Lunar and Planetary Information
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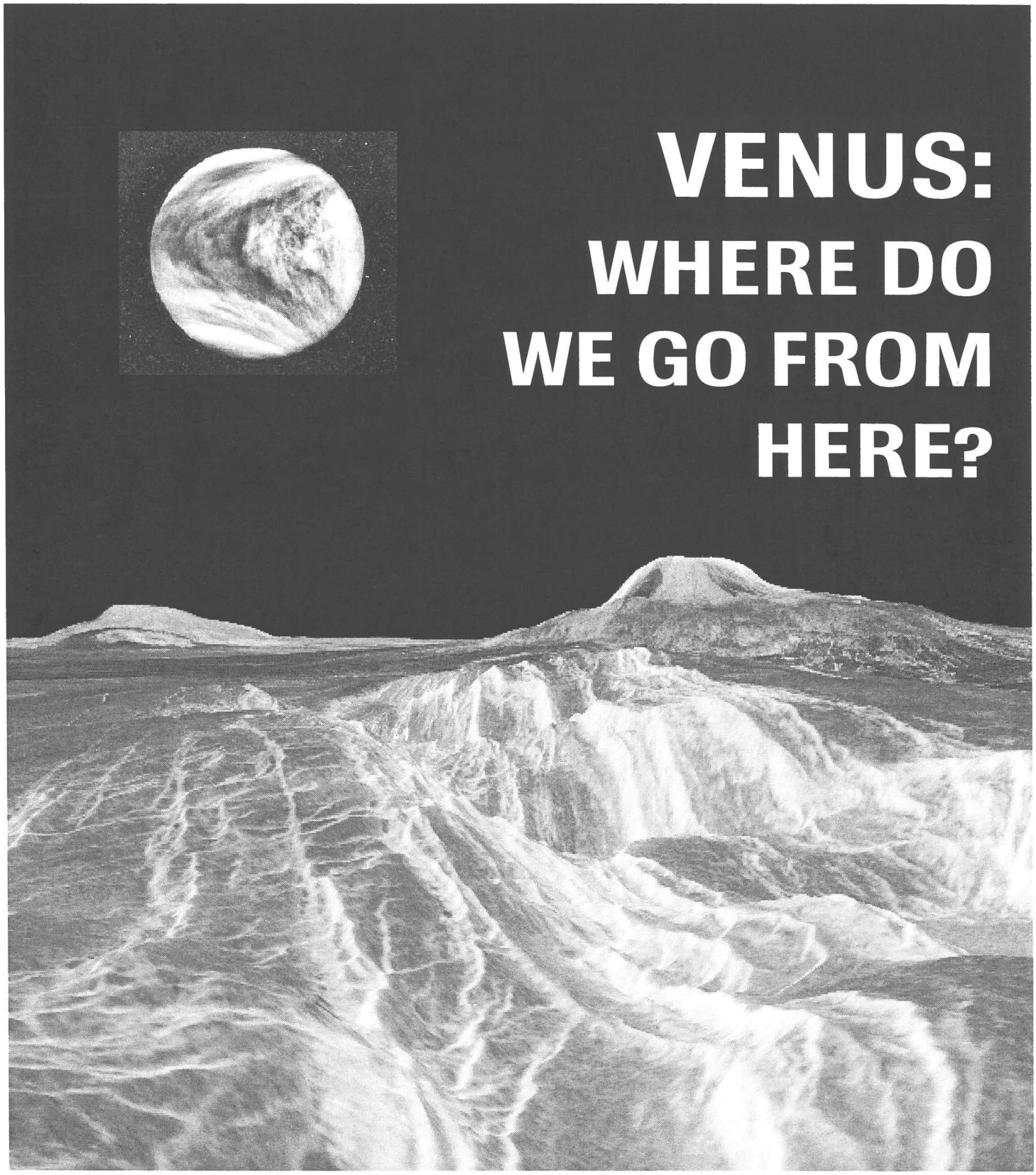
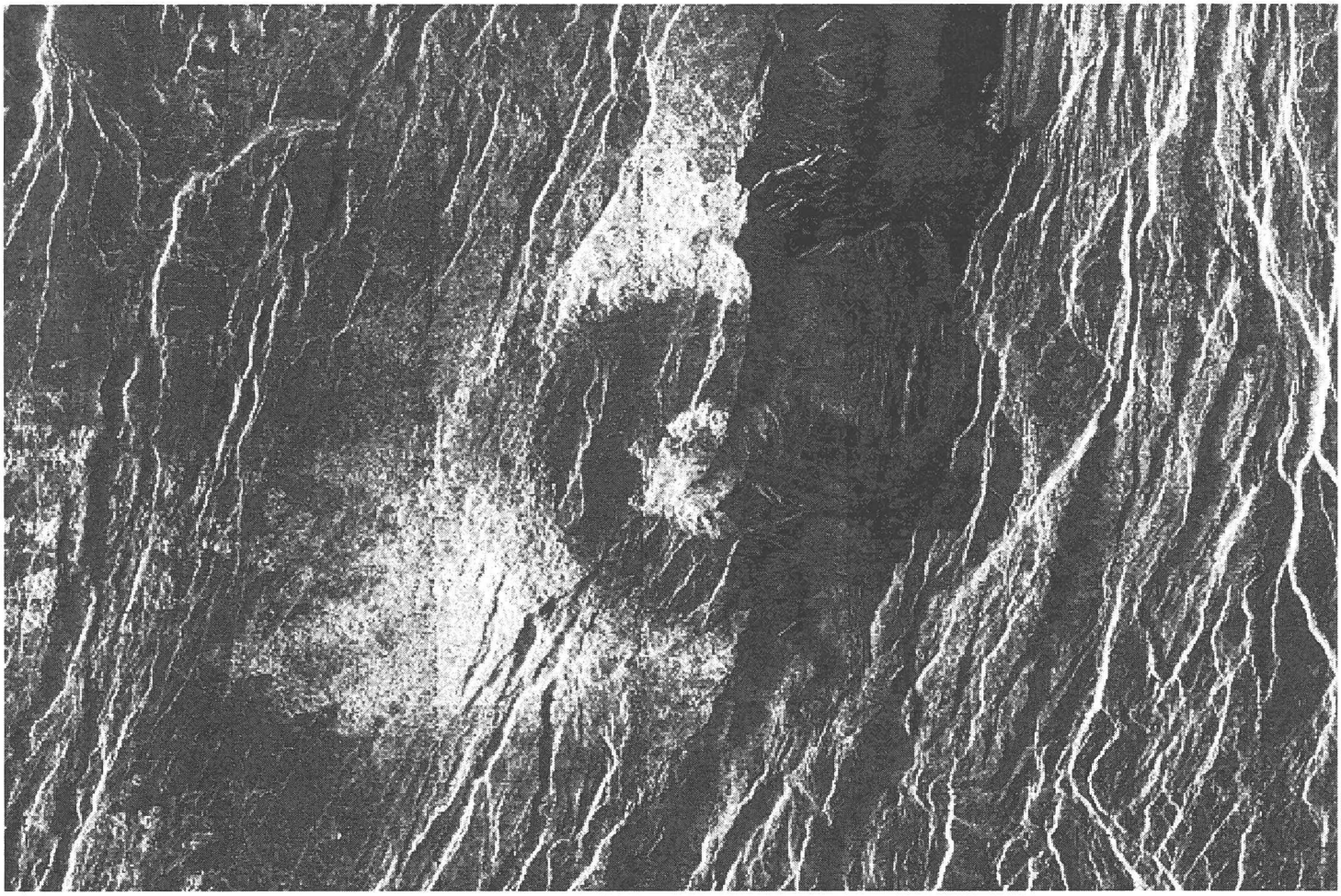


VENUS: WHERE DO WE GO FROM HERE?



The 37-km-diameter crater Somerville in Beta Regio, which has been rifted by Devana Chasma.

VENUS AFTER MAGELLAN:

Where Do We Go From Here?

—Walter S. Kiefer

The Magellan spacecraft's exploration of Venus spanned just over four years, from orbit insertion on August 10, 1990, to atmospheric entry on October 12, 1994. Its mission was divided into two parts. The first two years were dedicated to radar mapping of the planet, with 98% of the surface imaged at resolutions between 100 and 250 m. In addition, an altimetry map of the surface was developed at a resolution of about 10–20 km. Stereo imaging was obtained for about 20% of the planet, allowing higher-resolution local topography maps to be generated. Such stereo studies are quite time-consuming but are proving useful in some instances, such as assessing the degree to which some impact craters have been modified by later volcanic activity. This early phase of the mission was both exciting and often nerve-wracking for many of the participants, as documented in Henry Cooper's excellent book, *The Evening Star: Venus Observed.*

The last two years of the Magellan mission were dedicated to measuring regional variations in the gravity field of Venus. Initially, these measurements were made from Magellan's highly elliptical orbit. An aerobraking maneuver in mid 1993 transformed the orbit to near-circular, allowing much-improved resolution of the gravity field at high latitudes. These data provide our only means at present of "seeing," however nonuniquely, into the interior of Venus.

Because so much of the Earth's surface is covered by water, our knowledge of the features on the surface of Venus actually exceeds our knowledge of the Earth's surface. However, knowing what the surface looks like is not the same thing as understanding how it got that way, and many arguments still rage about the geological and geophysical processes that have been important in the evolution of Venus.

As a way of taking stock of the current state of affairs, the Venus II Conference was organized by the University of Arizona and held in Tucson, January 4–7, 1995. Over the next several years, many of the studies reported at that conference will appear in the journal literature and in a volume of the University of Arizona's Space Science Series. The thoughts in this essay are not so much a formal conference summary as a personal reflection on the current state and future prospects of Venus geoscience.

Prior to Magellan, many of the basic tectonic and volcanic landforms on Venus were known based on 1–2-km-resolution radar images obtained by the Arecibo Radio Observatory and by the Soviet Union's Venera 15 and 16 spacecraft. In addition, there was also a broad range of models for these features waiting to be tested with Magellan data. Magellan's much sharper view allowed some of these early models to be quickly rejected, for example, the proposal that Aphrodite Terra was analogous to a terrestrial oceanic spreading center/transform fault system.

In turn, Magellan data has posed many new mysteries. For example, there are numerous long lava channels on Venus; one is more than 6000 km long! Although clearly formed magmatically, these channels remain poorly understood. Thermal erosion (melting of the underlying rock by magmatic heat) of such long channels seems implausible. On the other hand, mechanical erosion (as in terrestrial rivers) requires large volumes of magma over long periods of time. What type of magma was involved, and where did it disappear to at the end of the channel? Detailed analysis of the landforms imaged by Magellan is likely to continue for years to come.

In addition to these landform and process-oriented studies, Magellan has also left us with two big-picture questions about Venus: (1) How has the tectonic and volcanic activity in the planet varied with time? Was there a "catastrophe" 300–500 million years ago? If so, how rapidly did activity subside after this event, and what processes in the mantle caused such an event? (2) How thick and strong is the present-day elastic layer on the outermost surface of Venus, and what does this imply for the amount of heat flowing out of the planet?

Based on the random distribution of impact craters and the limited number of tectonized or volcanically flooded craters on Venus, it has been proposed that Venus experienced a catastrophic resurfacing event 300–500 million years ago. In this a model, there has been little subsequent volcanic and tectonic activity, with the surface acting primarily as a passive accumulator of impact craters. In the most extreme model of this sort, the transition between rapid resurfacing and the near-cessation of activity occurs in less than 10 million years.

Other investigators have considered how crater density varies among geologically defined terrain units and concluded that a much longer period of activity is recorded on the presently visible surface. Further clues about the evolutionary history of Venus are likely to come from systematic, quadrangle-scale mapping. Regrettably, funding for such studies in the Venus Mapping Program has recently been terminated as part of the early shutdown of the Venus Data Analysis Program.

Understanding the origin of tessera units is likely to be one of the keys to understanding the global evolution of Venus. Tessera are the most tectonically deformed units on Venus and typically are the stratigraphically oldest layer in any given region. How did they form, and why is the deformation in these regions so much higher than in most other parts of the planet? Do they represent a single, global event, or have the various tessera units formed over a range of times? At present, tessera occupy about 10% of the surface, although it has been suggested that the distribution of small tessera within the lowland plains represents just the "tip of the iceberg" of a much more extensive, now mostly buried distribution of tessera. If correct, then this argues strongly for a rather marked change in the tectonic style of Venus. On the other hand, if buried tessera units are not significant, then the concentration of strain in geographically limited regions of the planet must be explained. One possibility is that tessera are intrinsically weaker than other regions on Venus (perhaps because of differing rock type) and hence more easily deformed.

How quickly tectonic and volcanic activity declined is an important constraint on venusian mantle dynamics. Although a number of mechanisms exist for introducing time-dependent variations in mantle activity, the cessation of volcanism and tectonism ultimately depends on diffusive cooling and thickening of the thermal boundary layer at the top of the mantle. The 10-million-year cessation interval proposed by some investigators is far too short for significant boundary layer cooling. From this perspective, a much longer evolutionary timescale is more plausible.

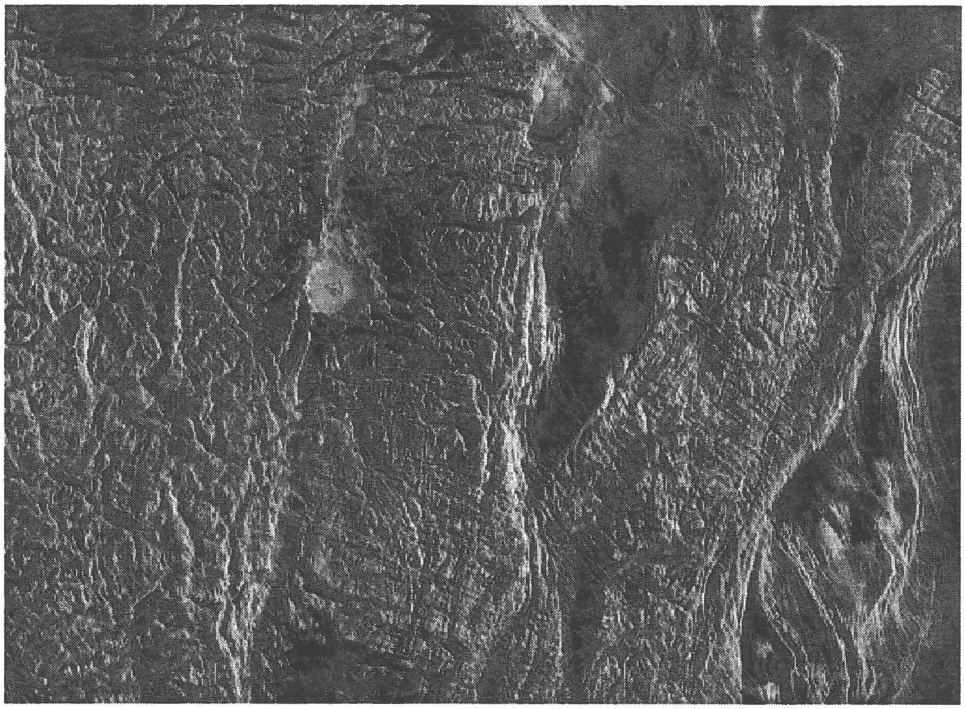
Doppler tracking of the Magellan spacecraft has recently allowed determination of the Venus gravity field up to spherical harmonic degree 75, corresponding to a surface resolution of 500 km, a factor of 4 better than the best pre-Magellan models. At least in some locations, it may be possible to extract still-higher-resolution gravity models from the tracking data. Such high-resolution models are useful in assessing flexure of a planet's elastic lithosphere, whose manifestations are most pronounced in short-wavelength gravity anomalies. Magellan made such studies possible for Venus for the first time, and initial analysis suggests an elastic lithosphere of 30 km or more in a number

of locations. Such a thick lithosphere was unexpected and implies a very low surface heat flow. However, recent simulations of very vigorous mantle convection produce short-wavelength gravity anomalies and topography that resemble those produced by flexure models. As a result, the elastic layer thickness on Venus remains uncertain. Further modeling that simultaneously incorporates both elastic flexure and mantle convection, as well as further work on determining the short-wavelength gravity field, will hopefully lead to better constraints on the elastic lithosphere thickness and indirectly on the near-surface thermal gradient and heat flow.

Magellan has completed our first-order reconnaissance of Venus, much as the Viking spacecraft did for Mars. So where do we go from here? From the standpoint of solid-body studies (atmospheric studies are another matter, and a problem for some other group of scientists), the most valuable follow-up missions involve landing spacecraft on the surface. Particularly useful would be one or more(!) sample return missions, which would allow detailed sample petrology and geochemistry measurements, including radiometric age dating, to be performed. Unfortunately, this is likely to be a long time in coming given the current fiscal climate.

From a geophysics perspective, a network mission to deploy seismometers and measure heat flow at various locations would be of great value. Such a mission would require a significant technology breakthrough to allow long mission durations at the very high Venus surface temperature, which again seems unlikely for the foreseeable future.

A financially more feasible mission would involve *in situ* chemical analysis of material at selected locations, similar to those performed by seven Venera and Vega landers. Those landers revealed a generally basaltic surface composition, although there were hints of a more felsic composition at two sites. A high-priority target for future probes of this sort should be a tessera unit, although the rough surface texture of these regions implies a relatively high risk of mission failure. Another high-priority target should be Ishtar Terra, where Lakshmi Planum provides a much safer landing target. For both the tessera and Ishtar, there are plausible reasons for thinking that these regions might be compositionally distinct from the basaltic plains. Testing this possibility would both narrow the allowed range of models for these particular features as well as place constraints on the overall degree and range of planetary differentiation.



Tessera in Tellus Regio. Image width is 600 km. Magellan F-MIDR40N088;201.

Although landers provide important ground truth on crustal composition, trying to characterize global variations in composition using landers alone on a point-by-point basis is a slow and frustrating activity. For planets with little or no atmosphere, orbital remote sensing admirably solves this problem. Unfortunately, the thick clouds of Venus prevent spectral studies from orbit in the visible and infrared, and radar wavelengths are poor discriminants among most rock types. What is needed to solve this problem is a mobile platform such as a balloon or propeller-driven drone aircraft, flying below the clouds but at a sufficiently high altitude (and low temperature) to allow reasonable mission lifetime. If atmospheric absorption bands do not obscure all of the interesting mineral absorptions in the visible and near-infrared, such a mission could characterize variations in crustal composition on at least a regional scale, while at the same time serving as a platform for atmospheric chemistry and dynamics studies.

(Dr. Kiefer is a Staff Scientist at LPI.)

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Pam Thompson, Editor

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Please send articles or announcements to: P. Thompson, 3600 Bay Area Boulevard, Houston TX 77058-1113.

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26th LPSC

The 26th Annual Lunar and Planetary Science Conference will be held March 13–17 in Houston, Texas. The conference will begin with a reception and registration Sunday, March 12, from 6:00 to 9:00 p.m. Registration will continue beginning at 7:30 a.m. on Monday morning, March 13, at the NASA Johnson Space Center. Sessions will be held at the NASA Johnson Space Center (JSC) and the Lunar and Planetary Institute (LPI) beginning at 8:30 a.m. on Monday, March 13, and ending Friday, March 17, at noon.

CONFERENCE PROGRAM

Technical Sessions

Technical sessions will be held at the Gilruth Center. Parallel sessions will be held in Room A (Room 104), Room B (the old gym), Room C (the new gym), and Room D (Room 206 upstairs). A Guide to Technical Sessions is included in this mailing. The preliminary program and first paragraph of the abstracts accepted for the conference are available on line; instructions for accessing the online system are included in this article.

Poster Presentations

Poster sessions have been scheduled for Tuesday and Thursday evenings from 6:30 to 9:30 at the LPI. Authors of papers selected for poster presentation will be available to display and discuss their results in the poster area during the assigned time period. Additionally, posters may be viewed at LPI each day of the conference. Shuttle transportation between the Gilruth Center and LPI will be available throughout the week. Each poster will have a space 40" × 40" for display. Requests for tables, computers, or video equipment, etc., cannot be honored due to the limited space available for poster displays.

Visual Aids

Standard support for dual-screen projection of slides and overheads will be provided in all technical sessions. A slide preview area will be available at the Gilruth Center. VCR images can be projected in Conference Rooms A, B, and C. In Conference Room D, a large-screen video monitor will be available. VCR tapes must be 1/2" VHS or 3/4" U/matic.

Authors presenting by poster who want to show VCR tapes may sign up for one-hour slots on a first-come, first-served basis in Room 204 of the Gilruth Center. A tape player and monitor will be available in that room for video presentations. You may want to advertise the times your video will be presented on your poster board during the Tuesday or Thursday evening session.

SPECIAL SESSIONS

Harold Masursky Lecture

The Harold Masursky Lecture Series will continue this year in a special plenary session to begin at 1:30 p.m. on Monday, March 13, 1995. The Masursky Lecturer is Dr. Michael J. Drake, who will present *The Moon: What We (Think We) Know About It, How We Know It, and What We Don't Know!* A special session devoted to the Clementine Mission will follow Dr. Drake's lecture.

Clementine Special Session

The Defense Department's Clementine Mission mapped the entire Moon in 11 wavelengths in the visible and near-infrared, in addition to obtaining global altimetry and selected high-resolution and thermal images. Data from this mission promise to revolutionize our knowledge and understanding of lunar processes and history. This session will consist of both invited and contributed talks from the Clementine Science and Flight teams that will give an overview of the scientific richness and potential of the Clementine data, as well as some of the exciting, initial scientific results. The Clementine Special Session will be held on Monday, March 13, 1995, at 2:30 p.m. following the Masursky Lecture.

Discovery Special Session

Because of the intense interest in the Discovery Missions, a special session on these and similar-scale missions is scheduled for Wednesday, March 15, 1995, in the afternoon. The session will consist of a brief overview of the Discovery Program status, followed by summary talks on Mars Pathfinder, NEAR, and the missions selected during the recently completed competition (these are expected to be announced in February). Similar mission concepts from ESA and elsewhere will also be discussed. The detailed schedule for this session will be available at the conference.

Special Poster/Display Sessions on Education

Two special poster/display sessions on education will be held at LPI on Tuesday and Thursday evenings during the regular technical poster sessions *instead of* an oral session at Gilruth. The education special sessions, *"Planetary Science Educational Activities and Technology,"* will be located in and around the LPI library. Participants who request them will be provided with tables, electrical outlets, and equipment, as well as poster space to display and demonstrate the programs and products they have developed. This format provides much more interactivity, which is lacking in an oral session; it allows participants to demonstrate some of the projects "hands-on" rather than simply describing them. Computer software, videos, handouts, etc., may be included as part of the presentations. Participants who will require tables, electrical outlets, computers, audio-visual equipment, Internet connections, or any other special equipment must submit a *written* request by fax (713-486-2186) or e-mail (hager@lpi.jsc.nasa.gov) no later than **February 24, 1995**.

SPECIAL EVENTS

Chili Cookoff and Tex-Mex Fiesta

The cookoff and Tex-Mex Fiesta will be held on Wednesday from 6:30 to 9:30 p.m. at the Landolt Pavilion. Out-of-town teams are encouraged to enter.

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 team participation. The goal of this event is fun, not serious cooking competition. Guest tickets may be purchased for $10.

Chili Cookoff Teams should complete an entry form (provided with the Third Announcement mailing) and return it to LPI by February 17 to enter a chili in the cookoff. The judges are hoping for a few good cooks, so organize your teams and enter now!

Reception for Award Winners
A reception will be hosted by GSA on Monday at 6:00 p.m. in Conference Room A. The 1994 winners of the Stephen E. Dwornik Student Paper Awards will be honored.

Computer Demonstrations and E-Mail Stations
All computer stations for demonstrations, displays, exhibits, and e-mail will be located at the LPI. The main displays will be located in the Center for Information and Research Services (library). Several stations will be available to participants for checking e-mail. The conference shuttle buses will make regular stops at LPI during the week of the conference.

CONFERENCE PROGRAM ONLINE

The program and first paragraph of abstracts for the 26th LPSC will be placed on line on or around February 1, 1995.

HOW TO GET THERE

World-Wide Web (WWW) Access
If you are using an Internet information browser like NCSA Mosaic, the URL for LPI is

http://cass.jsc.nasa.gov/lpi.html

Internet Access
At your system's prompt, type

telnet cass.jsc.nasa.gov
or
telnet 192.101.147.17

The username prompt should be displayed. Use only lower-case characters for logging onto this account.

USERNAME: cass
PASSWORD: online

Modem Access
For modem access (at 14.4K/9600 bps), DEC VT series terminal emulation (100 and above) is required.

(713) 244-2089
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Press <ENTER> until you receive the username prompt. Use only lower-case characters for logging onto this account.

If you have questions concerning the online abstracts or program, contact Sarah Enticknap (e-mail: enticknap@lpi.jsc.nasa.gov; phone: 713-486-2164). For questions about accessing the LPI computer or navigating the online system, contact Eleta Malewitz (e-mail: malewitz@lpi.jsc.nasa.gov; phone: 713-486-2197). Telephone assistance is available from 9:00 a.m. to 5:00 p.m. Central Time.

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 20,** 1995, 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 20. A preregistration form is enclosed. Requests for cancellation and a refunded fee will be accepted through March 10.

Those who fail to attend and do not notify the LPI Publications and Program Services Department prior to **March 10** will forfeit their full fee.

Sunday Night Registration
The Sunday night reception and registration will take place at the LPI at 3600 Bay Area Boulevard from 6:00 to 9:00 p.m. Shuttle buses will operate from selected hotels to the LPI on Sunday night. For those driving rental cars, see the information on overflow parking provided in this article under the heading "Conference Shuttle Services."

Registration will continue beginning at 7:30 a.m. to 5:00 p.m. on Monday morning, March 13, at the JSC Gilruth Center. The registration desk will be open from 8:00 a.m. to 5:00 p.m. Tuesday through Thursday and from 8:00 a.m. to noon on Friday.

CONFERENCE SHUTTLE SERVICES

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. No shuttle service is available from the Residence Inn by Marriott or the South Shore Harbour Resort. There will be rotational runs in the morning, during lunch, at the close of sessions, and to and from these hotels during special events. Your conference badge will serve as your bus ticket.

The conference shuttle will also make hourly stops at LPI during the week. Computer displays, exhibits, poster sessions, and other conference-related events will be located at the LPI throughout conference week.

In addition, for those driving rental cars, we will provide a "park and ride" service for anyone arriving at LPI for the reception and registration on Sunday evening or the poster sessions on Tuesday and Thursday evenings. If you arrive after the LPI parking lot has been filled, additional parking has been acquired in a lot at the University of Houston–Clear Lake (next door to LPI). Shuttle buses will pick you up at this lot and deliver you to the front door of LPI.

LOCAL GROUND TRANSPORTATION

Ground transportation from Houston Intercontinental and Houston Hobby Airports to the local area hotels at a reasonable cost is available through two shuttle services.

AAA Shuttle charges $10 one way from Hobby Airport and $15 one way from Houston Intercontinental Airport. Service is limited to three trips per day from each airport. The scheduled departures from Intercontinental are at

7:40 a.m., 11:15 a.m., and 2:45 p.m. Scheduled departures from Hobby are at 8:20 a.m., 11:50 a.m. and 3:20 p.m. The telephone number for AAA Shuttle is 713-338-7133.

Service from both airports is also available through Galveston Limousine Service (vans and small buses are used for the airport shuttle). This service offers trips from Intercontinental Airport from 7:00 a.m. through 10:00 p.m. every one and one-half hours. The scheduled trips from Hobby Airport are from 8:00 a.m. through 11:00 p.m. every one and one-half hours. The rate from either airport for a one-way trip is $15. The telephone numbers for Galveston Limousine Service are 713-223-2256 (Houston line) or 409-765-5288 (Galveston line).

No public transportation is available from the airports to the local area, or within the local area surrounding NASA Johnson Space Center. Taxi service is available from the airports and in the local area. Taxi service rates are approximately $20–25 from Hobby Airport or $50–60 from Intercontinental Airport.

MESSAGES AND FAXES

A message center will be in the conference registration area at the Gilruth Center during the technical sessions. People who need to contact attendees during the conference may call 713-483-0321, Monday through Thursday from 8:00 a.m. to 5:00 p.m., and on Friday from 8:00 a.m. until noon. A fax machine will be located at the staff desk for *incoming* messages only. Faxes should be sent to 713-483-8737. Telephone messages and faxes will be posted on a bulletin board near the Registration Desk.

FORMS AND INFORMATION

Please contact the LPI Publications and Program Services Department at 713-486-2166 for further information.

26th LPSC: GUIDE TO SESSIONS AND ACTIVITIES
March 13–17, 1995

(Letter designates Gilruth Center room.)

Monday Morning, 8:30 a.m.
A Basaltic Meteorites: Real and Virtual
B Mars Exploration: Pathfinder and Beyond
10:15 a.m. Lunar Exploration Strategies and Resources
C Origins of Planetary Systems
D Mercury
9:15 a.m. Remote Sensing

Monday Afternoon, 1:30 p.m.
C **Special Plenary Session**
Presentations to the 1994 Stephen E. Dwornik Student Paper Award Winners
followed by
Harold Masursky Lecture by Michael J. Drake
The Moon: What We (Think We) Know About It, How We Know It, and What We Don't Know!

Monday Afternoon, 2:30 p.m.
A Presolar Grains
B Mars Surface Mineralogy and Remote Sensing
C Special Session: Clementine Explores the Moon
D Outer Planets/Satellites

Monday Evening, 6:00 p.m.
A Reception hosted by GSA to honor the 1994 Stephen E. Dwornik Student Paper Award Winners

Tuesday Morning, 8:30 a.m.
A Chondrule Formation
B Mars Geophysics
C Lunar Highlands Rocks and Geology

Tuesday Afternoon, 1:30 p.m.
A Calcium-Aluminum-rich Inclusions and Their Formation Processes
B Mars Geology
C Lunar Mantle Processes and Mare Basalts
D Tektites and Impact Studies

Tuesday Evening, 6:30–9:30 p.m.
LPI Poster Session I
and
Education Special Session Displays
Planetary Science Educational Activities and Technology

Wednesday Morning, 8:30 a.m.
A Chondrites
B Meteorites and Mars I: Surface, Volatiles, and Atmosphere
C Meteorites from the Moon
9:45 a.m. Lunar Surface Processes
D Craters on the Earth with Diamonds

Wednesday Afternoon, 1:30 p.m.
A Meteorites and Mars II: Focus on ALH84001
B The Chicxulub Syndrome
C Special Session: Discovery

Wednesday Afternoon, 5:30 p.m.
C NASA Program Managers' Meeting

Wednesday Evening, 6:30–9:30 p.m.,
Conference Social Event, Landolt Pavilion

Thursday Morning, 8:30 a.m.
A Differentiated Meteorite Melange
B Venus Resurfacing and Lithospheric Properties
C The NEAR Mission and the Nature of S-class Asteroids

Thursday Afternoon, 1:30 p.m.
A Interplanetary Dust
B Venus Geology and Surface Properties
C Planetary Interior Processes
D Asteroids, Too

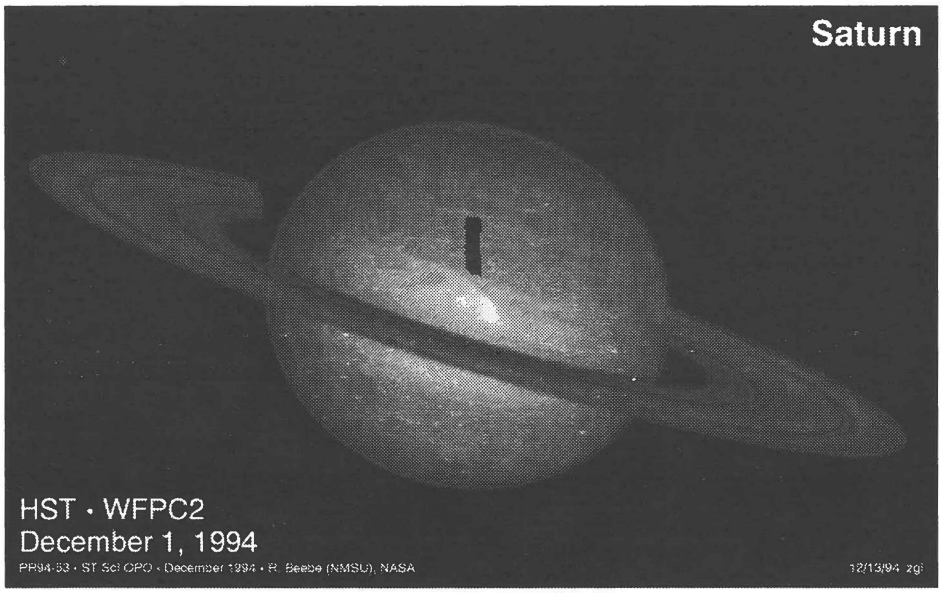
Thursday Evening, 6:30–9:30 p.m.
LPI Poster Session II
and
Education Special Session Displays
Planetary Science Educational Activities and Technology

Friday Morning, 8:30 a.m.
A Carbonaceous Chondrites
B Volcanism and Lava Flows
C Shoemaker-Levy 9 Impacts

NEWS FROM SPACE

STORM ON SATURN

This Hubble Space Telescope image of Saturn shows a rare storm that appears as a white arrowhead-shaped feature near the planet's equator. The storm is generated by an upwelling of warmer air, similar to a terrestrial thunderhead. The storm is about equal to the diameter of the Earth (about 7900 miles). Hubble is providing new details about the effects of Saturn's prevailing winds on the storm. The new image shows that the storm's motion and size have changed little since its discovery in September 1994.



Credit: Reta Beebe (New Mexico State University), D. Gilmore, L. Bergeron (STScI), and NASA.

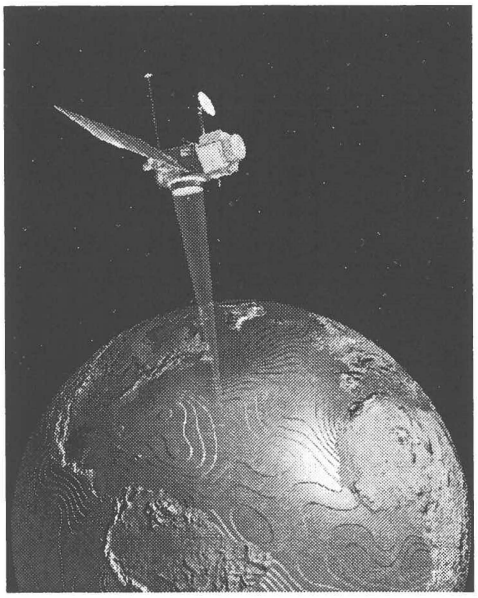
The storm was imaged with the Wide Field/Planetary Camera 2 in the wide field mode on December 1, 1994, when Saturn was 904 million miles from the Earth. The Hubble images reveal Saturn's prevailing winds as a dark wedge that eats into the western (left) side of the bright central cloud. The planet's strongest eastward winds (estimated to be 1000 miles per hour from analysis of Voyager spacecraft images) are at the latitude of the wedge.

To the north of this arrowhead-shaped feature, the winds decrease so that the storm center is moving eastward relative to the local flow. The clouds expanding north of the storm are swept westward by the winds at higher latitudes. The strong winds near the latitude of the dark wedge blow over the northern part of the storm, creating a secondary disturbance that generates the faint white clouds to the east (right) of the storm center. The storm's white clouds are ammonia ice crystals that form when an upward flow of warmer gases shoves its way through Saturn's frigid cloud tops. Hubble observed a similar, though larger, storm in September 1990, which was one of three major Saturn storms seen over the past two centuries. Although these events were separated by about 57 years (approximately 2 Saturnian years) there is yet no explanation why they apparently follow a cycle, occurring when it is summer in Saturn's northern hemisphere.

TOPEX/POSEIDON CONFIRMS RETURN OF STRONGER EL NINO

The El Nino phenomenon is back and getting stronger, according to scientists studying data from the ocean-observing TOPEX/POSEIDON satellite. El Nino is a climatic event that can bring devastating weather to several parts of the world, including the recent heavy rains and flooding in California, and the warmer-than-normal winter in the eastern United States.

"The satellite has observed high sea-surface elevation, which reflects an excessive amount of unusually warm water in the upper ocean," said Dr. Lee-Lveng Fu, JPL TOPEX/POSEIDON project scientist. "The associated excess of heat creates high sea-



TOPEX/POSEIDON spacecraft

surface temperatures, which affect the weather worldwide by heating the atmosphere and altering the atmospheric jet streams."

Jet streams are high-level winds, five to ten miles above the Earth's surface, created when warm and cold air masses meet. Shifts in the location of jet streams change temperatures and precipitation zones at the surface.

El Nino begins when the westward trade winds weaken and a large warm water mass, called a Kelvin wave, is allowed to move eastward along the equator in the Pacific Ocean. Data from the radar altimeter onboard TOPEX/POSEIDON, recorded from October through December 1994, reveal a new Kelvin wave moving toward the western coast of South America.

"This wave is currently occupying most of the tropical Pacific Ocean. It will take another month or two before the wave disperses. Compared to the El Nino condition of the winter of 1992–93, the present one appears somewhat stronger and might have stronger and longer lasting effects," Fu said.

TOPEX/POSEIDON, a joint program of NASA and the Centre Nationale d'Etudes Spatiales, uses a radar altimeter to precisely measure sea-surface height. Scientists use the data to produce global maps of ocean circulation. Launched August 10, 1992, the satellite has provided oceanographers with unprecedented global sea-level measurements that are accurate to better than 2 inches (5 centimeters). Sea surface height data are essential to understanding the role oceans play in regulating global climate, one of the least-understood areas of climate research.

"The global sea-surface elevation information provided by TOPEX/POSEIDON is unique because it is related to the amount of heat stored in the upper ocean, which is important for long-range weather forecasting. The speed and direction of ocean currents also can be determined from the elevation information, providing another piece of critical information about the ocean, which is the key to climate change," Fu said.

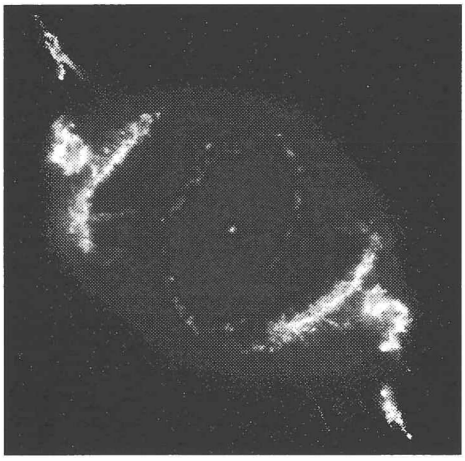
HUBBLE IMAGES A COMPLEX PLANETARY NEBULA

This Hubble Space Telescope image shows one of the most complex planetary nebulae ever seen, NGC 6543, nicknamed the Cat's Eye Nebula. It reveals surprisingly intricate structures including concentric gas shells, jets of high-speed gas, and unusual shock-induced knots of gas. Estimated to be 1000 years old, the nebula is a visual "fossil record" of the dynamics and late evolution of a dying star.

A preliminary interpretation suggests that the star might be a double-star system. The dynamical effects of two stars orbiting one another most easily explains the intricate structures, which are much more complicated than features seen in most planetary nebulae. (The two stars are too close together to be individually resolved and appear as a single point of light at the center of the nebula.)

According to this model, a fast stellar wind of gas blown off the central star created the elongated shell of dense, glowing gas. This structure is embedded inside two larger lobes of gas blown off the star at an earlier phase. These lobes are pinched by a ring of denser gas, presumably ejected along the orbital plane of the binary companion.

The suspected companion star also might be responsible for a pair of high-speed jets of gas that lie at right angles to this equatorial ring. If the companion were



Credit: J. P. Harrington and K. J. Borkowski (University of Maryland), and NASA

This color picture, taken with the WideField/Planetary Camera-2, is a composite of three images taken at different wavelengths (red, hydrogen-alpha; blue, neutral oxygen, 6300 angstroms; green, ionized nitrogen, 6584 angstroms). The image was taken on September 18, 1994.

pulling in material from a neighboring star, jets escaping along the companion's rotation axis could be produced.

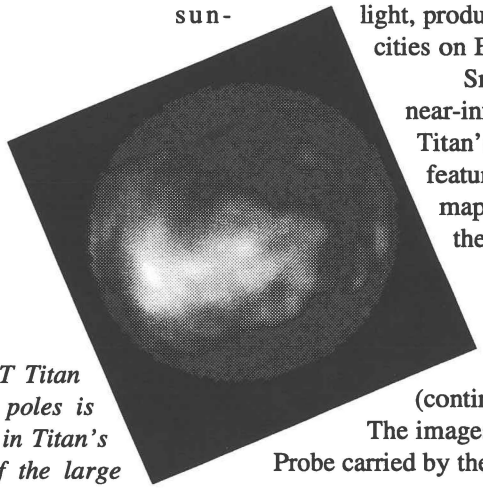
These jets would explain several puzzling features along the periphery of the gas lobes. Like a stream of water hitting a sand pile, the jets compress gas ahead of them, creating the curlicue features and bright arcs near the outer edge of the lobes. The twin jets are now pointing in different directions than these features. This suggests the jets are wobbling, or precessing, and turning on and off episodically.

The image was taken with the WideField/Planetary Camera-2 on September 18, 1994. NGC 6543 is 3000 light years away in the northern constellation Draco. The term planetary nebula is a misnomer; dying stars create these cocoons when they lose outer layers of gas. The process has nothing to do with planet formation, which is predicted to happen early in a star's life.

A GLIMPSE OF TITAN'S SURFACE

The first images of surface features on Titan have been made by Peter H. Smith, University of Arizona's Lunar and Planetary Laboratory, and a team using the Hubble Space Telescope in October 1994. They mapped light and dark features over the surface of Saturn's large, haze-shrouded moon for nearly a complete 16-day rotation. A prominent bright area is apparently a surface feature 2500 miles across, about the size of Australia.

Slightly smaller than Mars, Titan is the only body in the solar system besides Earth that may have oceans and rainfall, though the oceans and rain are ethane and methane rather than water. Scientists suspect that Titan's environment, although colder than –289° F, might be similar to Earth's billions of years ago, before life began pumping oxygen into the atmosphere. Titan's atmosphere, about four times as dense as Earth's, is primarily nitrogen laced with methane and ethane. This thick, orange, hydrocarbon haze was impenetrable at wavelengths used by cameras onboard Pioneer and Voyager spacecraft. The haze is formed as methane in the atmosphere is destroyed by sunlight, producing a hydrocarbon smog similar to smog found over large cities on Earth, but much thicker.

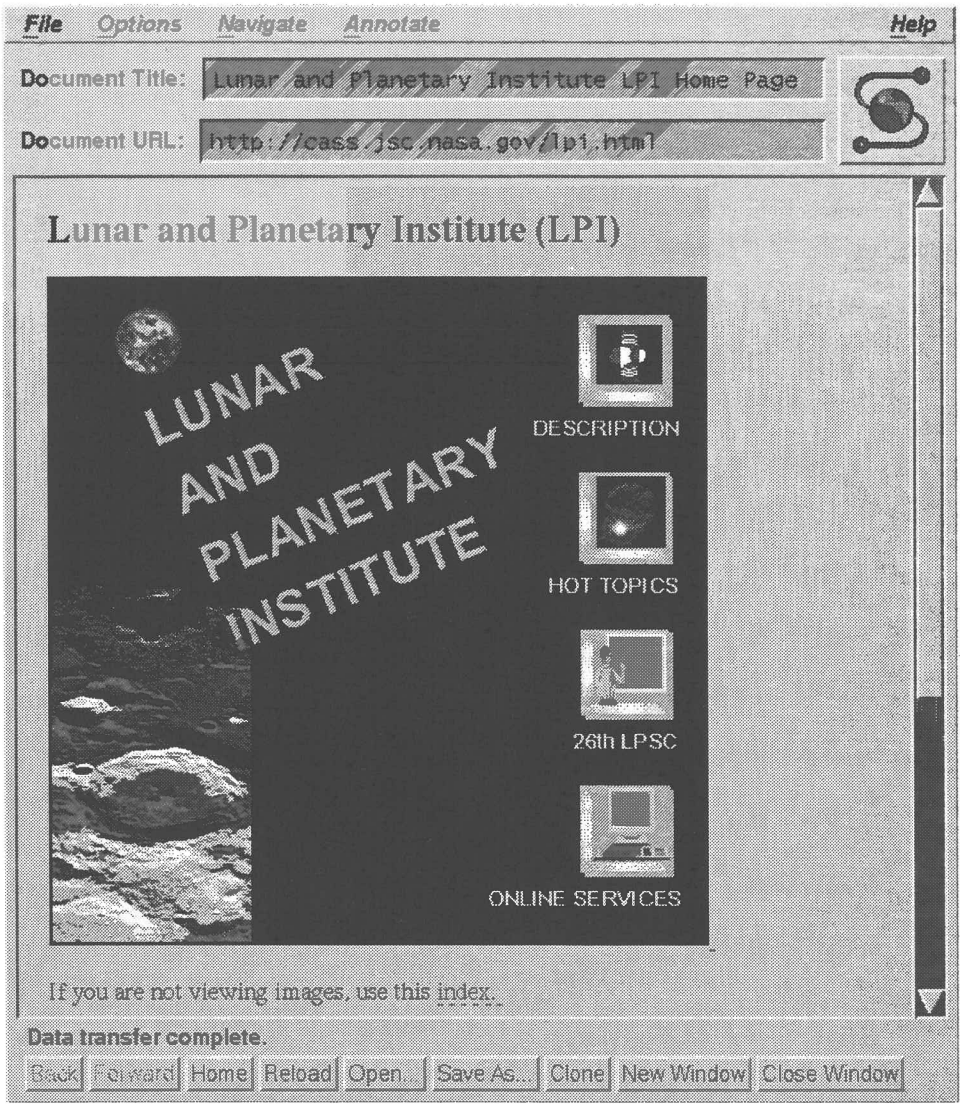


Global projection of the HST Titan data. The surface near the poles is never visible to an observer in Titan's equatorial plane because of the large optical path.

Smith's group used the Wide Field/Planetary Camera-2 at near-infrared wavelengths (between 0.85 and 1.05 μm), where Titan's haze is transparent enough to allow mapping of surface features by reflectivity. Only the polar regions could not be mapped because of viewing geometry and the thick haze near the edge of the disk. Image resolution is 360 miles.

Scientists have long suspected that Titan's surface is covered with a global ethane-methane ocean. The new images show that there is at least some solid surface, although what the light and dark regions might represent (continents, oceans, impact craters?) can't be determined.

The images may help scientists target "landing" sites for the Huygens Probe carried by the Cassini mission, a 7-year robotic spacecraft journey to Saturn in October 1997. The probe will parachute to Titan's surface.



A Beginner's Guide To The World-Wide Web

During the past year, a lot of excitement has been generated about the Internet in general and the World-Wide Web (WWW) in particular. I would venture to say that a certain portion of the readers of LPIB are already familiar with "surfing the net," but if you are one of those who have not had a chance to experience the Web yet, I would like to give you a quick tour. In less than the time you might spend reading one of the LPSC abstracts, I am going to describe some of the basics about accessing information on the Web.

What is the World-Wide Web?

Even though the Internet has been around for a while, it had always required users to learn a lot of arcane Unix commands before becoming proficient at getting around on the Internet. In 1989, the European Laboratory for Particle Physics CERN in Switzerland initiated the World-Wide Web project, and later the National Center for Supercomputing Applications (NCSA) at the University of Illinois developed a program (called a browser) named Mosaic that made navigating the net as simple as pointing and clicking a few buttons with your mouse. This has greatly simplified the process of information gathering and, as a result, the popularity of the Web exploded.

The World-Wide Web is a global hypermedia system that delivers text, graphics, sound, and video over the Internet. The best way is to think of it as a global virtual library where, with the click of a few buttons, images and text are automatically and transparently retrieved from sources around the world and displayed on your computer screen. All this is done without your having to know where the documents are stored or how they are accessed.

Why do I want to get on the Web?

With its newfound popularity, the WWW is fast becoming the tool of choice for universities, government agencies (e.g., NASA and NSF), organizers of scientific conferences and workshops (e.g., LPSC, DPS of AAS), and commercial companies to deliver information to their users and potential customers. It is also a fast and efficient way for users to find and access information online. Thus it is both a means to disseminate timely information, such as providing conference programs and abstracts to potential attendees, as well as a tool to search archival databases, such as the electronic abstracts at the Astrophysics Data System (ADS) or the images from a particular planetary mission from the Planetary Data System (PDS). And the subjects need not be confined to scientific research, since you can browse the collection at the Louvre just as easily as you can take an electronic tour of the White House or the Library of Congress.

How do I access the Web?

To get on the Web, you need two things. First, you need a program called an information browser such as Mosaic from NCSA. It runs on PCs , Macs, and X-windows displays. If you do not have one on your machine, talk to your computer systems manager and it can easily be set

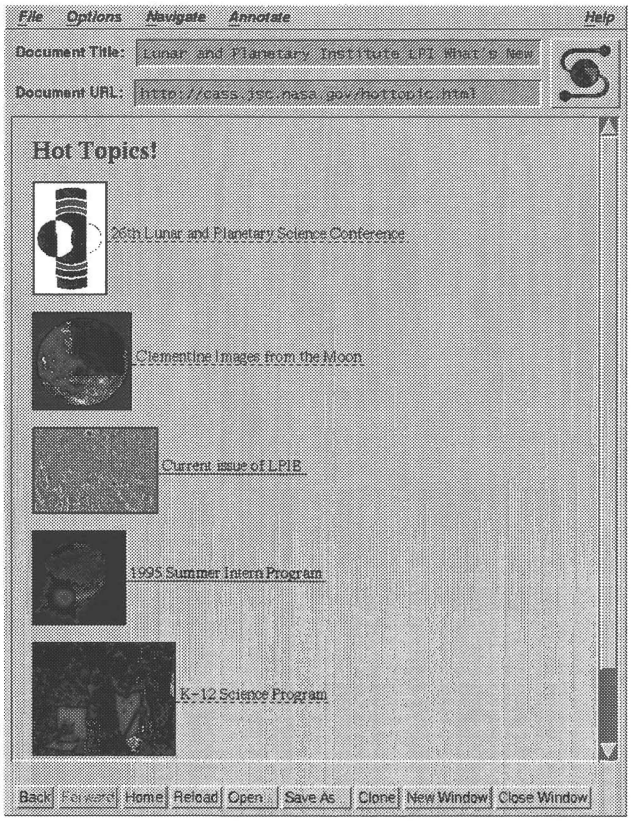
up on your computer*. It is expected that when Microsoft ships its Windows 95 product later this year, a web browser will be automatically installed in the Windows package. Second, you need to know the Uniform Resource Locator (URL) of the Home Page of the place you want to get the information from. The URL is like an electronic address on the Internet and the Home Page is like the entrance to your house. You may remember that not long ago, you added your fax number and e-mail address to your business card. Well, the URL of one's Home Page is fast becoming another line you find people scribbling onto pieces of paper when they exchange information. With these, you are ready.

An Example

I will use accessing the LPI Home Page via Mosaic as an example. The URL for the LPI Home Page is: **http://cass.jsc.nasa.gov/lpi.html**. After you have Mosaic opened on your screen, usually by typing the word **mosaic** or clicking on the **mosaic icon** in your Windows, you click on the "file" button and select the "open URL" option. Type in the URL (http://cass.jsc.nasa.gov/lpi.html) and hit return. The LPI Home Page should appear on your screen after a few seconds. It is a large image map with icons embedded in it. You can click on any of the four icons on the right side of the image, i.e., Description, Hot Topics, 26th LPSC, and Online Services to access information contained within the Home Page. Each click will launch you to the next level of information. If you are not using a browser that can display images, you can use the text index, which is highlighted and underlined.

Suppose you click on the Hot Topics icon: It will bring up another page of topics on your screen. If you click on Clementine Images, yet another screen appears with thumbnail images from the Clementine mission listed on the screen. Clicking on each image will bring the full image to the screen. Clicking on the word "caption" will display the image description. If you place the mouse arrow on the image and then click the right button, you will bring up a menu. With this menu, you can double the size of the image, save the image to your local disk, or rotate the image, just to name a few operations.

If you click on the 26th LPSC icon instead, the page for LPSC information will appear. Click on "Conference Announcements" to get the first, second, or third announcements. Click on "Program and Abstracts" to get the time and room number of talks. You can search for authors, speakers, and topics, and have the information displayed with or without the abstract. If you click on the "Print" button, you can have the information onscreen printed to your local printer, or you can e-mail the information to yourself by clicking on the "Mail to" option. Clicking on the "Back" button will bring up the previous page on the screen; repeating "Back" allows you to retrace your path through the Web.



Using the hypertext features of the Web, most home pages point to other home pages with related information. For example, from the LPI Home Page you can click on the highlighted text "PDS" (Planetary Data System) and the PDS Home Page will appear on your screen after a few seconds. Using this technique, you can roam the globe from continent to continent. A feature known as the "Hotlist" allows you to record the URL of places you have visited for return visits at a later date. This is equivalent to a list of frequently dialed numbers on your phone and is a handy way to get around without having to type in URLs all the time.

Some Observations

Someone once wrote that surfing the net is like going to college for the first time and discovering pizza parties. Some will like them so much that they'll skip classes and have all-night bull sessions with anchovies, pepperoni, and beer. Some will taste the pizza once and swear off pizzas completely. Some will partake in moderation and find the experience a refreshing break from their homework. Pizza, anyone??

* NCSA Mosaic can be downloaded free for noncommercial use by anonymous ftp at ftp.ncsa.uiuc.edu. A character mode browser called Lynx is available to run on Unix, VMS, and PCs from the University of Kansas. The program can be downloaded by anonymous ftp at ftp2.cc.ukans.edu. Also, commercial services like Prodigy have an option to connect to the WWW for an hourly rate. Other commercial services like America Online and Compuserve are also planning such options later this year.

—Kin Leung

(Mr. Leung is the LPI Computer Systems Manager and the Project Manager of LPI Online.)

USEFUL PLANETARY SCIENCE WORLD-WIDE WEB ADDRESSES

There is a wide array of planetary-science related information available using Mosaic and the World-Wide Web. Many of the locations listed here remain "under construction," so you may wish to revisit interesting sites from time to time.

We'll start our survey with the LPI Home Page, where you will currently find announcements of upcoming conferences and of the Undergraduate Summer intern program, a collection of databases and images, and on-line versions of recent LPI Bulletins.
http://cass.jsc.nasa.gov/lpi.html

The NASA Home Page (includes connections to home pages for the various field centers)
http://www.gsfc.nasa.gov/NASA_homepage.html

Guide to NASA Online Resources
http://naic.nasa.gov/naic/guide/

NASA Public Affairs
http://www.gsfc.nasa.gov/hqpao/hqpao_home.html

Recent News from JPL
http://www.jpl.nasa.gov/jplnews.html

Hubble Space Telescope Images
http://www.stsci.edu/EPA/Recent.html

The Planetary Data System Home Page (includes connections to the various PDS nodes)
http://stardust.jpl.nasa.gov/

PDS Geoscience Node
http://wwwpds.wustl.edu/

PDS Imaging Node
http://cdwings.jpl.nasa.gov/PDS/

The National Space Science Data Center
http://nssdc.gsfc.nasa.gov/planetary/planetary_home.html

The National Geophysical Data Center
http://www.ngdc.noaa.gov/ngdc.html

The National Center for Atmospheric Research
http://http.ucar.edu/metapage.html

Shuttle Imaging Radar (SIR-C)
http://edcwww.cr.usgs.gov/landdaac/sir-c/sir-c.html

Johnson Space Center Digital Image Collection (Earth Observations and Manned Space Flight Press Release Images)
http://images.jsc.nasa.gov/html/home.htm

Many recent and upcoming NASA planetary missions have Web home pages, including the Magellan Project
http://newproducts.jpl.nasa.gov/magellan/mgn.html

Magellan Image Browser
http://delcano.mit.edu/http/midr-help.html

Clementine Project
http://www.nrl.navy.mil/clementine/clementine.html
http://clementine.s1.gov/

Clementine Image Browser
http://www.nrl.navy.mil/clementine/clib

Project Galileo
http://www.jpl.nasa.gov/galileo/

Mars Global Surveyor Mission
http://www.jpl.nasa.gov/mgs.html

Mars Pathfinder Project
http://mpfwww.jpl.nasa.gov/

Near Earth Asteroid Rendezvous Mission
http://grant.jhuapl.edu/NEAR/

A number of sites provide access to imagery from the Comet Shoemaker-Levy 9 impacts with Jupiter. These include
http://www.stsci.edu/EPA/Comet.html
http://newproducts.jpl.nasa.gov/sl9/sl9.html

Hyperlinks to these addresses are available on the LPI Home Page in the "Online Services" section under the heading "Useful Planetary Science WWW Sites." This survey has undoubtedly omitted other sites of interest to the planetary science community. If you know of other Web sites that should be brought to the attention of LPI Bulletin readers, send the http address to thompson@lpi.jsc.nasa.gov for inclusion in a future issue of the Bulletin. Happy Webbing!

—Walter S. Kiefer, LPI

MEETINGS

PLANETARY IMPACT EVENTS: MATERIALS RESPONSE TO DYNAMIC HIGH PRESSURE

A special two-day symposium of the IV International Conference on Advanced Materials, entitled "Planetary Impact Events: Materials Response to Dynamic High Pressure," will be held in Cancun, Mexico, August 27– September 1, 1995. The participants will explore issues related to the shock-induced modification of minerals during natural impacts to better understand planetary impact processes.

Symposium topics will include Cratering Processes; Chicxulub Impact and the K/T Extinction; Diaplectic Phases; Experimental Shock-Loading; Impact-induced Hydrothermal Alteration of Minerals; Mineralogical Changes During Impact; Modeling Planetary Impacts; and Spectroscopy of Shocked Materials. Organizing Committee members are Laura J. Crossey, University of New Mexico, Albuquerque; Randall T. Cygan, Sandia National Laboratories, Albuquerque; and Luis Ernesto Marin Stillman, Universidad Nacional Autónoma de México, México City.

Abstract deadline for the meeting is May 31, 1995. For additional information and abstract forms contact Randall T. Cygan, Geochemistry Department, Sandia National Laboratories, Albuquerque NM 87111-0750. Phone: 505-844-7216; fax: 505-844-7216; e-mail: rtcygan@sandia.gov.

THE AMES STRUCTURE AND SIMILAR FEATURES—A WORKSHOP

Co-sponsored by the Oklahoma Geological Survey and Bartlesville Project Office of DOE, the workshop will be held March 28–29, 1995, in Norman at the Oklahoma Center for Continuing Education. The Ames structure, located on the Anadarko basin shelf in northwestern Oklahoma, is a prolific source of oil and gas with more than 50 producing wells. Discovered in 1991, it is a circular structure buried beneath more than 9000 feet of sediments. It is 6–10 miles in diameter with relief of about 600 feet. Ames has been interpreted as a meteorite impact crater, a volcanic caldera, or a solution/collapse feature. The event occurred in Early Ordovician time and influenced structure and sedimentation throughout the remaining Paleozoic Era, and possibly through Recent geologic time.

With an anticipated attendence of 200–300, the workshop will feature 24 oral presentations and 16 informal posters and displays. Program topics include craters in the solar system, terrestrial craters, geochemistry, crater recognition, and hydrocarbon potential. Topics on the Ames structure include exploration techniques, remote sensing, petrology, mineralogy, geochemistry, petroleum production, trapping mechanisms, reservoir characterization, source-rock facies, oil characterization, Landsat MSS, TM imagery, 3-D seismic imaging, phyllocarid crustaceans, basement rocks, gravity/magnetic modeling, shocked quartz, as well as evidence and interpretations for meteorite impact, volcanic, or dissolution-collapse origin of the structure. Reports on similar structures will include Marquez Dome, Wells Creek, Chicxulub, Haswell Hole, Calvin, Big Basin craters, Kentland Dome, Red Creek, and a 3000-year-old crater in central Nebraska.

For information, contact Ken Johnson or Jock Campbell, Oklahoma Geological Survey, University of Oklahoma, 100 E. Boyd, Room N-131, Norman OK 73019. Phone: 405-325-3031; fax: 405-325-7069.

CALENDAR 1995

FEBRUARY

7–10

1995 Yosemite Conference on Solar System Plasma Physics, Yosemite National Park, California. Contact: Jim Burch or Hunter Waite, Southwest Research Institute, P.O. Drawer 28510, San Antonio TX 78228. Phone: 210-522-2526; fax: 210-522-3493.

16–21

American Association for the Advancement of Science, annual meeting, Atlanta, Georgia. Contact: Nancy Houk, AAAS, 1333 H Street NW, Washington DC 20005. Phone: 202-326-6400.
Internet: houk@astro.lsa.umich.edu

27–28

1995 Conference on Quality in the Space Industry, League City, Texas. Contact: Helen Schneider, 5400 Bosque Boulevard, Suite 680, Waco TX 76710-4446. Phone: 817-776-3550; fax: 817-776-3767.

MARCH

13–17

26th 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

23–26

National Science Teachers Association Annual Meeting, Philadelphia, Pennsylvania. Contact: Convention Registration Office, NSTA, 1840 Wilson Boulevard, Arlington VA 22201. Phone: 703-243-7100; fax: 703-243-7177.

27–30

Solar System Ices, Toulouse, France. Contact: Michel Festou, Observatoire Midi-Pyrenees, 14, avenue Edouard-Belin, 31400-Toulouse, France. Fax: 33-61-53-67-22.
Internet: festou@obs-mip.fr

28–29

Ames Structure and Similar Features—A Workshop, Norman, Oklahoma. Contact: Ken Johnson *or* Jock Campbell, Oklahoma Geological Survey, University of Oklahoma, 100 E. Boyd, Room N-131, Norman OK 73019. Phone: 405-325-3031; fax: 405-325-7069.

27–30

Astrophysics in the Extreme Ultraviolet (IAU Colloquium 152), Berkeley, California. Contact: Sharon Lilly.
Internet: iau152@cea.berkeley.edu

APRIL

3–5

NASA/AIAA Life Sciences and Space Medicine Conference, Houston, Texas. Contact: Reginald M. Machell, AIAA Technical Chairman, 14923 Village Elm Street, Houston TX 77062-2914. Phone: 713-283-6000.

3–7

European Geophysical Society XX General Assembly, Hamburg, Germany. Contact: EGS Office, Postfach 49, Max-Planck-Str. 1, 37189 Katlenburg-Lindau, Germany. Phone: 49-5556-1440; fax: 49-5556-4709.
Internet: egs@linax1.dnet.gwdg.de

5–7

Workshop on the Moon as an International Scientific Resource, Hamburg, Germany. Contact: EGS Office, Postfach 49, Max-Planck-Str. 1, 37189 Katlenburg-Lindau, Germany. Phone: 49-5556-1440; fax: 49-5556-4709.
Internet: egs@linax1.dnet.gwdg.de

9–13

European Union of Geosciences (EUG 8), Strasbourg, France. Contact: EUG 8 Office, E.O.P.G., 5 Rue René Descartes, Strasbourg Cedex 67084, France. Phone: 33-88-41-63-93; fax: 33-88-41-17-66.
Internet: eug@eopg.u-strasbg.fr

22

75th Anniversary Astronomical Debate "The Distance Scale to Gamma-Ray Bursts," Washington, D.C. Contact: Robert Nemiroff.
WWW: http://antwrp.gsfc.nasa.gov/diamond_jubilee/debate.html

23–25

COBE Workshop: Unveiling the Cosmic Infrared Background, College Park, Maryland. Contact: Eli Dwek.
Internet: cibr@stars.gsfc.nasa.gov

MAY

4–7

The High Frontier Conference XII, Princeton, New Jersey. Contact: Barbara Faughan, Space Studies Institute, P.O. Box 82, Princeton NJ 08542. Phone: 609-921-0377; fax: 609-921-0389.
Internet: ssi@ssi.org

8–12

The Impact of Comet Shoemaker-Levy 9 on Jupiter (IAU Colloquium 156), Baltimore, Maryland. Contact: Michael A'Hearn.
Internet: ma@astro.umd.edu

CALENDAR 1995

MAY (CONTINUED)

9–11

Tenth Annual Goddard Conference on Space Applications of Artificial Intelligence and Emerging Information Technologies, Greenbelt, Maryland. Contact: James Rash, NASA Goddard Space Flight Center, Code 531.1, Greenbelt MD 20771. Phone: 301-286-3595; fax: 301-286-1724.
WWW: http://ddwilson.gsfc.nasa.gov

12–13

Planetary Surface Instruments Workshop, 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

15–17

Detection and Study of Extra-solar Terrestrial Planets: Techniques and Technology, Boulder, Colorado. Contact: Evelyn Haskell, Box 3905, Department of Physics, University of Wyoming, Laramie, WY 82071.
Internet: physeh@uwyo.edu

17–19

Joint Annual Meeting of the Geological Association of Canada and Mineralogical Association of Canada, British Columbia, Canada. Contact: Chris R. Barnes, General Chair, SEOS, University of Victoria, P.O. Box 1700, Victoria BC V8W 2Y2, Canada. Phone: 604-721-6120; fax: 604-721-6200.

18–21

National Space Society's 14th Annual International Space Development Conference, Cleveland, Ohio. Contact: Transquest Corporation, Cleveland OH. Fax: 216-888-3991.
Internet: charles@transquest.com *or* ff212@cleveland.freenet.edu
Anonymous ftp: ftp.wariat.org/pub/tranq

22–24

Workshop on Mercury and Its Magnetosphere, London, England. Contact: A. Balogh, The Blackett Laboratory, Prince Consort Road, London SW7 2BZ, U.K. Phone: 44-171-594-7768; fax: 44-171-594-7772.
Internet: balogh@uk.ac.ic.ph.spva

29–Jun 2

American Geophysical Union and Mineralogical Society of America Annual Spring Meeting, Baltimore, Maryland. Contact: AGU Meetings Department, 2000 Florida Avenue, NW, Washington DC 20009. Phone: 202-462-6900; fax: 202-328-0566.

MAY (CONTINUED)

29–Jun 2

CO: Twenty-five Years of Millimeter-wave Spectroscopy (IAU Symposium 170), Tucson, Arizona. Contact: CO Symposium, NRAO, Campus Building 65, 949 N. Cherry Avenue, Tucson AZ 85721-0655. Fax: 602-882-7955.
Internet: symp95@nrao.edu

JUNE

4–7

Polarimetry of the Interstellar Medium, Troy, New York. Contact: Polarimetry Conference, Department of Applied Physics and Astronomy, Rensselaer Polytechnic Institute, Troy NY 12180-3590. Phone: 518-276-6454; fax: 518-276-6680.
Internet: conf95@charon.phys.rpi.edu
Anonymous ftp: ariadne.phys.rpi.edu (cd conf95)
WWW: http://www.rpi.edu/

5–7

35th U.S. Symposium on Rock Mechanics, Lake Tahoe, Nevada/California. (Includes session on Planetary Rock Mechanics.) Contact: Richard Schultz, Co-Chair, Mackay School of Mines/172, University of Nevada, Reno NV 89557. Phone: 702-784-4318; fax: 702-784-1833.
Internet: schultz@mines.unr.edu

6–8

Twentieth Symposium on Antarctic Meteorites, Tokyo, Japan. Contact: Keizo Yanai, Secretary of the Symposium, Department of Antarctic Meteorites, National Institute of Polar Research, 9-10, Kaga 1-chome, Itabashi-ku, Tokyo 173, Japan. Phone: 03-3962-2938; fax: 03-3962-5711.

19–23

Gordon Research Conference on Origins of Solar Systems, New Hampton, New Hampshire. Contact: Anneila Sargent, Caltech 105-24, Pasadena CA 91107.
Internet: afs@mmstar.caltech.edu

25–30

Cataclysmic Variables and Related Objects, Keele University, England. Contact: F. Ringwald, Department of Physics, Keele University, Staffordshire, ST5 5BG, United Kingdom. Phone: 44-782-583319; fax: 44-782-711093.
Internet: cvconf@astro.keele.ac.uk

JULY

2–14

International Union of Geodesy and Geophysics XXI General Assembly, Boulder, Colorado. Contact: IUGG XXI General Assembly, c/o AGU, 2000 Florida Avenue, NW, Washington DC 20009. Phone: 202-462-6900; fax: 202-328-0566.
Internet: iugg_@kosmos.agu.org

20–23

Ecological Consequences of Earth Collisions with Small Bodies of the Solar System, Tomsk, Russia. Contact: Gennadij Andreev, Astronomical Observatory of the Tomsk State University, Box 1106, 634010 Tomsk, Russia. Phone: 7-3822-909721; fax: 7-3822-230450.
Internet: ok@siberia-ltd.tomsk.su *or* niipmm@urania.tomsk.su

24–31

Fifth International Tunguska Expedition, Tunguska Meteoritic Park, Evenkiya, Russia. Contact: Gennadij Andreev, Astronomical Observatory of the Tomsk State University, Box 1106, 634010 Tomsk, Russia. Phone: 7-3822-909721; fax: 7-3822-230450.

31–Aug 3

Workshop on Chaos in Gravitational *N*-Body Systems, La Plata, Argentina. Contact: J. C. Muzzio, Observatorio Astronómico, Paseo del Bosque, 1900 La Plata, Argentina. Fax: 54-21-21-1761 or 54-21-25-8985.
Internet: chaos@fcaglp.edu.ar

AUGUST

14–18

IAU Colloquium 150: Physics, Chemistry & Dynamics of Interplanetary Dust, Gainesville, Florida. Contact: M. S. Hanner.
Internet: msh@jplsc8.dnet.nasa.gov

27–Sept 1

IV International Conference on Advanced Materials—Planetary Impact Events: Materials Response to Dynamic High Pressure, Cancun, Mexico. Contact: Randall Cygan, Geochemistry Department, Sandia National Laboratories, Albuquerque NM 87111-0750. Phone: 505-844-7216; fax: 505-844-7216.
Internet: rtcygan@sandia.gov

SEPTEMBER

11–15

58th Annual Meteoritical Society Meeting, Washington, D.C. Contact: Glenn MacPherson, Department of Mineral Sciences, MRC-NHB 119, U.S. National Museum of Natural History, Smithsonian Institution, Washington DC 20560. Phone: 202-357-2260; fax: 202-357-2476.
Internet: mnhms044@sivm.si.edu

24–30

Mars Pathfinder Landing Site Workshop II: Characteristics of Ares Vallis Region, Spokane, Washington. **Field Trip I: Channeled Scablands (9/24–27); Field Trip II: Missoula Lake breakout (9/30),** Moses Lake area, Washington. 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

OCTOBER

8–13

27th Annual Meeting of the Division for Planetary Sciences of the American Astronomical Society, Kona, Hawaii. Contact: Karen Meech, University of Hawaii, Institute of Astronomy, 2680 Woodlawn Drive, Honolulu HI 96822.
Internet: meech@pavo.ifa.hawaii.edu

JANUARY 1996

22–26

New Extragalactic Perspectives in the New South Africa: Changing Perceptions of the Morphology, Dust Content, and Dust-Gas Ratios in Galaxies, Johannesburg, South Africa. Contact: David L. Block, Department of Computational & Applied Mathematics, Witwatersrand University, P.O. Box 60, WITS 2050, South Africa. Phone: 27-11-339-7965; fax: 27-11-716-3761.

29–Feb 2

OSETI II: The Search for Extraterrestrial Intelligence (SETI) in the Optical Spectrum, San Jose, California. Contact: Stuart A. Kingsley, The Columbus Optical SETI Observatory, 545 Northview Drive, Columbus OH 43209-1051. Phone: 614-258-7402; fax: 614-258-7459. Optical SETI BBS: 614-258-1710.

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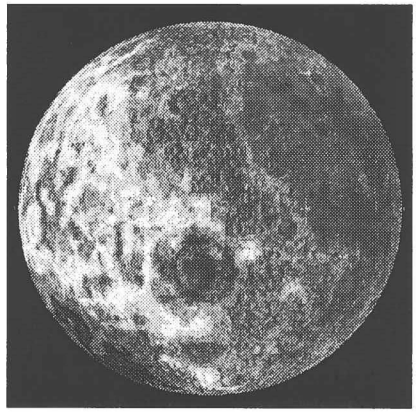

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