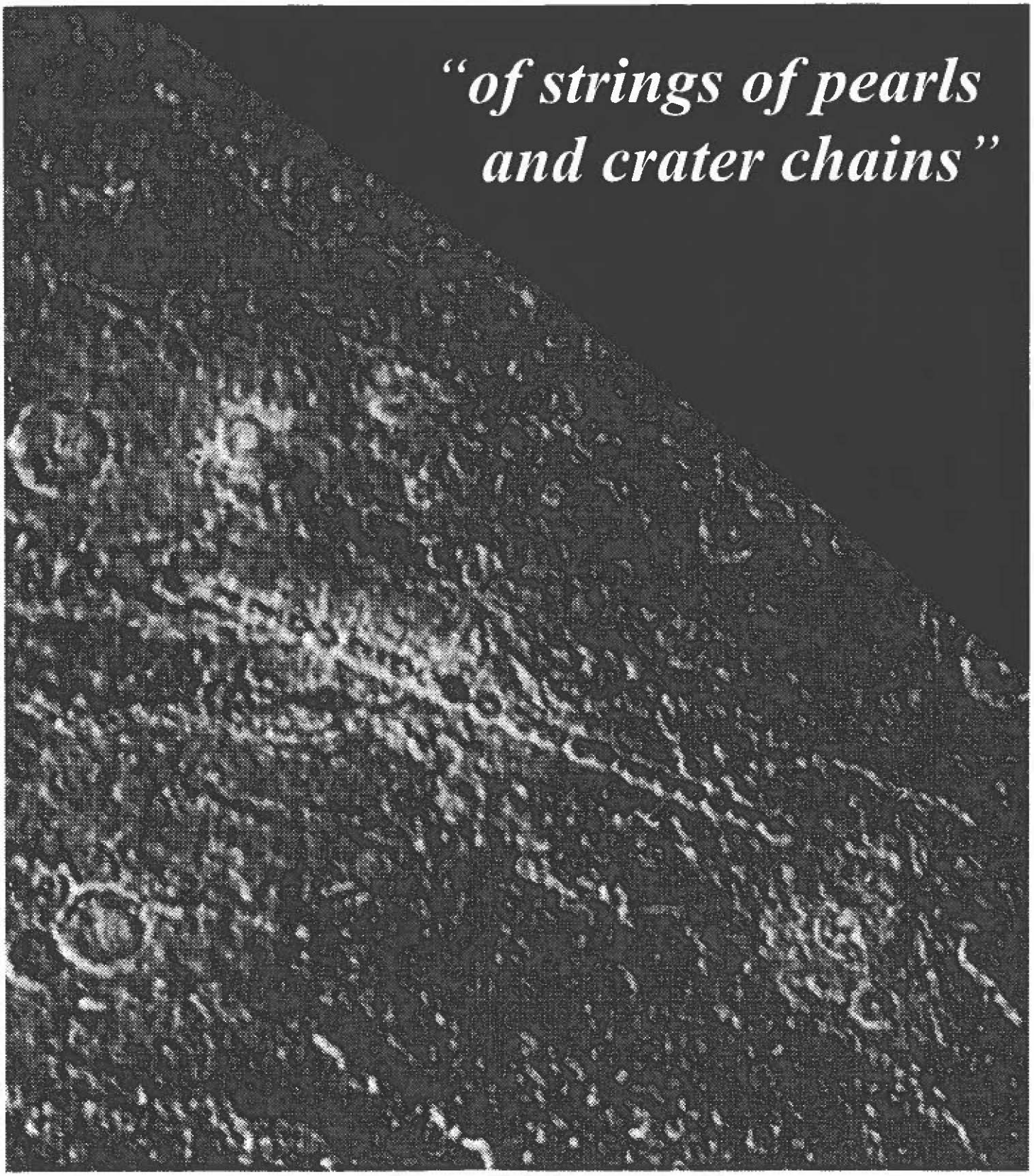


Comet to Hit Jupiter: *Jovians Doomed!*

by Paul M. Schenk

A STRING OF PEARLS

When Comet Shoemaker-Levy 9 strikes the nightside of Jupiter next summer, it won't light up our night skies with a brilliant flash. Nor will it ignite Jupiter, creating a second sun. It should result, however, in the greatest concentration ever of raw telescopic power trained on a single event. When discovered in March 1993, this comet quickly became a magnet for observers because of its striking "string of pearls" appearance—multiple fragments strung out in space. Shortly thereafter, orbital calculations indicated that the comet is in a steeply inclined, highly elliptical orbit around Jupiter and probably split apart during a very close pass by Jupiter the previous July. Comets have been observed to break up near solar perihelion, but this was the first observation of tidal fragmentation of an object in the modern era.

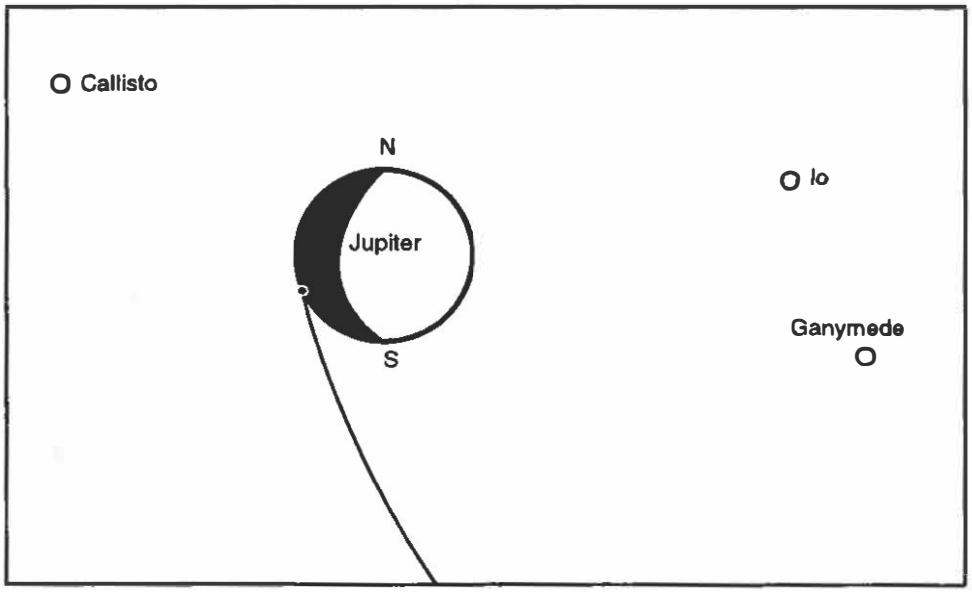
Excitement in the planetary science community went stratospheric when it was discovered that all 20 or so fragments of the comet will hit Jupiter (at 60 km per second) when they come around again next July. Never before have we *witnessed* a collision between two celestial bodies. Models will be tested, and fundamental natural processes will be observed for the first time. The thrill is tempered somewhat by the great distance involved (better there than here!) and the location of the impacts. Not only will the fragments plow into a nonsolid, "squishy" jovian atmosphere, but they will do so on the dark farside (at latitude ~37°S), invisible to direct observation from Earth.

OBSERVATIONS PLANNED

All is not lost, however. At a "Comet Pre-Crash Bash" workshop hosted by Dr. H. J. Melosh at the University of Arizona in August, observational plans and the latest ideas on this impending catastrophe were discussed. Plans are in progress to monitor any Galilean satellites that are behind Jupiter during the events. The flash of each impact and subsequent fireball may be visible by reflected light from the satellites. By some estimates the satellites may brighten as much as 20%. Amateur astronomers with CCDs or other instruments may be able to record these events (stay tuned to *Sky & Telescope, Astronomy*, or *Science News* for late updates).

Certainly, the short-term effects on the local atmosphere will be profound (each event may release the equivalent of millions of megatons of TNT). Thermal plumes may rise as high as 700 km. Whether any permanent disturbances, however, such as new Red Spots or White Ovals, will form is a subject of debate. Hubble Space Telescope should be monitoring the atmosphere for changes in cloud morphology as each impact site rotates into view 2–3 hours after impact.

The jovian system will be monitored for other possible effects. The comet has a broad dust tail. This dust tail may "turn off" or change as the fragments exit the solar wind and enter the jovian magnetosphere. Much of the dust will not impact the planet but some should pass through Jupiter's thin ring with possibly disruptive results.



The view of Jupiter by the Galileo spacecraft in July 1994 shown here with the trajectory of Comet Shoemaker-Levy, approaching from the south.

CAUSE OF CRATER CHAINS?

Although none of the fragments will hit any of Jupiter's large satellites, Melosh and P. M. Schenk (Lunar and Planetary Institute, Houston), reporting in the October 21 issue of *Nature*, have discovered geologic evidence that tidally split comets have hit the satellites in the

past. They propose that up to 15 very unusual linear crater chains on the satellites Ganymede and Callisto, unexplained for almost 15 years, were formed by comets similar to Shoemaker-Levy 9.

These chains, the longest of which is 620 km long and comprises 25 craters, were thought to resemble some secondary crater chains formed by material ejected from large basins such as we observe on the Moon. The Callisto chains are much straighter and more uniform in crater size than most secondary crater chains, however, and unpublished work by Schenk in the early 1980s failed to find suitable source basins on Callisto for most of these crater chains. In light of the remarkable string-of-pearls nature of the new comet, however, both Melosh and Schenk concluded that the crater chains on Callisto were formed by the past impact of tidally disrupted comets on the Galilean satellites.

Melosh and Schenk have constructed a model that describes the tidal breakup of comets during passage through Jupiter's Roche limit. They assume that the comet splits along planes perpendicular to the direction of Jupiter, similar to the orientation of apparent fracture planes in Mars' satellite, Phobos. Assuming that forces due to comet rotation or jetting of material are negligible, the subsequent orbital paths of the resulting fragments can be traced and are determined primarily by their different initial positions. As expected, the fragments slowly disperse as they recede from Jupiter.

This model predicts chain lengths at the Galilean satellites very similar to the observed crater chains. Most comet chains that impact the satellites should do so on the Jupiter-facing hemispheres, and should strike Ganymede as well as Callisto. Of the 13 such crater chains identified on Callisto, 12 are located on or very near the Jupiter-facing hemisphere. Also, three similar crater chains have been discovered during reexamination of the Voyager images of Ganymede (the low number may be due to Ganymede's younger surface).

From the observed lengths of comet chains on Callisto and their model, Melosh and Schenk estimate the original sizes of these comets as a few to ~10 km. Applied to Shoemaker-Levy, the model predicts a parent diameter of about 2 km.

Above—Gipul Catena, Callisto, is a 620-km-long crater chain. Cover image—The unnamed crater chain near Valhalla on Callisto is 350 km long. Researchers Schenk and Melosh suspect that these chains may have been formed by the impact of cometary fragments similar to Shoemaker-Levy.

From the number of crater chains on Callisto, and assuming a mean surface age of Callisto of ~4 billion years, the frequency of occurrence of tidal splitting of comets by Jupiter should be approximately 80 years, consistent with the observation of the splitting of comet Brooks 2 near Jupiter in 1886. Co-discoverer of the comet, Eugene Shoemaker confirms this estimate by an independent calculation.

The tidal disruption model also indicates that the strength of the parent comets is very low: less than ~0.001 bar in tension. This suggests a physical and mechanical model for comets in which stronger fragments are held together only weakly by mutual gravitational attraction. The crater sizes in the Callisto chains are also rather uniform, suggesting that these stronger fragments may be roughly uniform in size, approximately 0.4 km. This may reflect a fundamental planetesimal size among objects that accreted in the outer solar system.

THE VIEW FROM SPACECRAFT

Two spacecraft will have direct views of the events. Voyager 2 will see the impacts directly. Unfortunately, at a distance of 40 AU, Jupiter will be only 4 pixels across in any images. Galileo will have a better view, with a resolution of approximately 2500 km. The impacts will occur close to the edge of Jupiter's disk as seen by Galileo, and observations are being planned.

The magnitude of any impact-related phenomenon depends on the size of the individual fragments, which is uncertain. Initial estimates, based on the brightness of the surrounding dusty comas, suggested individual fragments were as large as 10 km; more recent estimates are a <5 km. Future observations are expected to reduce these values slightly, which will be important for proper interpretation of our observations. Spacecraft observations and geologic studies have shown that collision, or impact, is a critical process for planetary formation and evolution, as any dinosaur will attest. The unprecedented "events" of next summer at Jupiter should result in an explosive leap in our understanding of impact processes in general.

(Dr. Schenk is a staff scientist at the Lunar and Planetary Institute.)

HUBBLE TAKES A CLOSER LOOK AT SHOEMAKER-LEVY

NASA's Hubble Space Telescope has provided the most detailed look yet at the comet hurtling toward a July 1994 collision with the giant planet Jupiter.

Hubble's high resolution shows that the approximately 20 objects that comprise Comet P/Shoemaker-Levy 9 are much smaller than originally estimated from observations with groundbased telescopes. According to Dr. Harold Weaver of the Space Telescope Science Institute, the Hubble observations show that the cometary nuclei are probably no bigger than three miles across, instead of earlier estimates of nine miles.

The new Hubble data show that the impacts will unleash only 1/10th to 1/100th as much energy as thought previously. However, even with these new size estimates, the total energy of the collisions will be equivalent to 100 million megatons of TNT—10,000 times the total destructive power of the world's nuclear arsenal. The impacts will be as energetic as the collision of a large asteroid or comet with Earth 65 million years ago. This latter cosmic catastrophe is suspected to have caused the extinction of the dinosaurs and hundreds of other species at the K/T boundary.

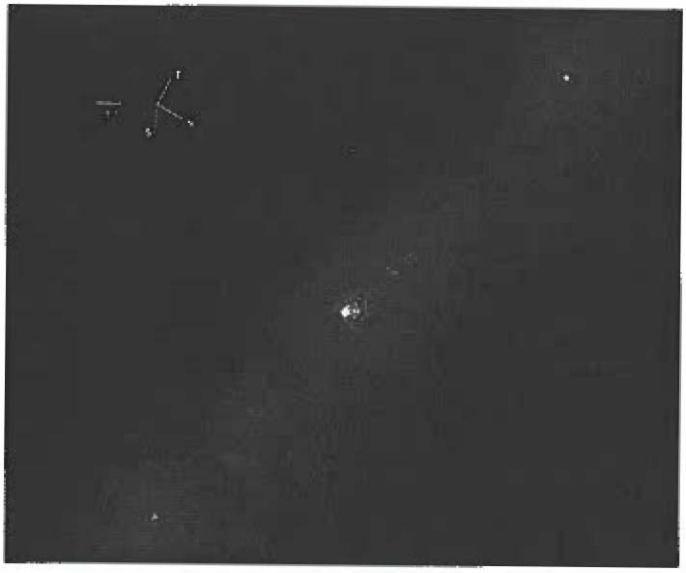
Since the comet's discovery last March, there have been widely varying estimates of how energetic the collisions with Jupiter will be. The force of the collision depends not only on the speed of the impacting bodies, but their size as well.

Measuring the sizes of the nuclei is very difficult because each nucleus is surrounded by a haze of dust or coma. "Most of the light being observed is due to scattering by dust in the coma," Weaver says. Relative to groundbased images, the Hubble image provides improved contrast between the nuclei and their comae, allowing a better estimate of the sizes. However, "even the current Hubble image does not allow a clear separation of nucleus and coma, so its size estimates are still probably only upper limits to the true nuclear sizes," according to Weaver.

The definitive answer might be available soon. During the December Hubble Servicing Mission a new camera called WFPC-2 (Wide Field and Planetary Camera 2), with corrective optics to compensate for aberration in Hubble's primary mirror, will be installed on the telescope. "The Hubble repair should provide images with much better contrast than the current images, and if the nuclei are close to the sizes we now think they are, then they should really pop out in the new Hubble images," Weaver says.

Hubble's sharp resolution shows that one bright knot in the comet stream is really four fragments close together. Two of the pieces have an apparent separation of only 700 miles. The Hubble image also shows that most of the visible nuclei have comparable sizes. Weaver says that the close match in size among the chunks suggests they might be the primordial "building blocks" of comets. According to calculations, the parent comet broke apart when it passed close to Jupiter in July 1992. "Jupiter's gravity might have disassembled the comet back into the primordial objects, called planetesimals, that were present when our Sun formed 4.5 billion years ago," Weaver says. "However, since the current Hubble observations cannot detect nuclei much smaller than about 2 km, the size distribution of the planetesimals is still indeterminate. Once Hubble's optics are fixed, we should get a better handle on the range of sizes within the planetesimal population."

Though commonly referred to as a comet, some astronomers think P/Shoemaker-Levy 9 might be an asteroid. In this case, it would have come from the asteroid belt between the orbits of Jupiter and Mars, rather than from a hypothetical comet belt beyond Pluto's orbit. However, no one has ever seen an asteroid break apart so it is difficult to predict how asteroids should behave under these circumstances. Likewise, since there are few detailed studies of comets as far away as Jupiter (500,000,000 miles), it's hard to know how a comet should behave at that distance.



CREDIT: DR. H. A. WEAVER AND MR. T. E. SMITH, STSCI

This is an enlargement of a NASA Hubble Space Telescope image of the "brightest nucleus" that is actually a group of at least four separate pieces. The image was taken with the Wide Field and Planetary Camera (WFPC), in PC mode, on July 1, 1993.

CREDIT: DR. J. V. SCOTTI, UNIVERSITY OF ARIZONA

CREDIT: DR. H. A. WEAVER AND MR. T. E. SMITH, STSCI

[Left] An image of Comet P/Shoemaker-Levy 9 taken on March 30, 1993 with the Spacewatch Camera of the University of Arizona. Although not clearly visible in this image, the bright "streak" near the center contains many individual nuclei and their associated comae and tails. In addition, light scattered from fine dust particles can be seen extending for large distances beyond the region of the streak. [Center] An image taken by the Planetary Camera of the Hubble Space Telescope on July 1, 1993, that shows the streak region in much greater detail. The appearance of this broken-up comet is reminiscent of a "string of pearls." [Right] An enlargement of the HST image in the region of the brightest nucleus. By looking carefully, one can tell that the "brightest nucleus" near the center of the frame is actually a group of at least four separate pieces that are blurred together when observed at lower resolution.

At Jupiter's distance the comet's surface is so cold that the sublimation rate of water ice is very small. "On the other hand, the breakup of the comet may have released an unusually large number of icy grains, exposing such a large surface area to the sun that the sublimation might become detectable," Weaver says. "Also, there are probably substances present that are more volatile than water ice."

Weaver's team took spectra near the brightest fragment to search for molecules that might have been released from subliming ice. This would provide strong evidence that P/Shoemaker-Levy 9 is a comet, not an asteroid. Spectroscopic observations made with Hubble Faint Object Spectrograph failed to find hydroxyl molecules that would be a clear indicator of cometary origin.

Another way to address this mystery is by watching the evolution of the surrounding coma. A cometary origin would be likely if the coma is continually replenished by gas streaming off the fragments, since comets are more icy than asteroids. However, if the coma simply spreads out, eventually completely disappearing, the coma might just be dust from a broken-up asteroid. The current Hubble image shows that the coma is apparently not continually being replenished, but more observations are needed to monitor the coma development further.

The "collision with Jupiter" is expected to occur over a six-day period around July 21, 1994. The effect of the impact will depend not only on the size and velocity of the cometary nuclei, but also their composition and structure. Comets are very porous, and thus might break up high in the atmosphere. For example, on June 30, 1908, a 160-foot (50-meter)-wide cometary nucleus or stony meteor is suspected to have disintegrated in Earth's atmosphere at an altitude of 5 miles (8 km).

The resulting explosion leveled hundreds of thousands of acres of forest in Siberia's Tunguska River Valley.

The Jupiter impacts could produce spectacular phenomena in the giant planet's multicolor cloud tops. The plummeting comet nuclei would turn into gigantic versions of meteors or "shooting stars." Each 100-mile-wide, blue-white fireball would blow a hole in Jupiter's atmosphere the size of Texas. Although the impacts are predicted to occur on Jupiter's farside (not observable from Earth), it's likely that the effects on the atmosphere will still be visible as the impact zone rotates into the Earth's view. (Jupiter's rotation rate is 9 hours, 50 minutes.)

The Hubble telescope is expected to be a key player during next year's encounter, although there are no definite observing plans yet. Due to its low level of scattered light and high angular resolution, the Hubble should be able to observe the comet even when the glare of Jupiter prevents further groundbased observations. After the impact, the Hubble images should show details in Jupiter's atmosphere that are unattainable by any other means.

The comet was discovered last March by Dr. Carolyn Shoemaker of Northern Arizona University, Dr. Eugene Shoemaker of the U.S. Geological Survey, and veteran amateur comet observer David Levy. The HST observing team consists of the discoverers, Weaver, and 15 others from a variety of institutions. ⌀

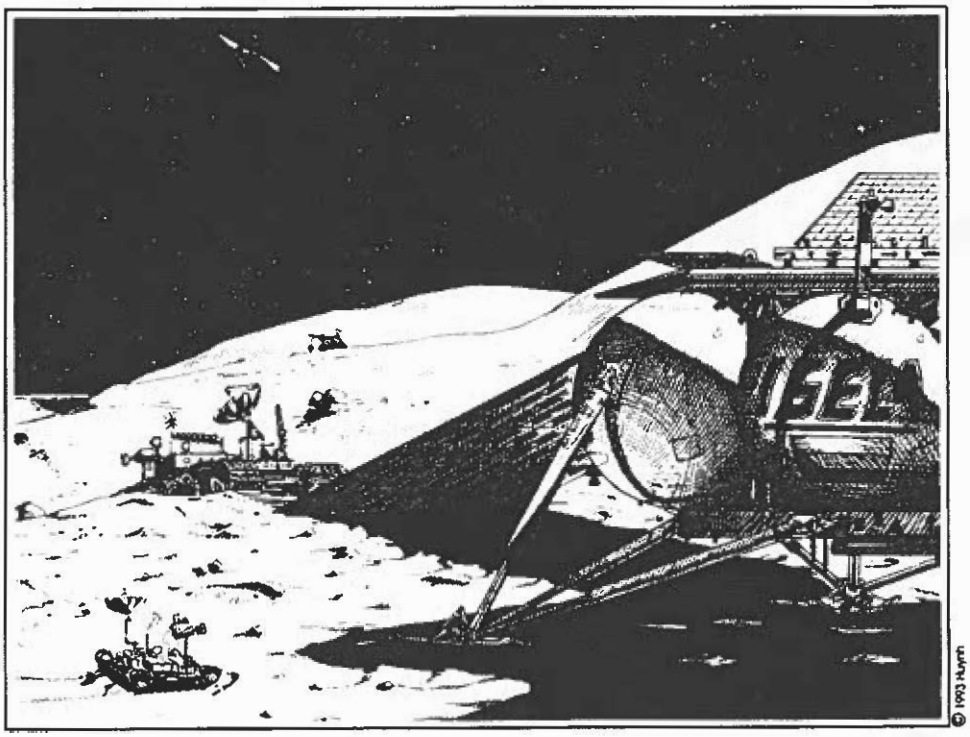
NEW VENTURE PLANS LUNAR LANDINGS BEFORE 2000

International Space Enterprises (ISE), a commercial space corporation in San Diego, California, and a Russian space firm, Lavochkin Association (LA), have formed a joint venture company, ISELA, to market regularly scheduled robotic missions to the Moon beginning in 1996.

ISELA has planned a series of eight missions to lunar orbit and the lunar surface through the year 2000. The first mission, scheduled for July 1996, will deliver various scientific instruments and a communication satellite to lunar orbit to aid in transmitting data and communications from future missions. Seven landing missions will be conducted at a rate of about two per year and will carry government and commercial payloads including telescopes, rovers, stereovision cameras, and geological sample collection and analysis instrumentation.

Preparations for these missions have been underway for nearly a year and a half. ISE has recently completed the first phase of a research program to develop data and capabilities in support of lunar and planetary missions. The next phase of the contract will be to develop more detailed designs of lunar/planetary landing systems and specific mission plans.

The first of the lunar landing vehicles, ISELA-600, is based on the Mars '94 spacecraft and will be capable of delivering 1.5 metric tons to lunar orbit and 600 kg to the lunar surface. The second, ISELA-1500, will be capable of delivering 3 metric tons to lunar orbit and 1500 kg to the lunar surface. The use of flight-proven hardware in both models will allow operation five to seven years earlier than any competing system, according to the company. Both landers will utilize a newly designed payload support structure, the Universal Payload Adapter (UPA), which will provide electric, thermal, and data relay services for up to 15 individual payloads. The partners hope that the volume, capability, and flexibility of the ISELA system will reduce the cost of lunar exploration, bringing it well within reach of universities, scientists, and commercial companies.



Commercial U.S.-Russian venture hopes to begin robotic lunar missions in 1996.

"Our unique combination of reliable and cost-effective international space transportation systems will enable us to generate the economies of scale necessary to make space exploration truly affordable," said Mr. Simon.

"There has been significant interest from university, government and commercial users alike," said Mr. David Mazaika, ISE's Vice President for Business Development. ISE is presently negotiating with 22 U.S. corporations representing traditional markets such as telecommunications, geology, mapping, and astronomy and nontraditional participants such as automobile, consumer electronics, and entertainment firms. In addition, ISE has been having discussions with scientists around the world who, after two decades of being unable to purchase transportation to the Moon to conduct their experiments, are eagerly awaiting such capabilities.

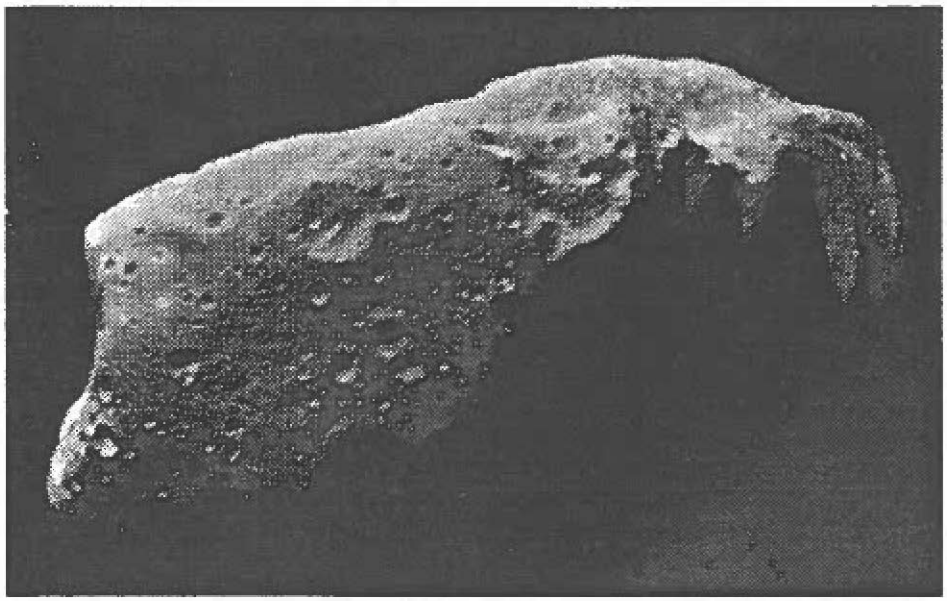
Lavochkin designed and built the Luna series of Moon probes that included six orbiters and eight successful landers from 1966–1976. Three landers returned soil samples and two carried Lunokhod rovers that traveled tens of kilometers across the lunar surface. The company also designed and built the Venera probes that provided orbital mapping and surface data from Venus.

Two spacecraft of a third-generation Lavochkin design were launched toward Phobos in 1989. Communication problems eventually shut down both craft. An upgraded version of this design is being used for the Mars '94 and Mars '96 missions.

Further information on ISELA can be obtained from International Space Enterprises, 4909 Murphy Canyon Road, Suite 330, San Diego, CA 92123.

NEWS FROM SPACE

GALILEO ENCOUNTER WITH IDA



This view of asteroid 243 Ida is a mosaic of five image frames acquired at ranges of 3057 to 3821 km on August 28. About 52 km long, Ida is classified as an S-type asteroid, similar to stony or stony-iron meteorites. The extensive cratering that is visible would seem to preclude a geologically young surface.

NASA's Galileo spacecraft detected changes in the interplanetary magnetic field as it passed the asteroid Ida on August 28. Dr. Margaret Kivelson, principal investigator of the Galileo magnetometer and a physicist at UCLA, reported that the instrument measured several field rotations, as it had two years ago while flying by the asteroid Gaspra. Magnetic field rotations, in which the direction of the magnetic field swings or shifts, are commonly observed in interplanetary space.

"The team believes these observed rotations were produced by the interaction of the solar wind with Ida," Kivelson said. However, several sorts of interactions could cause the field to rotate, and thus the observations do not necessarily show that the asteroid has a magnetic field. Before Galileo's Gaspra encounter in October 1991, small asteroids were not generally expected to have their own magnetic fields, though some meteorites have measurable fields. Analysis of data from Galileo's Ida flyby has not progressed far enough for Kivelson's team to speculate on whether this asteroid is also magnetized, she said.

Galileo is now on its way to Jupiter, where in 1995 it will direct its instrumented probe into the atmosphere and then go into orbit to conduct a two-year survey of Jupiter, its satellites, and its magnetosphere.

SHUTTLE RAT EXPERIMENT YIELDS UNEXPECTED RESULTS

Unexpected results from a recent space shuttle experiment on rats may some day lead to the discovery of the genes that direct bone cells to produce more bone. Last April's third Physiological and Anatomical Rodent Experiment (PARE-3) studied changes in the activity of bone-forming cells after nine days of space flight. It also investigated whether these changes were reversed within three days of return to Earth.

"We were totally surprised by some of the data from this flight experiment," said Dr. Emily Morey-Holton of NASA Ames Research Center. Although she cautioned that much research remains to be done, Morey-Holton said the findings may accelerate the development of drugs to stimulate the production of new bone. Such medications could be important not only for astronauts on long-duration space missions but also for people on Earth suffering from bone-weakening disorders.

At the end of the mission Morey-Holton and co-investigators Drs. Kim Westerlind and Russell Turner of the Mayo Clinic found a decrease in the production of certain chemical messages necessary for bone formation. This was followed within 24 hours by a dramatic increase in production of these chemicals. Levels again decreased within 72 hours after landing. The 40% decrease in chemical messages was seen in cells on the

outer surface of the lower leg bones (cortical bone). These messages direct bone-forming cells to produce proteins that are part of the process that forms new bone. The investigators had expected this decrease since space flight is known to slow the rate of bone growth.

"The big surprise was an unexpected 300% increase in these proteins within 24 hours after return to Earth," Morey-Holton said. "The response to reloading must have occurred almost immediately," she said. (Walking or movement against the force of gravity is known as a load.) Morey-Holton said reexposure to Earth's gravity may have caused the cells to overcompensate for the slowed bone growth during space flight.

"This suggests that the best time to learn about the initial steps in bone formation may be within 24 hours after space flight," Morey-Holton said. "The increase is probably large enough to allow scientists to establish a time course of events during the 24-hour period," she said. "It may be possible to tease out the genes involved in initiating cortical bone formation. If you know what the actual trigger is, you should be able to use that particular message to actually stimulate bone formation." This, in turn, could lead to development of drug therapy.

FROZEN MOLECULAR HYDROGEN DISCOVERED IN STELLAR NURSERY

Scientists at NASA Ames Research Center and the Joint Astronomy Centre, Hilo, Hawaii, have discovered an unexpected type of molecule in the ices of a star-forming cloud. Scott Sandford, Louis Allamandola, and Thomas Geballe have detected large amounts of molecular hydrogen frozen into the ice grains in a dense molecular cloud in Rho Ophiuchus. Rho Ophiuchus is a region in the Milky Way galaxy where new stars are being formed.

"Molecular hydrogen [a molecule composed of two hydrogen atoms] is the most abundant molecule in the universe," said Sandford, an Ames space scientist. "It is also the most volatile. Because of this, it has been widely thought that all molecular hydrogen should exist as a gas and that none of it should be frozen on the cold dust grains that make up interstellar clouds. Our recent discovery shows that this widely held assumption is not correct. The chemistry in these ices may be dramatically different than we thought."

"Since many people think that the ices in comets are made from interstellar ices, there may be implications for understanding comet models," said Ames researcher Allamandola. "This opens new areas of research that haven't been properly considered before."

"For example, the great volatility of molecular hydrogen in ices may help explain why some comets are active at great distances from the sun, distances at which water ices would be too cold to be active," Sandford said.

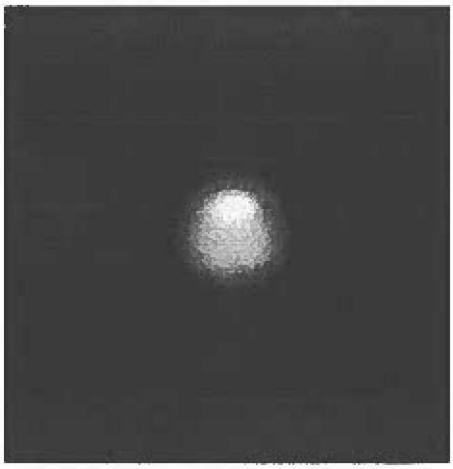
The observations of molecular hydrogen were made with the United Kingdom Infrared Telescope (UKIRT) on Mauna Kea, Hawaii. "Most people felt the search was a long shot, because the structure of molecular hydrogen makes it nearly invisible at infrared wavelengths," said Geballe, Associate Director of UKIRT in Hilo. Geballe, an astronomer at UKIRT, aided Sandford in the search.

The successful observations followed recent laboratory studies showing that molecular hydrogen might be present in the ices in dense molecular clouds, not in pure form, but trapped in the more abundant water ice. "We know that interstellar ices contain

several kinds of chemical compounds, including water, methanol and carbon monoxide," Sandford said. "The presence of these molecules in the ices is not surprising. They are in the clouds as gas, and the dust grains in the same clouds are cold enough that gas hitting them would freeze out, much like the way that frost forms on your windows on a cold night," he said.

"Laboratory studies show that under the nearly perfect vacuum of space, molecular hydrogen will only freeze out into an ice at temperatures just above the absolute lowest temperature possible in the universe," Allamandola said. "While dense molecular clouds often get very cold, they probably never attain the lower temperatures needed to freeze out pure molecular hydrogen ices." However, Sandford's and Allamandola's laboratory studies found that molecular hydrogen can be formed directly inside the ice grains made of water and methanol. The molecule is made in the ice through exposure to ultraviolet radiation.

"Once formed in the ice, the surrounding, less volatile water molecules trap it. Water molecules stick to each other tightly at these cold temperatures and form a strong network that holds the hydrogen molecule inside the ice. We now would like to see if we can detect molecular hydrogen-containing ices in other clouds. Our lab results suggest that the molecule should be common in many clouds," Sandford said.



This image showing Neptune's new appearance was obtained with the University of Hawaii 2.2-m telescope (Mauna Kea, Hawaii) on July 12, 1993 by MIT astronomer H. B. Hammel and graduate student R. P. LeBeau. The only clearly visible structure is a very bright region in the planet's northern hemisphere. For the past decade, the reflectivity at this wavelength has been dominated by bright features in the southern hemisphere. The image was taken through a near-infrared methane band filter. North is up and east is to the left.

A NEW LOOK FOR NEPTUNE

Recent images of Neptune show that the planet has taken on a whole new look. This past summer, Dr. Heidi B. Hammel (MIT) was studying Neptune with the University of Hawaii 2.2-m telescope on Mauna Kea. She found that for the first time since such imaging began, the planet's northern hemisphere looks significantly brighter than the southern hemisphere. In the past, some images had occasionally shown a feature or two at northern latitudes, and the Voyager spacecraft revealed some faint wispy structures there. However, those structures were always accompanied by bright features in the southern hemisphere.

The image at left was obtained on July 12, 1993 by Hammel and graduate student R. P. LeBeau. The only clearly visible structure is a very bright region in the planet's northern hemisphere. For the past decade, the reflectivity at this wavelength has been dominated by bright features in the southern hemisphere. The image was taken through a near-infrared methane band filter. "These new images are strikingly different than anything I've ever seen before," says Hammel, who has been studying Neptune for nearly a decade and took a series of simultaneous groundbased images during the 1989 Voyager encounter with the planet. "The implications for the atmospheric dynamics are intriguing." Hammel looks forward to imaging Neptune with the Hubble Space Telescope after its optics are refurbished later this year. "That will be the best opportunity to try and really figure out what Neptune is up to these days." One lesson is clear: Images taken during a spacecraft flyby provide only a brief snapshot of planetary atmospheres that can later change dramatically.

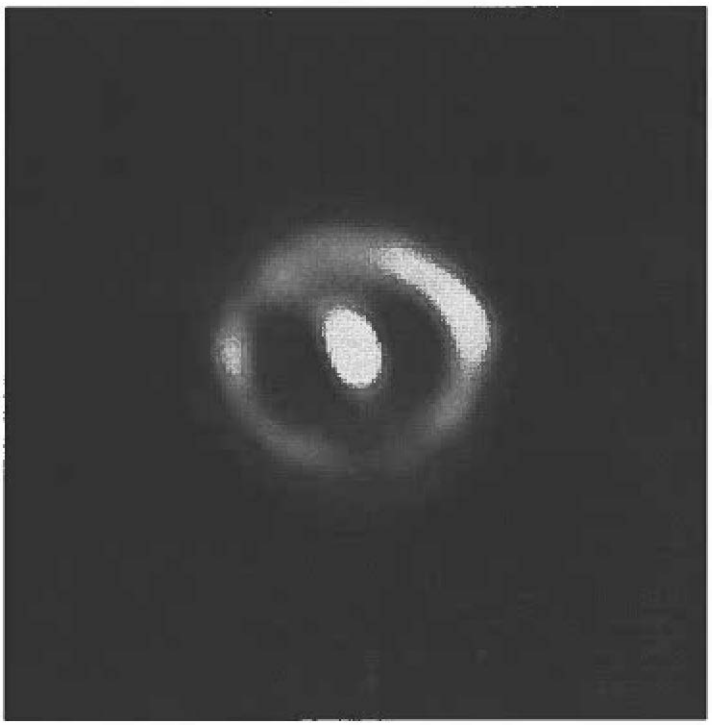
HUBBLE SEES GAS SHELL AROUND NOVA CYGNI 1992

NASA's Hubble Space Telescope (HST) has given astronomers their earliest look at a rapidly ballooning bubble of gas blasted off a star. The shell surrounds Nova Cygni 1992, which erupted February 19, 1992. A nova is a thermonuclear explosion that occurs on the surface of a white dwarf star in a double-star system. Nova Cygni 1992 was one of the brightest novae in 20 years, reaching naked-eye visibility for a brief period.

The HST observations provide a unique opportunity to understand the nova mechanism, according to Dr. Francesco Paresce of the European Space Agency and the Space Telescope Science Institute. "This is the first time we've been able to separate the white dwarf star from the ejecta so early in the nova event," he says. Hubble, because of its high resolution, has "arrived at the scene of the crime" much earlier than ground-based telescopes could have. (The shell will not be resolved from the ground for at least another five years.) The shell is so young that it still contains a record of the initial conditions of the explosion, which will allow astronomers to construct the history of the nova explosion. By the time the shell can be resolved with groundbased telescopes, it will have been deformed and chemically contaminated by passing through other material around the star.

The HST image, taken with the European Space Agency's Faint Object Camera, reveals a remarkably circular yet slightly lumpy ringlike structure. The ring is the edge of a bubble of hot gas. The shell is 74 billion miles across, or 10 times the diameter of the solar system. A beam of light could cross the shell in 4-1/2 days. By knowing the shell's diameter, as calculated from a comparison between its angular size and it expansion velocity (as measured from groundbased observations), astronomers can measure precisely the distance to Nova Cygni, which turns out to be 10,430 light years.

A striking relic of the explosion is an unusual barlike structure across the middle of the ring. Astronomers think it might mark the edge-on plane of the orbits of the two members of the binary system. A large amount of gas stirred up along the plane would make the shell denser in the plane of the orbit of the double star. An alternative possibility is that the bar is produced by twin jets of gas ejected from the star and spanning the distance between the shell and the star.



CREDIT: FRANCESCO PARESCE, ESA/STSCI AND NASA

GAS SHELL AROUND NOVA CYGNI 1992—The HST image was taken in ultraviolet light with the European Space Agency's Faint Object Camera on May 31, 1993, 467 days after the explosion. The FOC reveals a remarkably circular yet slightly lumpy ringlike structure. The ring is the edge of the bubble's shell of hot gas. A striking relic of the explosion is an unusual barlike structure across the middle of the ring. It might mark the edge-on plane of the orbits of the two members of the binary star system that triggered the nova.

A nova occurs in a double-star system where one member is a normal star and the other is a white dwarf, a compact corpse of the core of a Sun-like star that is about the size of Earth. The compact and gravitationally powerful white dwarf pulls material from its stellar companion. This material accumulates on the white dwarf's surface until pressures and temperatures increase to the stage where thermonuclear reactions take place.

The entire white dwarf's surface explodes as a gigantic hydrogen bomb. A nova releases as much energy as our Sun produces in 1000 years. As the expanding shell of hot gas envelopes both stars, they continue to orbit inside it. This should produce a thick disk of gas created through the "egg beater" motion of the two stars, according to astronomers. The bar in the Nova Cygni 1992 image may be the relic of the this event.

Shells around older novae, seen by groundbased telescopes, are deformed by passage through interstellar space, and are faint and tenuous. HST observations will be able to trace the expansion of the shell to a much earlier time in the history of the nova. Watching the evolution of the shell will also reveal how heavy elements, processed in the star's envelope, are ejected back into space. Such explosions enrich space with elements such as oxygen, carbon, and silicon that are the fundamental building blocks for new generations of planets and living things.

PUBLICATIONS FROM LPI

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NEW IN PRINT

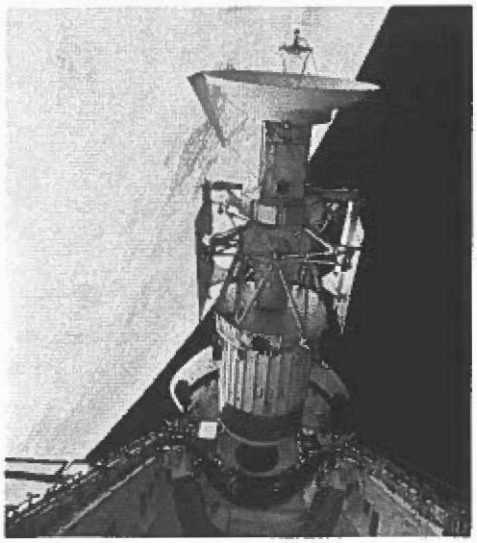
These publications are available from the publisher listed or may be ordered through local bookstores.

A REVIEW

THE EVENING STAR—Venus Observed

by Henry F. S. Cooper Jr.
Farrar Straus Giroux, New York, 1993, 274 pp.
Hardcover. $22.00

—by Robert Herrick



This book traces the history of the Magellan mission to Venus from its inception to the end of 1992 (when the book was sent to the publisher). The author is a space-science writer who has written several books and has contributed pieces to *The New Yorker* magazine.

A disadvantage of an outside observer writing the mission history is that there are bound to be some inaccurate descriptions of events and discussions that took place when the author was not present. Most notably, from my perspective as a participant, Mr. Cooper sometimes ascribes scientific ideas to the person who described them to him, rather than to the person who actually developed them. However, this disadvantage is minor compared to the much broader perspective the author achieves compared to what any single member of the Magellan project could provide.

The author includes a brief, yet comprehensive, history of pre-Magellan exploration and the resulting geologic theories. However, the majority of the book is a narrative of the Magellan mission beginning roughly at the time of Venus orbit insertion. The narrative interleaves spacecraft operation segments with segments describing the ongoing scientific analysis of the returned data. Mr. Cooper describes both the events and the personalities involved. Where appropriate, he also includes relevant topics such as the Deep Space Network and the funding battles for various aspects of the extended mission.

Through liberal use of analogy he manages to create engaging and thorough descriptions that are understandable for nonscientists and nonengineers (some of my favorite analogies are the descriptions of certain scientists as different rock types). Despite Cooper's descriptive powers, I felt the book could have benefited from a few illustrations (there are none except the pre- and post-Magellan maps printed on the endpapers). Those not familiar at all with the mission may wish to obtain *Magellan: Revealing the Face of Venus*, a well-illustrated brochure available from the U.S. Government Printing Office*.

In the interest of remaining an impartial observer, Mr. Cooper understates the depth of some of the conflicts among members of the scientific team, and he is a little too kind in his description of some truly awful scientific hypotheses about Venus that have been presented over time. This is probably just as well.

In summary, I found *The Evening Star—Venus Observed* to be a comprehensive and interesting description of the Magellan mission. Even those connected with the mission will probably learn something new from the book. It gives one a pretty good sense of how NASA conducts unmanned space exploration. I plan to give the book to all my friends and relatives who wonder what I do for a living.

Dr. Herrick is a postdoctoral fellow at the Lunar and Planetary Institute. He was a graduate student for Principal Investigator Roger J. Phillips on the Magellan mission.

*Magellan: Revealing the Face of Venus, *ISBN 0-16-042197-7 ($2.25), is available from the U.S. Government Printing Office, Superintendent of Documents, Mail Stop SSOP, Washington DC 20402-9328.*

NEW IN PRINT

ExInEd
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ELECTRONIC PICTURE BOOKS FOR READERS AND WRITERS

What do Henry Ford and the ExInEd program of the Special Studies Office (SSO) at the Space Telescope Science Institute have in common? Both are pioneers in developing new vehicles to run on the superhighways of the future. For Henry, it was Model Ts; for the SSO, it's a series of Electronic PictureBooks, which are learning aids being developed to share the highlights and challenges of space science research with todays's modern adventure seekers.

ExInEd's Electronic PictureBooks are part of a NASA-funded experiment to discover and develop new and better ways to assemble and distribute the results of astronomy and planetary science research, particularly images. Electronic PictureBooks run on Macintosh computers, and each contains a tutorial, text, color images, and many navigational features to assist the reader.

For Readers . . .

The growing list of Electronic PictureBook titles includes *Gems of Hubble,* which spotlights some of the most spectacular and informative images taken with the scientific instruments of the Hubble Space Telescope during its first year of operation; *Magellan Highlights of Venus*, a survey of the exciting first-year results of Magellan, the NASA spacecraft sent to map the surface of Venus with imaging radar; *Terrestrial Impact Craters*, a look at some of the most geologically interesting impact craters on Earth; *Endeavour Views the Earth*, a world tour by NASA astronaut Jay Apt using shuttle pictures of the Earth; *The World FactBook*, a sourcebook designed to accompany *Endeavour Views the Earth* or to be used as a stand-alone reference work; *Scientific Results from the Goddard High Resolution Spectrograph*, an overview of the recent findings from one of the Hubble Space Telescope's five science instruments; and *The Impact Catastrophe that Ended the Mesozoic Era*, a collection of paintings by artist William Hartmann depicting the catastrophic event that is believed to have contributed to the demise of the dinosaurs.

These Electronic PictureBooks and others are now available from SSO's electronic bulletin board at 410-516-4880, on the commercial network America On-Line, and via the Internet with either anonymous ftp or retrieval software such as Gopher or Fetch to host address **stsci.edu**. For detailed instructions on how to download an Electronic PictureBook, please either write to us directly at Special Studies Office, Space Telescope Science Institute, 3700 San Martin Drive, Baltimore MD 21218 or, if you have a fax machine, you can dial ExInEd's "FaxForum," an automated on-demand fax delivery system at 410-516-4541. When calling the FaxForum, choose location number 3121 from the voice menu and then document number 301, and then simply follow the voice prompts to order the document delivered to your fax machine.

. . . And Writers

ExInEd is also accepting proposals for new Electronic PictureBooks from interested authors. Electronic PictureBooks are created from preexisting text and graphics, usually in the form of slide sets, articles, or lecture material. If you are interested in having an Electronic PictureBook produced from your material, please contact us for authoring instructions, either by calling ExInEd's FaxForum and choosing location number 3121 and then document number 302, or by writing to the Special Studies Office of the Space Telescope Science Institute at the address above. Happy motoring!

—by Bob Brown, STScI (Courtesy SPACE TELESCOPE SCIENCE INSTITUTE NEWSLETTER, *Vol. 10, No. 2.)*

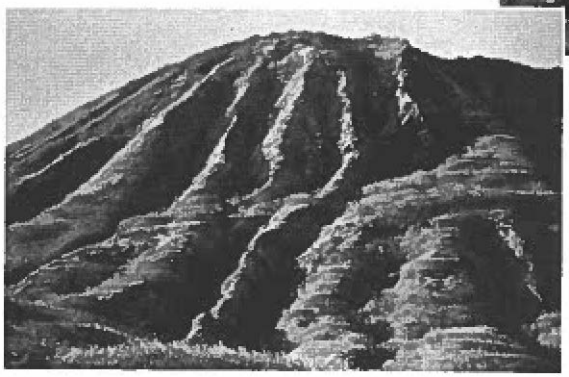
FROM TEXAS SPACE GRANT CONSORTIUM

To Rise From Earth—An Easy to Understand Guide to Space Flight, by Wayne Lee, is available from the Texas Space Grant Consortium, Austin, Texas. Unusually well designed and heavily illustrated with black-and-white photographs and drawings, the book is a clear and concise treatment of many facets of space flight and space exploration. The chapter subtitles suggest the range of material presented: An Introduction to Orbits and Rockets; Orbital Mechanics Without Math; How to Perform Space Maneuvers; The Story of the Race to the Moon; How the Space Shuttle Works and What it Does; The Role of Satellites in the Age of Information; How to Reach Other Planets; and A Look at a Future Piloted Mars Mission. Suitable for high school students, college undergraduates, and adults, the book delves into these topics without recourse to mathematical equations but uses dozens of attractive and well-thought-out diagrams to illustrate concepts. Paperbound, 8½ × 11", 280 pp., $10.00 from TSGC, 1-800-248-8742, between 8:30 a.m. and 4:30 p.m. CST.

NEW SLIDE SET FROM LPI

VOLCANIC FEATURES OF HAWAII AND OTHER WORLDS

This set of 20 slides compiled by Peter Mouginis-Mark includes a booklet of captions with glossary and suggested reading list. Because of their frequent occurrence and relatively nonexplosive character, Hawaiian eruptions are some of the most extensively studied in the world. Observing the emplacement of lava flows or the dispersal of ash from a fire fountain provides detailed information on the way that volcanos work. Because of their similar composition and shape, the two most active Hawaiian volcanos (Mauna Loa and Kilauea) are also studied by geologists who look at the other planets. Indeed, if you can't actually be working on the Moon, Mars, Venus, or the jovian moon Io, Hawaii is the next best place to be!



This slide set is intended to show that although Hawaiian volcanos are small when compared to those found on the other planets, we can learn a considerable amount about how the extraterrestrial features were formed. Comparison of the size of lava flow fields and the dimensions of channels on volcanos can suggest how features seen in Viking Orbiter, Apollo, Voyager, and Magellan images were formed.

The views of Hawaiian volcanos and volcanic features provided in the set show the diversity of volcanic landscapes in Hawaii as they relate to volcanos on the planets. The set is not a comprehensive view of the geology of Hawaii, nor are all the volcanos found in Hawaii presented. Rather, examples of lava flow structures, cones, types of eruptions, and their deposits are compared to features that may have a similar origin on the planets. Whenever possible, the scale of the planetary example is shown by means of an insert of one or more of the Hawaiian Islands—demonstrating the amazing size of features on Mars, Venus, and Io.

continued on page 18

The 25th Annual Lunar and Planetary Science Conference will be held March 14–18 in Houston. As usual, sessions will be held at the NASA Johnson Space Center and the Lunar and Planetary Institute.

ABSTRACTS

The LPSC program committee requests that researchers submit written abstracts by January 7, 1994. General Information for Preparing and Submitting 25th LPSC Abstracts is available from LPI's Publications and Program Services Department. Abstracts received after January 7 will not be considered by the program committee nor included in the abstract volume. Abstracts submitted by fax or e-mail will not be accepted.

Abstracts should be short (2-page) papers that can be cited in the literature. The first paragraph of each abstract will be scanned for electronic dissemination prior to the conference, thus it should convey an overview of the essentials of the entire abstract.

ORAL PRESENTATIONS

Oral presentations will be scheduled during the four and a half days of parallel sessions Monday through Friday noon. Talks will be eight minutes with seven minutes for discussion.

POSTER PRESENTATIONS

Poster sessions will be Tuesday and Thursday evenings from 6:30–9:30 at LPI. Authors of poster presentations will be asked to discuss their results in the poster area during the session. Shuttle transportation between the Gilruth Center and LPI will be available. Each poster will have a space 44" × 44" for display. Requests for tables, computers or video equipment, etc., cannot be honored due to the limited space available for poster displays.

SPECIAL SESSIONS

THE PLANET MERCURY

A special session on the planet Mercury is being organized to highlight both recent scientific results of research and studies for the Discovery mission. Those who submit abstracts for this session should mark "other" and write in "Mercury" on the abstract information form.

SPECIAL POSTER/DISPLAY SESSIONS ON EDUCATION

Two special poster/display sessions on education will be held at LPI on the Tuesday and Thursday evenings during the regular technical poster sessions, *instead of* an oral session at Gilruth. The education special sessions will be mounted in and around the LPI library; participants will be provided with tables, electrical outlets, and equipment (for those who need them) as well as poster space to display and demonstrate the programs and products they have developed. This format will provide much more interactivity, which participants felt was lacking at the oral session. It will allow participants to do some of the "hands-on" projects rather than describe them orally. Computer software, videos, hand-outs, etc., can be included as part of the presentations.

Participants will be selected on the basis of the traditional informative abstracts by the program committee. Those who submit abstracts for this session should mark "other" and write in "Education" on the abstract information form.

SPECIAL EVENTS

25th ANNIVERSARY CELEBRATION AT SPACE CENTER HOUSTON

A reception will be held at the new Space Center Houston to celebrate the twenty-fifth year of the LPSC. All exhibits and displays as well as the IMAX theater will be open at no charge to badged conference participants on Monday evening, March 14, from 8:00 to 10:00. A dessert and coffee buffet will be served at 9:00 p.m.

CHILI COOKOFF AND BARBECUE DINNER

What would a celebration year of LPSC be without this traditional event? The cookoff and barbecue will be held on Wednesday from 6:30–9:30 p.m. at the Landolt Pavilion. Because the conference staff can no longer provide cooking equipment, the "preparation on site" rule common to most cookoffs will be waived to encourage more teams from out of town to enter. The goal of this event is fun, not serious cooking competition.

ONLINE PROGRAM

The program and first paragraph of abstracts for the 25th LPSC will be put on line around February 4, 1994. You can connect using the NASA Science Internet (NSI) or can dial direct.

On NSI/Internet, type
TELNET LPI.JSC.NASA.GOV or
TELNET 192.101.147.11
On NSI/DECNET, type
SETHOST LPI
To dial direct (9600/2400/1200 baud), call
713-244-2090 or 713-244-2091

For all three methods of access, respond to USERNAME: LPI. No password is necessary. Choose "Meeting Information and Abstracts," and follow the menus. You can review general information about the 25th LPSC and search, display, or download the program with or without abstracts.

If you have trouble accessing the LPI computer, or need help with the online system, contact Eleta Malewitz (phone: 713-486-2197; e-mail: malewitz@lpi.jsc.nasa.gov) or Sarah Enticknap (phone: 713-486-2164; e-mail: enticknap@lpi.jsc.nasa.gov).

REGISTRATION

PREREGISTRATION

A fee of $50 ($30 for students) will be assessed each participant to cover various conference services. You must preregister and prepay by **February 28, 1994**, to avoid the $10 late fee. Foreign participants who state on the registration form that they have a currency exchange problem may pay in cash at the meeting and avoid the $10 late fee if they return the form by February 28. Requests for cancellation and a refunded fee will be accepted through March 11.

SUNDAY NIGHT REGISTRATION

The Sunday night reception and registration will take place at the LPI at 3600 Bay Area Boulevard from 6:00–9:30 p.m. Shuttle buses will operate from selected hotels to LPI on Sunday night; they will also make hourly stops there during the week. Computer displays, exhibits, poster sessions, and other conference-related events will be located at LPI throughout the week.

TRAVEL/LODGING

A travel discount is being offered by Continental Airlines. To take advantage of this discount, please use the toll-free number for Continental (800-468-7022) and reference the "easy access number" ZC75. As always, it is wise to check other airlines' prices to be certain of getting the lowest available rate.

Although making reservations is the responsibility of each person, we have negotiated reduced rates at some locations. When you call a hotel, be sure to tell them that you are with the Lunar and Planetary Science Conference and ask for the conference rate.

Conference shuttle buses will provide service between selected hotels (Nassau Bay Hilton, Days Inn, Holiday Inn, Ramada Kings Inn, Quality Inn, Motel 6, and Best Western NASA Inn), the JSC Gilruth Center, and LPI. There will be runs in the morning, during lunch, at the close of sessions, and to and from these hotels during special events. Your conference badge serves as your bus ticket.

FOR MORE INFORMATION

Please contact the LPI Publications and Program Services Department for further information about conference logistics (713-486-2166) or abstracts (713-486-2161).

NEW IN PRINT

continued from page 15

The set is subdivided into five general topics. These topics may form the focus of individual high school classes, or they may be useful as segments in an undergraduate class. A brief discussion of the relevance of each topic to planetary volcanology is included prior to each group of slide captions. $20.00 from Order Department, Lunar and Planetary Institute (see Order Form in this Bulletin).

NEW FROM LGI

The Lunar Geotechnical Institute announces that the report "Mechanical Properties of Lunar Soils and Implications for a Lunar Base," TR93-02 is available without charge. Request from LGI, P.O. Box 5056, Lakeland FL 33807-5056. Phone: 813-646-1842; Fax: 813-644-5920.

NEW CATALOGS FOR EDUCATORS

FROM MMI CORPORATION

MMI Corporation announces the release of their new Astronomy Materials catalogs for 1994-95. The general catalog, *Astronomy, Space Science and Planitarium Guide,* (100 pp.) includes 35mm slides, videos, optical discs, CD-ROM, computer software, portable and permanent planetariums, globes, models, lab manuals, telescopes, laserdisc players and overhead projectors. Among a wide variety of new products are: Einstein 2.0 planetarium lab for grades K–8, recently released software for physics, new videos for chaos, virtual reality and artificial intelligence, The Mechanical Universe Annenberg/CPB Project modules and more.

A new K-12 level *Astronomy Materials* catalog is available as well as a *Geology and Earth Science Materials* catalog. Catalogs are free to educators. For others: $3.00 domestic postage or $5.00 overseas mailing. MMI Corporation, P.O. Box 19907, Baltimore MD 21211. Phone: 410-366-1222; Fax: 410-366-6311.

FROM A.S.P.

The nonprofit Astronomical Society of the Pacific has just published a new catalog of materials for teaching and enjoying astronomy. The illustrated, color catalog includes video and audio tapes, books, computer software and CD-ROMs, slides and videodiscs, sky observing aids, posters, and charts.

New items include extensive files of astronomical images on CD-ROM; a videotape on the Harvard-Smithsonian project to map the galaxies in the universe; a reasonably priced teacher's solar system slide set; an updated version of the braille astronomy book *Touch the Stars,* a videotape on the latest results from the Hubble Telescope; an astronomy and space exploration desktop calendar full of unique images; a collection of astronomical book titles for children; and assorted gift items for all with an interest in astronomy. Available free by sending name and address with three first class stamps to Catalog Requests Department, A.S.P. 390 Ashton Avenue, San Francisco CA 94112. Phone: 415-337-1100.

MEETINGS

SPACE 94 AND ROBOTICS CONFERENCES

Space 94: Engineering, Construction, and Operations in Space and the co-located conference Robotics for Challenging Environments will be held at the Albuquerque Convention Center in Albuquerque, New Mexico, February 26–March 3, 1994. The theme is "space resources in the service of humankind." The Robotics Conference will feature not only space applications but also underwater, nuclear industry, and environmental uses of technology. Sessions will focus on structures, materials, dynamics, and controls, and Mission to Planet Earth will be discussed.

On February 27, there will be a tutorial on Mining and Processing of Extraterrestrial Resources. A Workshop for Users of Lunar Materials will be held on February 28. University students are invited to participate in a lunar shelter contest using robotics. There will also be presentations by elementary, middle schools and high school students and sessions for Young Astronauts.

Contact the Space 94/Robotics Action Center at 1-800-SPACE94 or Stewart Johnson at 505-848-4013 for more information.

WORKSHOP ON FORMATION OF THE EARTH'S CORE

A European Association of Geochemistry workshop of the chemical and mineralogical constraints of core formation in the Earth is being jointly organized by the Max-Planck-Institut für Chemie in Mainz (Herbert Palme) and the Bayerisches Geoinstitutät in Bayreuth (Hugh O'Neill). Topics will include siderophile-element abundances in the mantle, partitioning of elements between core and mantle, constraints from high-pressure mineral physics, and significance of the isotopic composition of Os and Pb for core formation. Suggestions for additional topics are invited. The workshop will be held at the Max-Planck-Institut für Chemie in Mainz on April 18–19, 1994. For more information, contact Herbert Palme, Max-Planck-Institut für Chemie, Postfach 3060, 55020 Mainz, Germany. Phone: 49-6131-305-346; Fax: 49-6131-371-290; Internet: palme@mpch-mainz.mpg.dbp.de.

EXOBIOLOGICAL STRATEGY FOR THE EXPLORATION OF MARS

A meeting to develop a strategy for obtaining important exobiological information during exploration of Mars is planned for April 27–28, 1994, at NASA Ames Research Center, Moffett Field, California. Participants will include members of the exobiology and broader-based planetary science communities with significant international representation. The meeting will be followed by a smaller workshop, probably in September 1994, at which time a team of about a dozen will write a report that defines the scientific strategy for exobiological exploration of Mars.

To focus discussion at the April meeting, a paper by Harold P. Klein and Donald DeVincenzi will be distributed to participants before the meeting to serve as a strawman strategy. Participants will be asked to make their contributions as modifications, elaborations, amplifications, or implementation of that document.
Oral presentations will be by invitation only, but participants are urged to contribute poster presentations and to participate in numerous discussion sessions. Posters will be selected on the basis of one-page abstracts submitted to John F. Kerridge by February 1, 1994. Because of the focused nature of the meeting and limited capacity at

the site, the organizing committee will accept only those abstracts that address the objectives of the meeting.

Further information is available from Michael E. Meyer, 202-358-0292, or the meeting co-organizers, Donald DeVincenzi, 415-604-5251, and John Kerridge, 202-358-0292 or 619-534-0921. Abstracts may be submitted to John Kerridge, Code SLC, NASA Headquarters, Washington DC 20546.

PUBLIC LECTURES AT THE K/T EVENT CONFERENCE

The Conference on New Developments Regarding the K/T Event and Other Catastrophes in Earth History will be held in Houston, February 9–12, 1994. Two distinguished speakers will present lectures open to the public on February 12, the final evening of the meeting. Dr. Jack Horner of the Museum of the Rockies will discuss dinosaurian ecology and reproduction, and Dr. Dale Russell of the Canadian Museum of Nature will examine the evolutionary significance of dinosaurs. The lectures will be held at the University of Houston-Clear Lake.

CONFERENCE ON PHYSICS OF THE MOON AND PLANETS

The Astronomical Observatory of Kharkov University, Main Astronomical Observatory of the Ukrainian Academy of Sciences, and the Ukrainian Astronomical Association are organizing a conference on Physics of the Moon and Planets dedicated to the 100th anniversary of the birth of academician Nikolaj Barabashov, planetologist and founder of the Kharkov Planetology School. The conference will be held June 6–10 in Kharkov, Ukraine. Topics of interest will include solid surfaces of celestial bodies; atmospheres of planets and satellites; origin, evolution, and dynamics of solar system bodies; and future strategies and techniques for planetary investigations. Abstracts and proceedings of the meeting will be published. For more information, contact Irina Belskaya, Astronomical Observatory, Sumskaya Str. 35, 310022 Kharkov, Ukraine. Phone: 0572-43-24-28; Internet: irina@astron.kharkov.ua.

CALENDAR 1993

NOVEMBER

8-12

Third LDEF Post-Retrieval Symposium, Williamsburg, Virginia. Contact: Arlene Levine, Mail Stop 404, LDEF Science Office, NASA Langley Research Center, Hampton VA 23681-0001. Phone: 804-864-3318; fax: 804-864-8094.
Internet: a.s.levine@larc.nasa.gov

15-17

Mars: Past, Present, and Future Results from the MSATT Program, Houston, Texas. Contact: Publications and Program Services Department, LPI, 3600 Bay Area Boulevard, Houston TX 77058-1113. Phone: 713-486-2166; fax: 713-486-2160.

15-17

Planetary Data Visualization Workshop, San Juan Capistrano, California. Contact: Doug Nash (program) or Elaine Noel (logistics), San Juan Institute, 31872 Camino Capistrano, San Juan Capistrano CA 92675. Phone: 714-240-2010; fax: 714-240-0482.

18-20

NASA Workshop on Isotopic Anomalies: "Interstellar Grains in the Laboratory," St. Louis, Missouri. Contact: Ernst Zinner, McDonnell Center for the Space Sciences, Campus Box 1105, Washington University, One Brookings Drive, St. Louis MO 63130. Phone: 314-935-6240; fax: 314-935-4083.
Internet: ekz@arthur.wustl.edu

29-Dec 3

75 Years of Hirayama Collisional Families, Tokyo, Japan. Contact: Prof. S. Isobe.
Internet: oisobe@cl.mtk.nao.ac.jp

DECEMBER

6-10

American Geophysical Union, Fall Meeting, San Francisco, California. Contact: AGU Meetings Department, 2000 Florida Avenue NW, Washington DC 20009. Phone: 202-462-6900; fax: 202-328-0566.
Internet: sbell@kosmos.agu.org

JANUARY 1994

9-13

11th Symposium on Space Nuclear Power and Propulsion: "Enabling the 21st Century," Albuquerque, New Mexico. Contact: The Institute for Space Nuclear Power Studies, University of New Mexico, Albuquerque NM 87131-1341. Phone: Mohamed El-Genk, (Technical Chair) 505-277-5442; Mary Bragg, (Administrative Chair) 505-277-4950.

FEBRUARY

1-3

Icy Galilean Satellites: An International Conference, San Juan Capistrano, California. Contact: Doug Nash (program) or Elaine Noel (logistics), San Juan Institute, 31872 Camino Capistrano, San Juan Capistrano CA 92675. Phone: 714-240-2010; fax: 714-240-0482.

9-12

New Developments Regarding the K/T Event and Other Catastrophes in Earth History, Houston, Texas. Contact: Publications and Program Services Department, LPI, 3600 Bay Area Boulevard, Houston TX 77058-1113. Phone: 713-486-2149; fax: 713-486-2160.
Internet: holley@lpi.jsc.nasa.gov

18-23

American Association for the Advancement of Science, annual meeting, San Francisco, California. Contact: AAAS, 1333 H Street NW, Washington DC 20005. Phone: 202-326-6400.

26-Mar 3

Space 94: 4th International Conference and Exposition on Engineering, Construction, and Operations in Space and Conference and Exposition/Demonstration on Robotics for Challenging Environments, Albuquerque, New Mexico. Contact: Stewart W. Johnson, Space 94 General Chair, BDM International, Inc., 1801 Randolph Road SE, Albuquerque NM 87106. Phone: 505-848-4013; fax: 505-848-5528. *Or:* Action Center, Space 94; Phone: 1-800-SPACE94; fax: 505-272-7355.

MARCH

13-18

Physics of the Magnetopause, San Diego, California. Contact: AGU Meetings Department, 2000 Florida Avenue NW, Washington DC 20009. Phone: 202-462-6900 or (toll free in North America) 1-800-966-2481; fax: 202-328-0566.
Internet: sbell@kosmos.agu.org

13-18

SPIE Symposium on Astronomical Telescopes & Instrumentation for the 21st Century, Kona, Hawaii. Contact: SPIE—The International Society for Optical Engineering, P.O. Box 10, Bellingham WA 98227-0010. Phone: 206-676-3290; fax: 206-647-1445.
Internet: spie@mom.spie.org
CompuServe: 71630,2177

14-18

25th Lunar and Planetary Science Conference, Houston, Texas. Contact: Publications and Program Services Department, LPI, 3600 Bay Area Boulevard, Houston TX 77058-1113. Phone: 713-486-2166; fax: 713-486-2160.
Internet: simmons@lpi.jsc.nasa.gov

APRIL

9-10

Physics of Accretion Disks Around Compact Objects and Young Stars, Houston, Texas. Contact: Publications and Program Services Department, LPI, 3600 Bay Area Boulevard, Houston TX 77058-1113. Phone: 713-486-2166; fax: 713-486-2160.

12-15

IAA/AAS International Conference on Low-Cost Planetary Missions, Laurel, Maryland. Contact: The Johns Hopkins University, Applied Physics Laboratory, Mail Stop 4-266, Johns Hopkins Road, Laurel MD 20723-6099.

18-19

Workshop on Formation of the Earth's Core, Mainz, Germany. Contact: Herbert Palme, Max-Planck-Institut für Chemie, Postfach 3060, 55020 Mainz, Germany. Phone: 49-6131-305-346; fax: 49-6131-371-290.
Internet: palme@mpch-mainz.mpg.dbp.de

25-30

VIIth International Symposium on the Observation of the Continental Crust through Drilling, Santa Fe, New Mexico. Contact: Earl Hoskins, DOSECC, College of Geosciences & Maritime Studies, Texas A&M University, College Station TX 77843-3148. Phone: 409-845-3651; fax: 409-845-0056.
Internet: hoskins@pluto.tamu.edu

27-28

Exobiological Strategy for the Exploration of Mars, Moffett Field, California. Contact: John F. Kerridge, Code SLC, NASA Headquarters, Washington DC 20546. Phone: 202-358-0292 or 619-534-0921.

MAY

9

Tenth Thematic Conference on Geologic Remote Sensing, San Antonio, Texas. Contact: Nancy Wallman, ERIM Conferences, P.O. Box 134001, Ann Arbor MI 48113-4001. Phone: 313-994-1200 ext. 3234; fax: 313-994-5123.

15-18

Annual Meeting of the Geological Association of Canada and Mineralogical Association of Canada, Waterloo, Ontario, Canada. Contact: Alan V. Morgan, Department of Earth Sciences, University of Waterloo, Waterloo, Ontario N2L 3G1, Canada. Phone: 519-885-1211 ext. 3231; fax: 519-746-7484.

MAY (CONTINUED)

16-19

The Diffuse Interstellar bands, Boulder, Colorado. Contact: A.G.G.M. Tielens, Mail Stop 245-3, NASA Ames Research Center, Moffett Field CA 94035-1000. Phone: 415-604-6230.

JUNE

5-11

ICOG-8: Eighth International Conference on Geochronology, Cosmochronology, and Isotope Geology, Berkeley, California. Contact: ICOG-8, Krebs Convention Management Services, 555 De Haro Street, Suite 200, San Francisco CA 94107-2348. Phone: 415-255-1297; fax: 415-255-8496.

6-8

International Conference on Comparative Planetology, Pasadena, California. Contact: Neil L. Nickle, Jet Propulsion Laboratory. Phone: 818-354-8244.

6-10

Conference on Physics of the Moon and Planets, Kharkov, Ukraine. Contact: Irina Belskaya, Astronomical Observatory, Sumskaya Str. 35, 310022 Kharkov, Ukraine. Phone: 0572-43-24-28.
Internet: irina@astron.kharkov.ua

25-30

106th Annual Meeting of the Astronomical Society of the Pacific, Flagstaff, Arizona. Contact: ASP at Universe '94, 390 Ashton Avenue, San Francisco CA 94112. Phone: 415-337-1100.

28-30

ASP Scientific Symposium: Completing the Inventory of the Solar System, Flagstaff, Arizona. Contact: Robert Millis, Lowell Observatory, 1400 W. Mars Hill Road, Flagstaff AZ 86001. Phone: 602-774-3358; fax: 602-774-6296.
Internet: rlm@lowell.edu

JULY

21-22

Workshop on Meteorites from Hot and Cold Deserts, Nordlingen, Germany. Contact: Michael Zolensky, Mail Code SN2, NASA Johnson Space Center, Houston TX. Phone: 713-483-5128; fax: 713-483-5347.
Internet: zolensky@curate.jsc.nasa.gov

CALENDAR

JULY (CONTINUED)

25-29

57th Meeting of the Meteoritical Society, Prague, Czech Republic. Contact: Publications and Program Services Department, LPI, 3600 Bay Area Boulevard, Houston TX 77058-1113. Phone: 713-486-2166; fax: 713-486-2160.

AUGUST

28-30

Meteoroids, Bratislava, Slovakia. Contact: Anton Hajduk or Vladimir Porubcan, Astronomical Institute SAV, Dubravska 9, 84228 Bratislava, Slovakia. Phone: 42-7-375157; fax: 42-7-375157. Internet: astropor@savba.savba.cs

OCTOBER

13-15

Chondrules and the Protoplanetary Disk, Albuquerque, New Mexico. Contact: Publications and Program Services Department, LPI, 3600 Bay Area Boulevard, Houston TX 77058-1113. Phone: 713-486-2166; fax: 713-486-2160.

MARS OBSERVER INVESTIGATION BOARD STATUS REPORT

The Mars Observer Investigation Board held its third set of meetings, Wednesday through Friday, Oct. 20–22, in Washington, D.C. Since the last set of board meetings, technical teams have conducted reviews of specific Mars Observer subsystems at the Jet Propulsion Laboratory, Pasadena, California and Martin Marietta Aerospace, East Windsor, N.J.

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Pam Thompson, Editor

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Plausible scenarios for what could have caused the loss of communication with the Mars Observer spacecraft are still being developed and technically challenged.

The board previously had recommended a program to attempt to activate the Balloon Relay Experiment, an instrument onboard Mars Observer. After several attempts to activate the experiment, ground station engineers did not detect any return signals. The NASA Deep Space Network stationed at Goldstone, Calif., and the Jodrell Bank Observatory, United Kingdom, were used. Non-activation of the Balloon Relay Experiment leads the board to conclude that a Mars Observer failure scenario involving only the spacecraft downlink portion of the telecommunications system is highly unlikely.

In the coming weeks, the board will evaluate results of hardware and software tests, and in some cases, computer simulations of various spacecraft subsystems. A final report will be released and made public after final acceptance by the NASA Administrator. The board includes: Dr. Timothy Coffey, (Chairman), Director of Research at the Naval Research Laboratory, Thomas C. Betterton, Rear Admiral, U.S. Navy, Peter G. Wilhelm, Director of Naval Center for Space Technology, NRL, Dr. Michael D. Griffin, Chief Engineer, NASA, Dr. Joseph Janni, Chief Scientist, Air Force Phillips Laboratory, and Dr. Kathryn D. Sullivan, Chief Scientist, National Oceanic and Atmospheric Administration.

Communication with the Mars Observer was lost at 6 p.m. PDT on Saturday, August 21. The spacecraft was set to enter Mars orbit at approximately 1:30 p.m. PDT on Tuesday, August 24.

In setting up the team, Goldin said, "I have full confidence that the board will do its utmost in providing a thorough and systematic review to determine the cause for the loss of communications with Mars Observer." The final report is still scheduled to be completed in late November.

INSIDE

25th LPSC Plans

See Page 16 for details

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