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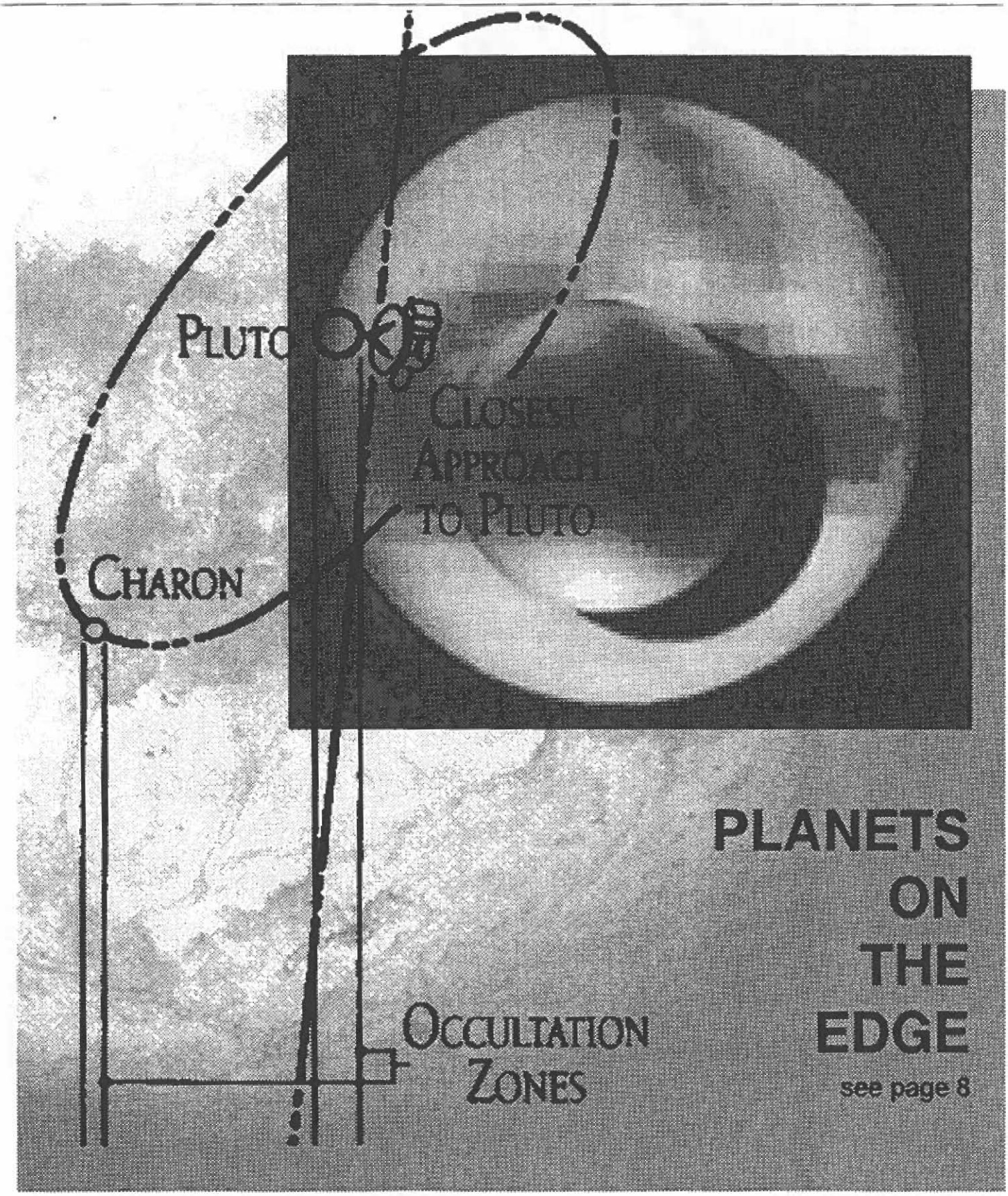


PLANETS ON THE EDGE

see page 8

FRANCES B. WARANIUS RETIRES FROM LPI

A Principal Architect of a Special Library

Few people know that some of the core collection of the Lunar and Planetary Institute's library arrived by trunkloads in Fran Waranius's Plymouth Duster. Now, on the eve of her retirement, the story can be told.

The time was post-Apollo 17, and NASA contractors were told to clear the decks of the Research Data Facility for Earth resources data that needed storage space. Waranius remembers trips to JSC where she and a NASA colleague loaded the throw-aways into her car rather than the dumpster at the other end of a loading dock. The haul included documents and photographs from the Ranger, Surveyor, Lunar Orbiter, and Apollo missions. A memorandum of understanding eventually established LPI as a repository for the lunar program materials, but for about six months, Waranius's unofficial trips salvaged many of the things that make LPI's collection unique.

The episode illustrates her vital, career-long concern with preserving the heritage of the lunar and planetary science programs for students of the future. "I *never* refused a file cabinet," she says of her quest for the artifacts that allow us to construct the history of the planetary science program.

FROM LSI TO LPI

Waranius began her tenure at the Lunar Science Institute as a Cataloging Consultant in 1970 and was appointed Librarian in July, 1971. She catalogued the LSI library's first book, and now, more than 11,000 volumes later, she will retire on September 1. She leaves the post of Librarian in the Center for Information and Research Services of the Lunar and Planetary Institute.

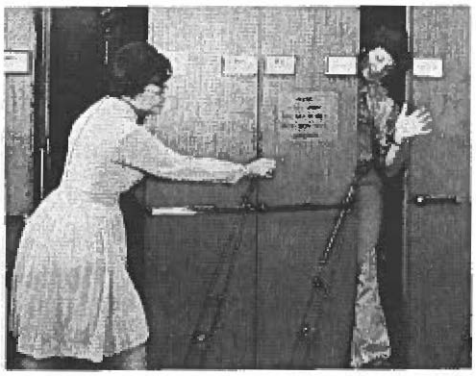
"Fran is one of those rare individuals whose personality and dedication leaves a lasting and profound impression on an organization. While Fran always strove to assure that the library functioned well, she kept a constant eye toward the evolving needs of the scientific and engineering communities that use the Institute library," said LPI Director David Black. "She was effective because she loved her library, and she believed deeply in the nation's space program. We will miss her, but she has left us her strong spirit as a legacy."

Her philosophy of the special library has always guided her. A chief tenet of this philosophy is personalized service to the user above all. LPI staff and scientists can attest to this from the nuggets of information tagged "FYI—Fran" that cross their desks each year. Another tenet is the importance of networking to maximize your resources. "You can't own everything. The idea is to know who owns what," is a principle embodied in her long and close association with special libraries around the world.

Waranius feels that the LPI library is an incomparable facility but not primarily for its book and journal collection. "You can find these things somewhere else, though maybe not all in one place," she notes, "but the collection of documentary materials, the early mission products—Surveyor, Ranger, Orbiter, even early Apollo—exist nowhere else."

"We have notes and minutes of the early [lunar] Science Working Groups, landing site selection meetings, designs for lunar rovers and lunar bases that go back to the '60s. People are going to *need* these things as we get ready to go back. Students and planners need to realize that we've *done* this before, and, recently, they have begun to seek these things out."

Reflecting on the manned space program today, Waranius laments that we're not already on Mars. Of working



during the Apollo era she says. "Those were the glory days. We cheered every Apollo up and cried every one down. You had a feeling that everything you were doing—even just adding update pages to manuals—was wonderful, *wonderful*."

CHALLENGES OF BUILDING A COLLECTION

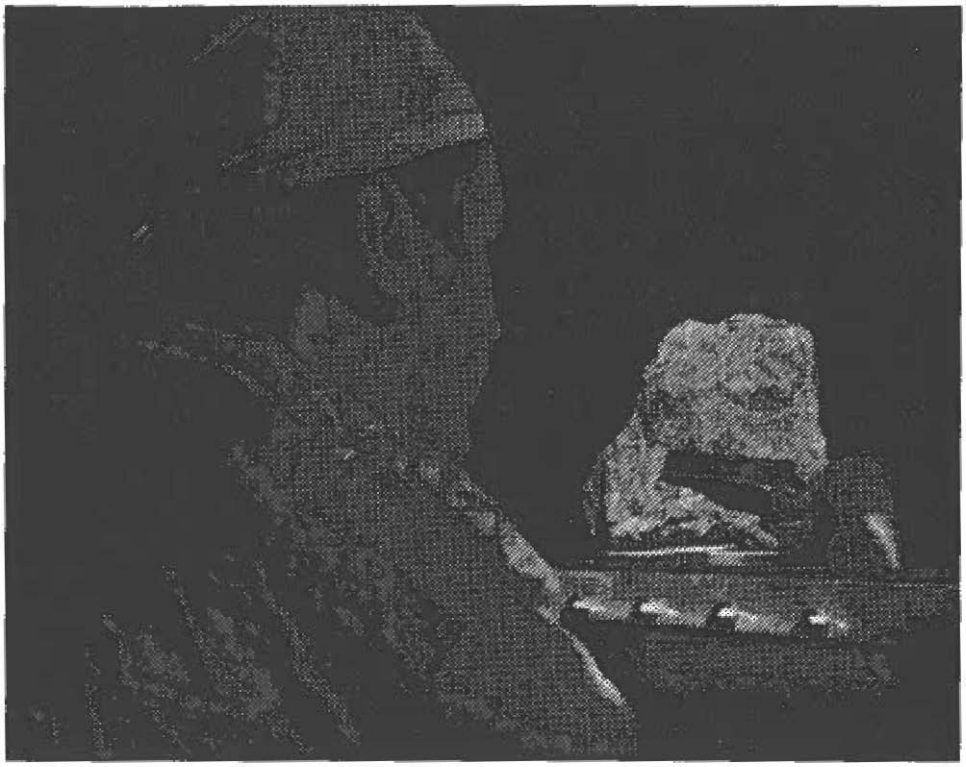
To establish a basic collection in geology and astronomy, Waranius says "you rely on your people," in this case, the planetary science community that has grown along with the library.

Dr. Bevan French, a Discipline Scientist at NASA Headquarters, who managed NASA's research program on lunar samples and meteorites from 1975 to 1984, recalls that "Fran was essentially an active and effective member of the planetary science community. She had a marvelous rapport with both the established scientists and the new young investigators, and a lot of library and educational business got done as the result of conversations with people who just dropped by LPI to say hello to Fran."

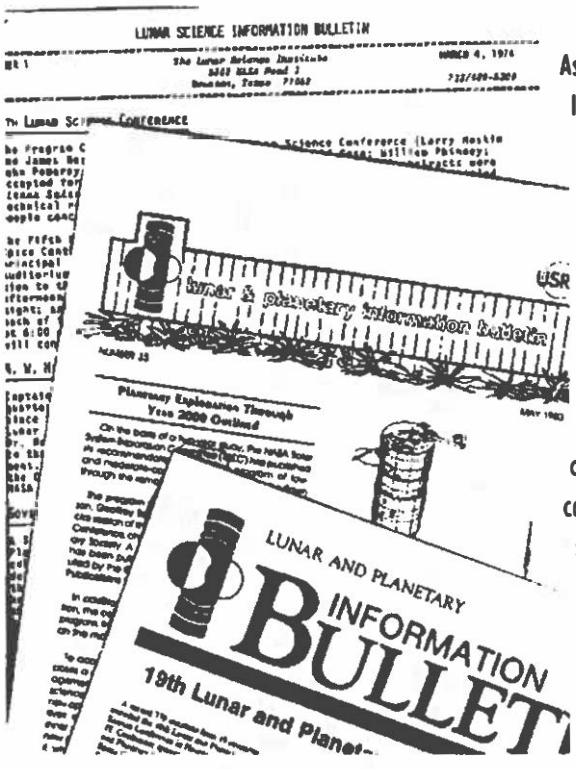
These conversations and other contacts helped Waranius acquire materials for the library. "Everybody in NASA and the community sent publications to Fran at LPI simply because we knew that she would make sure they were used," French commented. "Anything that the library itself didn't need would go to students or visitors. Nothing would be wasted." In 1976, this close relationship and some fast footwork between Waranius and NASA Headquarters salvaged nearly 2000 copies of a NASA photographic atlas, *The Moon as Viewed by Lunar Orbiter*, which the Government Printing Office was discarding. "We managed to get them shipped to LPI instead of to the dump," French recalls. "They made marvelous handouts at the next Lunar and Planetary Science Conference, and they are still a collector's item for people working on lunar science and planning a future return to the Moon."

One of the challenges of building and curating the collection is its bulk. It's only recently that planetary data has begun to be distributed in digital form. Waranius notes that one of the biggest problems was finding equipment to hold things. Some

continued on page 17



The LPI Library collection documents the earliest days of lunar science including the beginnings of lunar sample analysis.



As co-editor of Issue 1 in March 1974 and sole editor of Issues 2 through 57 (November 1990), Fran Waranius provided another important service by publishing the Lunar and Planetary Information Bulletin. Originally the Lunar Science Information Bulletin, it was conceived as a way to enhance communication within the lunar science community. Readership has grown from 500 in 1974 to almost 6000 today.

NEW IN PRINT

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

MICA: U.S. NAVAL OBSERVATORY'S ASTRONOMICAL ALMANAC FOR THE PC AND MACINTOSH

The U.S. Naval Observatory recently introduced *MICA, the Multiyear Interactive Computer Almanac. MICA* is a software system that provides high-precision astronomical data in tabular form for a wide variety of celestial objects. Designed for professional applications, *MICA* calculates, in real-time, much of the information tabulated in the benchmark annual publication, *The Astronomical Almanac.* However, *MICA* goes beyond traditional almanacs by enabling the user to calculate data for user-specified locations at user-specified times within a ten-year interval (1990–1999).

Specifically, *MICA* can provide the following information:

- nine types of positions of celestial objects, including geocentric and topocentric apparent places, astrometric places, and topocentric horizon coordinates
- time and Earth orientation data, including sidereal time, nutation components, and obliquity of the ecliptic
- times of rise, set, and transit of celestial objects, and times of civil, nautical, and astronomical twilight
- data on the apparent size, illumination, and orientation of the Sun, Moon, and major planets for telescopic observations
- a summary of the instantaneous configuration of the Sun, Moon, and major planets at user-specified times

The data provided by *MICA* match the high precision and benchmark accuracy of *The Astronomical Almanac. MICA* features a ten-year solar system ephemeris (the Jet Propulsion Laboratory's DE200/LE200), an internal catalog of the 21 brightest stars and Polaris, and five additional catalogs of astronomical objects. Furthermore, *MICA* has the ability to access specialized catalogs created by a competent user. *MICA* tables can be generated in either of two different time scales, with either civil or Julian dates. Rise, set, transit, and twilight times can be tabulated for any time zone. The *MICA* software is accompanied by a comprehensive User's Guide that contains an explanatory chapter on modern astronomical calculations.

MICA is available in versions for IBM and compatible PCs and Apple Macintosh systems. Both DOS and Macintosh versions reflect the latest thinking about how users and almanacs interact. The DOS version of *MICA* features an easy-to-use menu-driven interface. The Macintosh version offers a full-featured Macintosh graphical user interface.

The DOS version of *MICA* requires an IBM PC or compatible running DOS version 2.0 or higher and at least 512K of RAM. A hard drive with 2 megabytes of free space is also required. A processor with a clock speed of at least 8 MHz and a math coprocessor are highly recommended. Both 5 1/4 inch 360K and 3 1/2 inch 720K disks are provided in the package.

The Macintosh version requires a Macintosh Plus or higher with at least 1 megabyte of RAM running System 6.0.2 or higher. It is compatible with System 7, requiring at least 1 megabyte of

memory in addition to the system requirements. A hard drive with at least 2 megabytes of free space is also required. Macintosh systems with 68020 or higher processors and math coprocessors are highly recommended.

Both versions of *MICA* are distributed for the U.S. Naval Observatory by the National Technical Information Service (NTIS). Each version costs $55.00 ($80.00 outside the US, Canada, and Mexico). Checks and credit cards are accepted for payment. To order, or for more information, contact: U.S. Department of Commerce, National Technical Information Service, 5285 Port Royal Road, Springfield VA 22161. Phone: 703-487-4650; Fax: 703-321-8547.

SHUTTLE EARTH OBS VIDEO DISK AVAILABLE FROM NASA JSC

The Space Shuttle Earth Observations video disk is available to the public from Johnson Space Center. It contains 91,500 still images of Earth taken during shuttle missions STS-1 through STS-44 (1981–1991). A wealth of information about the planet's oceans, lakes, rivers, weather, and geology is captured in these images. The video disk package includes the disk itself, a Guide to Images booklet, and two IBM-formatted floppy disks containing the image description database. $55.00 (checks payable to NASA) from Bunny Dean, Mail Code AP4, NASA Johnson Space Center, 2101 NASA Road One, Houston TX 77058.

NEW FROM LGI

The newest technical report, "Resources Exploration: Industry Perspective: The Franchise Model," TR93-01 is available free from the Lunar Geotechnical Institute. Order from LGI, P.O. Box 5056, Lakeland FL 33807-5056. Phone: 813-646-1842; Fax: 813-644-5920.

AVAILABLE FROM GPO

MAGELLAN BOOKLET

The 24-page booklet, *Magellan*, published in 1993, describing the mapping mission to Venus is available from the U.S. Government Printing Office. Paperbound, illustrated and in color, stock number 033-000-01127-0, $2.25. Send prepayment to Superintendent of Documents, Washington DC 20402-93325; to order by credit card, phone: 202-783-3238.

SET OF SOLAR SYSTEM POSTERS

Our Solar System, a distinctive poster set released by NASA, features photographs and images of planetary objects taken during a variety of spacecraft missions. The set of 12 8×11-inch posters includes images of the Sun, Mercury, Venus, Earth, Moon, Mars, asteroid Gaspra, Jupiter, Saturn, Uranus, Neptune and Comet Halley. Information about the bodies is printed on the back of each poster. Stock number 033-000-01120-2. $2.25 from Superintendent of Documents, P.O. Box 371954, Pittsburgh PA 15250-7954. Credit card orders by phone: 202-783-3238; or fax: 202-512-2250.

NEW IN PRINT

NEW FROM THE ASTRONOMICAL SOCIETY OF THE PACIFIC

NEW HUBBLE TELESCOPE IMAGES

A slide and information set featuring 20 new images from the Hubble Space Telescope is available from the non-profit A.S.P. The slides include color views of the huge storm in the atmosphere of Saturn, the surface of Mars, a complex jet in the Orion Nebula, stars in the dense cluster 47 Tucanae, the inner jet in the giant galaxy M87, a "starburst galaxy," and an unusual "X" structure marking a possible black hole in the Whirlpool Galaxy. The slides come with a booklet of captions and a preview of the mission planned by NASA to correct Hubble's eyesight. $29.95 from A.S.P., HST Slide Orders, 390 Ashton Avenue, San Francisco CA 94112.

CONSTELLATION SLIDE SET

Each slide in this helpful teaching set shows two views of a constellation side by side: an actual picture of the constellation in the night sky and a clear, color line drawing of the constellation figure and boundaries drawn at the same scale. Names of the brightest stars and Messier objects are also marked. To insure outstanding image quality, each slide is made through a painstaking triple exposure process in the labs of Science Graphics. The accompanying booklet by O. Richard Norton gives detailed information about the mythologic background of the constellation as well as data on the astronomical objects in each slide. It also contains a glossary. $87.95 from A.S.P., Item Number AS 289, Constellation Slide Set Orders, 390 Ashton Avenue, San Francisco CA 94112.

STScI PREPARING A DESKTOP UNIVERSE FOR ASTRONOMERS

Astronomers at the Space Telescope Science Institute (STScI) in Baltimore, Maryland report that their ambitious program to make a digitized survey of the entire sky available to astronomers around the world will debut by the end of this year. At that time, STScI plans to have the survey of the southern sky digitally compressed and stored on a set of 60 CD-ROMs. STScI has completed the compression of the southern sky and is about to begin compressing digital scans of the northern sky. The northern images will be distributed on 40 CD-ROMs in 1994.

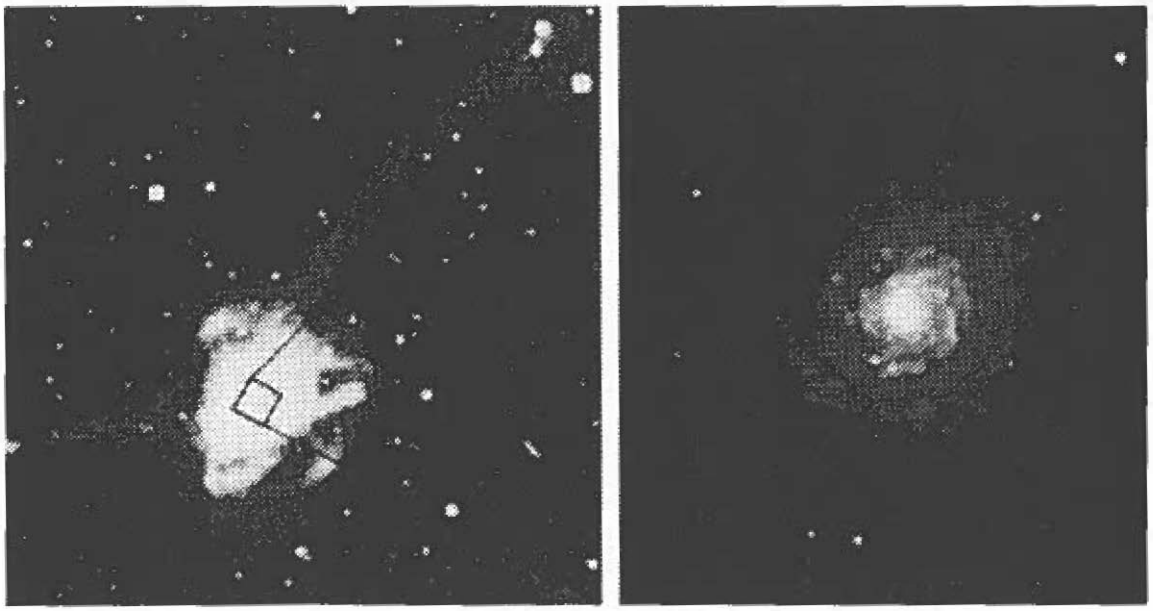
"Photographic sky surveys have had a tremendous impact on astronomy. The sky survey CD set will be one of the most important astronomical research tools ever created," said project scientist Marc Postman. "It will afford astronomers rapid access to images of the sky in a format that is readily digested by modern computers." Postman explained that two versions of the entire sky are being produced — one at a compression factor of 10 that is nearly indistinguishable from the original data, and one at a compression factor of about 100. The latter will fit on just ten CD-ROMs. "While the higher compression is not suitable for professional research activity," Postman emphasized that the ten CD-ROM set will provide an invaluable tool for the educational and amateur communities.

The original sky survey photographs were taken with wide-angle Schmidt telescopes — the Oschin Telescope on Mount Palomar (California) and the United Kingdom Schmidt Telescope at Siding Spring in New South Wales, Australia. The Oschin Telescope is operated by the California Institute of Technology; the UK Schmidt was operated by the Royal Observatory Edinburgh until 1988 and subsequently by the Anglo-Australian Observatory. The surveys being compressed are the southern J band

survey (894 plates; epoch 1975–1984) and the northern Palomar E band survey (583 plates; epoch 1950–1956). They were first digitized during an intensive eight-year effort by STScI astronomers to prepare the Guide Star Catalog that provides the coordinates of target stars used by the Hubble Space Telescope for acquiring and locking onto celestial targets.

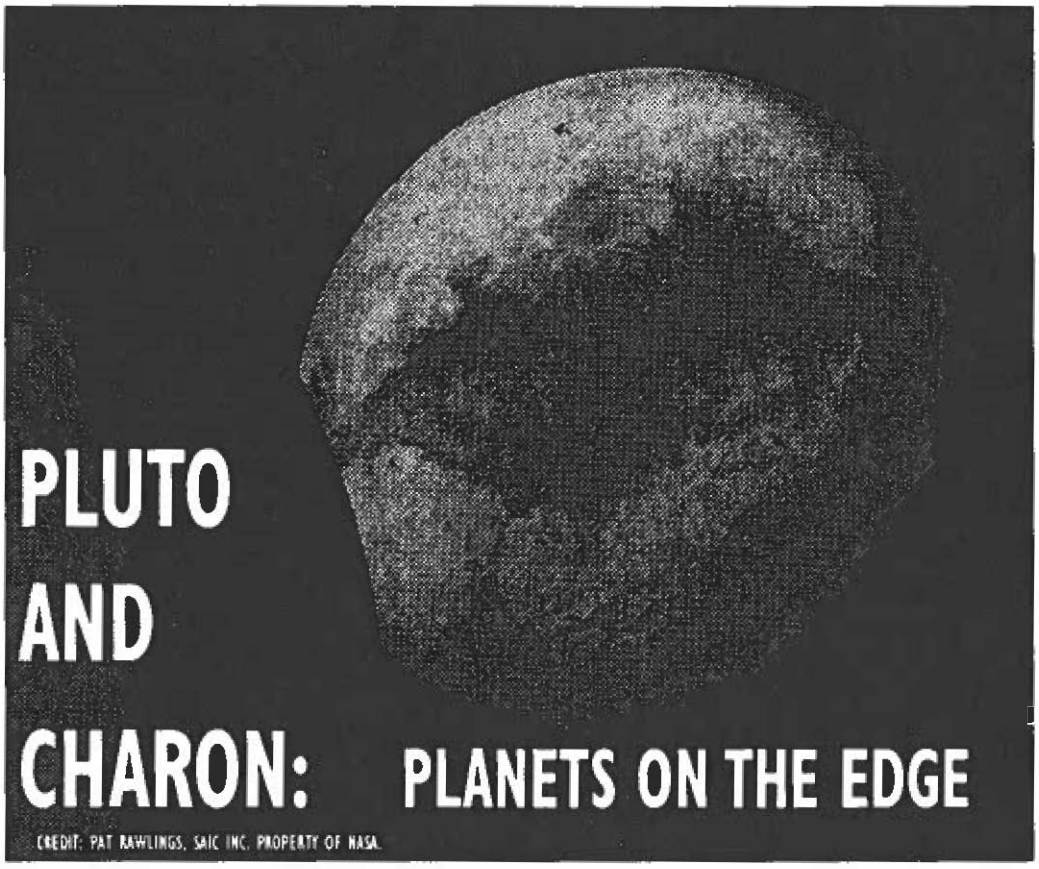
To make the digitized sky survey more accessible to researchers, STScI astronomers identified and extensively tested an algorithm that can compress the data by a ratio of 10:1 without significantly degrading the accuracy of stellar positions and brightnesses. When the sky survey CD-ROMs are released, all astronomers will have a powerful resource for doing a wide range of research. "One of the very exciting scientific projects that will be greatly aided by this database is the mapping of the three-dimensional distribution of galaxies 900 million light-years away," said Postman.

The first release of the compressed data is expected late in 1993. A distribution plan is being worked out to make the compressed sky survey sets affordable to libraries, astronomy departments, and amateurs around the world. For further information, contact Marc Postman, STScI, 410-338-5072.



***WHEN GALAXIES COLLIDE**—The Hubble Telescope has discovered a pinwheel-shaped disk and about 40 very bright, young globular clusters (right) at the center of a head-on collision between two disk-shaped galaxies (left) that may be in the process of merging into a single giant elliptical galaxy. The disk looks very much like a face-on spiral galaxy but is only 1/20 the diameter of the total galaxy (NGC 7252). It is a system of interstellar gas and stars orbiting the bright nucleus of NGC 7252. This is the latest in a series of Hubble discoveries of disk or ring-like objects in the cores of galaxies that are revealing more about the dynamics of galaxy collision and merger and the formation of giant elliptical galaxies.*

Although poorly understood, the Pluto-Charon system is certainly not boring. As the largest solid-body object beyond the orbit of Saturn, Pluto may be the last survivor of a family of outer solar system planetesimals or possibly planetary embryos. The recent discovery of a thin atmosphere and the identification of highly volatile gases frozen on the surface, as well as complex albedo patterns, suggest a complex geologic history for this system. Furthermore, Pluto's highly elongated, Neptune-crossing orbit and the existence of its large satellite, Charon, imply a rich dynamical history as well. Its composition and dynamical history are key tracers of the evolution of the outermost solar nebula.



PLUTO AND CHARON: PLANETS ON THE EDGE

by Paul Schenk and Renu Malhotra

On July 6–9 this year, planetary astronomers and geologists gathered in Flagstaff at the Pluto & Charon meeting to discuss the latest data and theories as well as plans for a proposed mission to this fascinating binary planet system. The proposed "fast flyby" mission late this decade met with universal approval. In contrast, there was considerable disagreement about even relatively simple issues such as Pluto's radius and Charon's density, underscoring the need for a spacecraft mission to characterize this system.

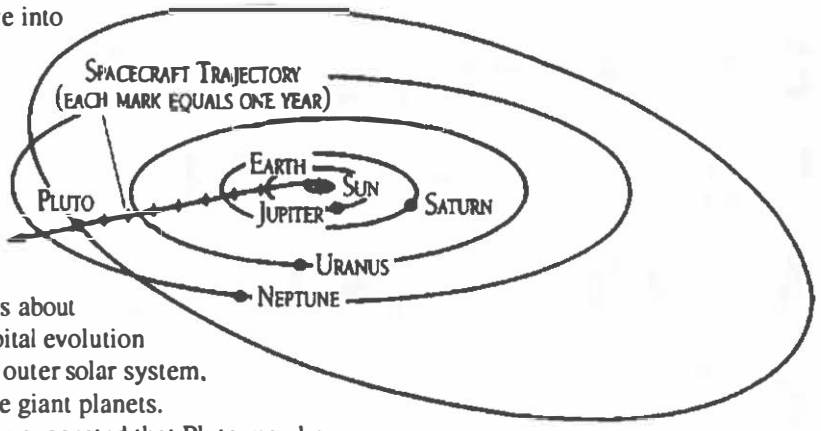
Estimates of Pluto's radius based on analyses of the mutual eclipse events with Charon during 1985–1990 differ from stellar occultation results: the latter imply a slightly larger radius, hence a lower density and higher ice-to-rock ratio. These seemingly small differences lead to profoundly different inferences about the internal structure of the planet.

For Charon, Hubble Space Telescope astrometric measurements indicate a density of 1.3 g/cc, while Earth-based speckle astrometry yields a density closer to 2 g/cc. Again, these differences have important implications for the origin of this binary system. A low density Charon would support a large-impact origin, similar to that currently favored for the Earth-Moon binary.

Disagreement also emerged over the surface temperature of Pluto, which controls the mobility of volatile frosts. The Infrared Astronomical Satellite (IRAS) observed Pluto in the infrared, implying a surface temperature in the mid-50 K range, whereas millimeter-wavelength observations and the albedo imply temperatures in the mid-30 K's. The Pluto-Charon eclipse events have been used to reconstruct Pluto's surface albedo on a scale of about 100 km. Differing inversion techniques produce albedo maps that differ slightly in detail but which agree in the existence of a bright polar cap and a dark spot at mid-northern latitudes. It appears that despite Pluto's large distance from the Sun and low solar insolation, it may have a surprisingly active "climate."

The dynamical history of the Pluto-Charon system is potentially a tracer for the evolution of planetesimals and embryonic planets that populated the outer solar system 4.5 billion years ago. Although Pluto's orbit overlaps Neptune's, a complicated set of nested resonances protects these planets from close encounters. The strongest is the 3:2 mean motion resonance with Neptune (Pluto's orbital period is exactly one-and-a-half times Neptune's period), which ensures that conjunctions of these planets occur away from Pluto's perihelion when Pluto is closer to the Sun than Neptune. Yet another resonance condition ensures that at perihelion Pluto is always far above the plane of Neptune's orbit, further increasing the distance of closest approach.

Billion year integrations of the planetary orbits indicate that Pluto's orbit is chaotic, yet stable—an apparent contradiction. It is unlikely that Pluto-Charon formed in this strange orbit. An old suggestion that Pluto may be an escaped satellite of Neptune has become untenable in the face of a variety of dynamical arguments. Theories that were put forward at the meeting argue for formation in a more typical near-circular coplanar orbit and subsequent capture into the 3:2 resonance early in solar system history. The dynamics of Pluto may have a great deal to tell us about the early orbital evolution of the entire outer solar system, including the giant planets.



It has been suggested that Pluto may be a "twin" of Neptune's large retrograde satellite, Triton, because of their similarity in size, bulk density and surface composition. Nitrogen, carbon monoxide, and methane, common terrestrial atmospheric constituents (at least in the Houston area), are frozen on the surfaces of both bodies. CO_2 is also frozen on the surface of Triton, but, so far, water frost has been identified only on Charon. Triton and Pluto both possess thin atmospheres of nitrogen and methane.

Pluto is not another Triton, however. It may be somewhat less dense than Triton; it is significantly darker, and Charon is darker still. Moreover, Pluto has probably not experienced the catastrophic thermal history of Triton associated with its capture by Neptune.

So, it appears that we have a reasonable first-order assessment of the bulk properties of the Pluto-Charon system, but there is considerable uncertainty in its bulk composition and its geologic and dynamical history. Was Pluto ever geologically active? How does the geology reflect the internal composition? What does this system tell us about the outer solar nebula and how planets form and evolve in that cold, distant environment?

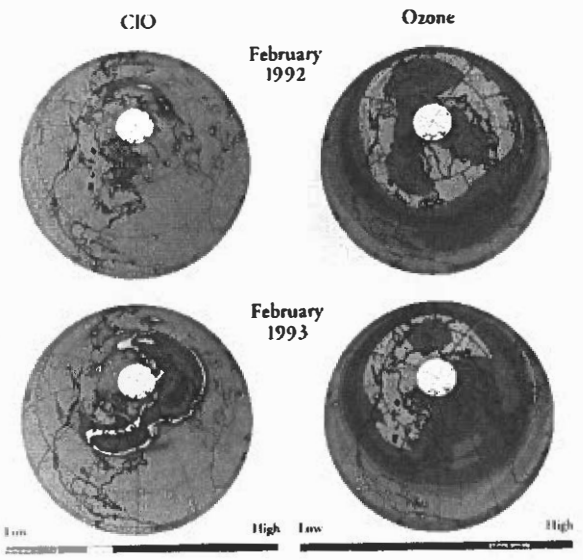
The mission to Pluto, currently in the preliminary planning stage, aims to answer some of these questions and has clearly already inspired much new thinking about the distant system. The difficulties in reaching this target 4 billion kilometers from Earth place serious constraints on the mission (such as a long, seven-year flight time), but new technology and very lightweight instruments under development offset some of these problems (see The Pluto Reconnaissance Flyby Mission, *EOS, AGU Transactions, 74*, p. 73, 1993, for details). This mission should provide a detailed look at the geology and composition of the surfaces of both Pluto and Charon, and will complete the reconnaissance of the planets. At least one prediction is relatively secure: we are due for some surprises at Pluto. ∅

(Dr. Schenk and Dr. Malhotra are staff scientists at the Lunar and Planetary Institute.)

PARAMETER	PLUTO	CHARON
Distance from the Sun, astronomical units	39.44 (mean) 29.64 (min.) 49.24 (max.)	Same Same Same
Period of solar orbit, Earth years	247.7	Same
Period of rotation, Earth days	6.3872	Same
Inclination of axis, degrees	122	Same
Inclination of solar orbit to ecliptic, degrees	17.15	Same
Distance from Pluto, kilometers	—	19,400 (appx.)
Equatorial diameter, kilometers	2,400 (appx.)	1,200 (appx.)
Known surface ices	CH_4,N_2,CO	H_2O
Atmosphere	Confirmed	Unlikely

A comparison of Pluto and its known moon shows many similarities and some key differences.

OZONE DESTROYING CHLORINE PERSISTED LONGER OVER THE ARCTIC IN 1992-93 WINTER



The chlorine monoxide maps (above) represent a layer about 20 km above Earth's surface. The ozone maps show the total amount averaged over the period February 15 to March 6 in each year. Chlorine monoxide maps (lower left) represent the same 20-km layer and compare the north and south polar regions a year apart.

Ozone-destroying forms of chlorine existed for much longer in the Arctic stratosphere this winter than last, say scientists. Northern Hemisphere ozone abundance also was observed to be some 10% below that measured during the same period last year, with some regions 20% lower.

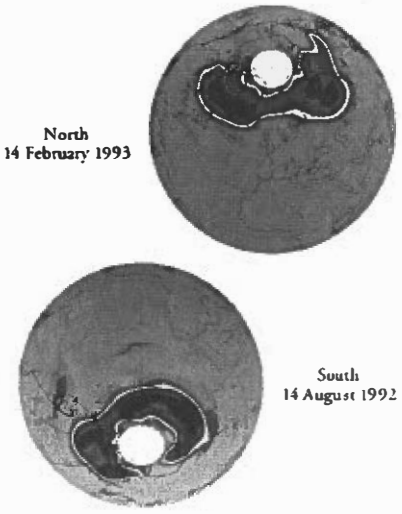
UARS CONTINUES TO MAP STRATOSPHERE

Using NASA's Upper Atmosphere Research Satellite (UARS), Dr. Joe Waters and colleagues at the Jet Propulsion Laboratory (JPL) and Edinburgh University have collected daily maps of ozone and other gases and of temperature in different layers of the stratosphere. One of their most critical measurements is of chlorine monoxide, a form of chlorine that destroys ozone. They reported the results in the scientific journal *Nature*.

"Ozone concentrations in the Arctic in a layer about 12 miles (20 kilometers) high, where most chlorine monoxide was located, decreased by 0.7% per day from mid-February through early March 1993," Waters said. Ozone levels normally increase in this area at this time of the year, he added.

Chlorine already in the stratosphere from chlorofluorocarbons is converted to ozone-destroying forms by chemistry occurring in clouds that form at low temperature.

Last year, the scientists measured large abundances of chlorine monoxide in the Arctic, but the concentrations decreased after the stratosphere warmed in late January. This winter, the stratosphere remained cold through February, and chlorine monoxide remained abundant through early March.



CONDITIONS RECALL PRE-'92 ANTARCTIC

About as much chlorine monoxide was seen in the northern polar regions in February 1993 as was measured at the South Pole before the 1992 Antarctic ozone hole formed.

"We do not see a well-defined area of ozone loss that could be described as an Arctic ozone hole," Waters said, "but the smaller abundances of ozone seen throughout the Northern Hemisphere this winter raise the question of whether the chlorine destruction of ozone has been spread over a wider area." Record low values of ozone also have been reported recently by the World Meteorological Organization and Environment Canada.

The microwave limb sounder aboard UARS was developed and is operated by JPL, led by Waters and sponsored by NASA's Office of Mission to Planet Earth. Additional members are from Edinburgh University, Heriot-Watt University and the Rutherford-Appleton Laboratory in the United Kingdom.

UARS, launched September 12, 1991, aboard Space Shuttle Discovery, is managed by NASA's Goddard Space Flight Center, Greenbelt, Maryland.

PUBLICATIONS FROM LPI

QUANTITY	CODE	TITLE	PRICE	TOTAL
		BOOKS		
	B-ACM	ASTEROIDS, COMETS, METEORS 1991	$80.00	
	PRO-22	PROCEEDINGS OF LUNAR AND PLANETARY SCIENCE, VOLUME 22	$25.00	
	PRO-20	PROCEEDINGS OF THE TWENTIETH LUNAR AND PLANETARY SCIENCE CONFERENCE	$25.00	
	B-ORIGINS	ORIGIN OF THE MOON	$15.00	
	B-BASES	LUNAR BASES AND SPACE ACTIVITIES OF THE 21ST CENTURY	$15.00	
		SLIDE SETS		
	S-HAWAII	VOLCANIC FEATURES OF HAWAII AND OTHER WORLDS *NEW*	$20.00	
	S-TOUR	A SPACECRAFT TOUR OF THE SOLAR SYSTEM	$20.00	
	S-IMPACT	TERRESTRIAL IMPACT CRATERS	$18.00	
	S-WINDS	THE WINDS OF MARS: AEOLIAN ACTIVITY AND LANDFORMS	$18.00	
	S-STONES	STONES, WIND, AND ICE: A GUIDE TO MARTIAN IMPACT CRATERS	$18.00	
	S-VOLC	VOLCANOES ON MARS	$15.00	
	S-APOLLO	APOLLO LANDING SITES	$20.00	
	S-OCEANS	SHUTTLE VIEWS THE EARTH: THE OCEANS FROM SPACE	$20.00	
	S-CLOUDS	SHUTTLE VIEWS THE EARTH: CLOUDS FROM SPACE	$20.00	
	S-GEOL	SHUTTLE VIEWS THE EARTH: GEOLOGY FROM SPACE	$20.00	
		TECHNICAL REPORTS AVAILABLE FOR THE COST OF SHIPPING AND HANDLING, EXCEPT 88-03		
	88-03	ASTRONAUT'S GUIDE TO TERRESTRIAL IMPACT CRATERS	$4.00	
	92-01	TOWARDS OTHER PLANETARY SYSTEMS (TOPS): A TECHNOLOGY NEEDS ASSESSMENT WORKSHOP	$0.00	
	92-03	WORKSHOP ON THE PHYSICS AND CHEMISTRY OF MAGMA OCEANS FROM 1 BAR TO 4 MBAR	$0.00	
	92-04	WORKSHOP ON CHEMICAL WEATHERING ON MARS, PARTS 1 & 2	$0.00	
	92-05	WORKSHOP ON THE EVOLUTION OF THE MARTIAN ATMOSPHERE	$0.00	
	92-06	JOINT WORKSHOP ON NEW TECHNOLOGIES FOR LUNAR RESOURCE ASSESSMENT	$0.00	
	92-07	WORKSHOP ON INNOVATIVE INSTRUMENTATION FOR THE IN SITU STUDY OF ATMOSPHERE SURFACE INTERACTIONS OF MARS, PARTS 1 & 2	$0.00	
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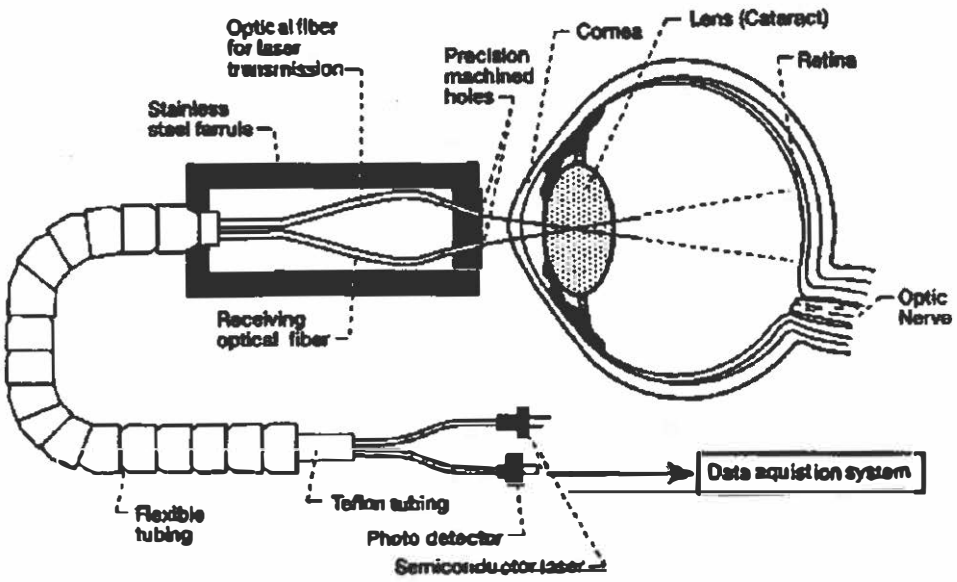


Fiber optic system for early detection of cataracts.

CATARACT SUFFERERS COULD BENEFIT FROM SPACE TECHNOLOGY

Thousands of potential cataract sufferers may benefit from a technology under development at NASA's Lewis Research Center. Recently, researchers announced a new diagnostic tool that may lead to treatment of cataracts while they are in the earliest formative stages. According to Dr. Rafat Ansari, project scientist, "Once a series of voluntary patient studies is completed using this prototype tool, pharmaceutical companies then may have the opportunity to develop the necessary drugs to neutralize a developing cataract."

The tool is a small, fiber optic probe that can detect protein crystals suspended in the fluid inside the eye's lens. These crystals are suspected of forming into a cloudy mass over time, thus causing cataracts. "Until now," according to Ansari, "physicians have not had the technology to tell what is really happening inside the lens." Along with Professor Harbans Dwadwal of the State University of New York at Stoneybrook, Ansari has developed an instrument that uses laser light to detect cataracts in the very early formative stages.

An optical fiber transmits a low-power laser beam that is scattered inside the eye; the reflections are picked up by a return fiber optical path. The reflected light is sampled by a detector inside the small device. The laser light is very weak so there is no risk to eye damage from the laser. The electrical signal from the detector is fed to a laptop computer where it is analyzed and where it also could be stored permanently. Measurements that indicate a change in protein particle size might indicate the onset of a cataract.

Ansari points out that this probe's ability to measure the sizes of very small particles suspended in solutions may have industrial uses as well as the application he has developed in ophthalmology. Originally developed for an experiment in materials processing aboard the space shuttle, the diagnostic tool is small enough to fit in a shirt pocket. Ansari is a research professor at Cleveland's Case Western Reserve University who works as a project scientist for the Materials Division, Lewis Research Center.

NASA PROVIDING MIDWEST FLOODING INFORMATION

NASA is providing assistance to the Federal Emergency Management Agency's (FEMA) efforts to gather information on the flood-damaged Midwest. In July, personnel from NASA's John C. Stennis Space Center (SSC) flew specialized sensors mounted in an airplane over portions of the midwestern states. With digital imagery, information from a particular area can be collected, computer-analyzed, and compiled

PHOTO: NASA

The above color infrared photograph, acquired by NASA's John C. Stennis Space Center July 18, clearly shows the devastating impact flooding has had on Cape Giradeau, Missouri.

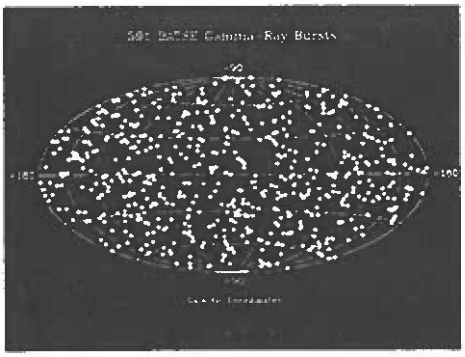
more quickly than with conventional photography. The resulting information is more versatile than other forms of data. Changes in conditions can be updated and edited immediately.

FEMA will use these images to assist in charting flood-damaged areas, to boost the emergency management agency's computer database on the region, and to update flood insurance maps. In addition, the data will be used in assessing the status of residential and industrial areas and related infrastructure such as roads, bridges, and rail services.

Another major concern to FEMA is getting initial disaster assistance to the people who need it most. "The NASA data will be especially useful to the Federal Emergency Management Agency in their efforts to quickly settle flood insurance claims, making sure those who need the help receive assistance in a very timely manner," said NASA's Roy Estess, Director of SSC. "This is an effective use of available resources that can save taxpayer dollars."

While flying the aerial reconnaissance mission, digital imagery and high-resolution infrared photographs were taken of the flooded region. Flights from 41,000 feet and 6,600 feet produced both multispectral digital imagery and color photography at a variety of resolutions to 15 feet.

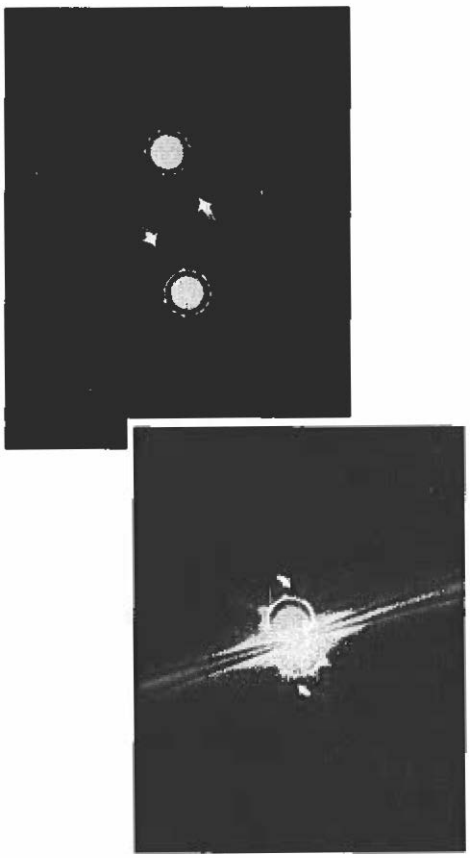
While other agencies are furnishing data to FEMA, NASA is the only agency offering digital imagery," Estess said. SSC can respond quickly with important information in emergency situations. The NASA facility has played an integral part in developing digital imaging technology for use in disaster assessment. In August 1992, SSC provided the state of Florida with both digital imagery and infrared photography of South Florida areas hit hardest by hurricane Andrew. The imagery helped officials assess the damage, prioritize relief efforts and develop long-term land use plans.



GAMMA-RAY BURSTS: MORE MYSTERIOUS THAN EVER

New findings from the Compton Gamma-Ray Observatory indicate that powerful gamma-ray bursts, one of the great mysteries of astronomy, may be more energetic than previously thought and appear to originate far beyond the Milky Way galaxy. The data raise the possibility that the bursts of high energy radiation may be caused by unknown objects or phenomena in the universe, scientists said.

"These results eliminate some theoretical models entirely and produce severe constraints on other possible theories" about the source of the gamma-ray bursts, said Carl E. Fichtel of NASA's Goddard Space Flight Center. He is the co-principal investigator for one of the satellite's instruments, the Energetic Gamma Ray Experiment Telescope (EGRET). The critical new data include observations of the highest energy gamma-rays ever recorded in a burst.



One theory involves two neutron stars in orbit around each other, ultimately so close that they touch and merge. The merger releases a "fireball" of energy that is focused by the two stars into a beam of gamma rays that we see when one beam is in Earth's line of sight. At the distance of the Earth, the beam would actually intersect not only the Earth but many galaxies.

A two-year mapping survey by another instrument on the orbiting observatory, the Burst and Transient Source Experiment (BATSE), show that the bursts are evenly distributed in space. BATSE has seen an average of one gamma-ray burst a day since the observatory was launched on April 5, 1991. As of March 23, 1993, 591 bursts have been recorded. The pattern of the bursts on the sky has shown them to be distributed like no other known objects in the Milky Way, indicating that they may originate outside the galaxy, said Chryssa Kouveliotou, a BATSE team member who works for Universities Space Research Association, a contractor at NASA's Marshall Space Flight Center

An important clue to the puzzle was obtained on January 31, 1993, when EGRET recorded a gamma-ray burst that was 10 times higher in energy than any previously observed since the launch of Compton. The burst — dubbed the "Super Bowl Burst" because it was seen on Super Bowl Sunday — was more than 100 times brighter at its peak than the brightest steady source of gamma rays in the Milky Way galaxy and more than 1000 times brighter than any other known sources outside the Milky Way.

Aside from its extreme brightness, this event is similar in most other respects to the other bursts recorded by Compton and earlier satellites. Because bursts this bright are relatively rare and the EGRET experiment views only a small portion of the sky at a particular time, astronomers were incredibly lucky to have this event occur when EGRET was pointed in that general direction. The nature of the burst indicates that many more may be occurring than scientists detect.

"The EGRET observation of the highest-energy gamma rays suggests they may be emitted in a small beam, like a spotlight, to escape the source," said Brenda Dingus, an EGRET team member who works for Universities Space Research Association at Goddard. "However, to observe such a small beam, it must be pointed at us. So there may be many more objects emitting gamma-ray bursts that we do not see because their beams point elsewhere."

Both the BATSE and EGRET results undercut the two most widely accepted models that attempted to explain gamma-ray bursts prior to Compton's launch. One model says the bursts are energy releases from neutron stars and are confined to the Milky Way galaxy and a region, or "halo," surrounding it. A neutron star is the small, extremely dense remnant core of a star that has exploded in a supernova. Since the Earth is in the outer suburbs of the Milky Way, more bursts should be seen toward the more densely populated center of the galaxy than elsewhere, according to this model. "But that hasn't turned out to be the case. Gamma-ray bursts do not seem to cluster in a preferred region of the sky," said Kouveliotou. "These bursts are emitted from all directions and vary greatly in intensity and time structure."

Another model suggests that gamma-ray bursts emanate from the distant reaches of the universe, possibly the result of stellar explosions or neutron stars or black holes colliding. Many of these models predict that the gamma rays are the thermal energy produced in these explosions or collisions. But the gamma rays seen by EGRET from the Super Bowl Burst are not of the thermal type. "This begs the question — If these collisions or explosions are not the source of gamma-ray bursts, what are? We don't know yet," said Marshall's Gerald Fishman, the BATSE Principal Investigator. "It is possible that some new object or phenomenon is producing these bursts."

Fishman said the Compton data will be studied by scientists from around the world who are seeking to unravel the puzzle of gamma-ray bursts. "It's difficult to say exactly where this new information will lead," said Fishman, "but it's probably safe to assume that we'll have to rewrite the textbook on gamma-ray bursts."

Cohen accepted a commemorative plaque from LPI Director David Black at a reception hosted by the Center for Advanced Space Studies in recognition of the support and friendship the retiring JSC Director has given the Institute.

AARON COHEN RETIRES FROM JSC DIRECTORSHIP

Aaron Cohen has accepted an appointment as the Zachry Professor of Engineering at his alma mater, Texas A&M University, and will retire as Director of the Johnson Space Center on August 20 to assume his engineering faculty duties when the fall term opens. Paul J. Weitz, Deputy Director of JSC, will become Acting Director.

Cohen came to NASA in 1962 and served in key leadership roles in the Apollo Program, where his efforts were critical to the successes of all six U.S. lunar landings. He subsequently served as the Manager for the Space Shuttle orbiter, directing the design, development, production, and initial flight testing of the orbiter. He was made responsible for all engineering and research at JSC following the successful completion of the Space Shuttle orbital flight tests, assuming his present responsibilities as Director in 1986. From March 1992 until March 1993, he served as Acting Deputy Administrator of NASA.

Dan Goldin, the NASA Administrator, said of Cohen, "Aaron represents all of the finest you could hope for in a government servant. His career and his accomplishments speak for themselves. He provides a benchmark. He has brought technical excellence, integrity, dedication and leadership to the Johnson Space Center and NASA. I know my fellow NASA employees join me in saying we will sorely miss him and his wise counsel and advice." Goldin announced that Cohen will serve as a Special Consultant to the Administrator on human spaceflight as well as research and technology. "Even though Aaron will be involved with his duties at Texas A&M, he has agreed to continue to assist NASA in answering the challenges that lie ahead. His continuing involvement will allow us to take advantage of his tremendous experience, knowledge, and expertise. Both Texas A&M and NASA can continue to benefit from the involvement of one of NASA's finest managers and engineers."

In announcing his plans Cohen said, "I am leaving with a great sense of accomplishment, but also with an enormous feeling of nostalgia. I have had the privilege of working with the giants of our profession, and I have had the good fortune to see future giants in the making. I am confident our nation's future space endeavors will be in good hands, and I look forward to helping Texas A&M educate our nation's future engineers."

Cohen's many honors include the highest award for senior Federal executives, the Presidential Rank of Distinguished Executive (1982 and 1988), and he has three times been the recipient of NASA's highest award, the Distinguished Service Medal. He is a member of the National Academy of Engineering, a Fellow of the American Astronautical Society and the American Institute of Aeronautics and Astronautics, a Distinguished Alumnus of Texas A&M, recipient of honorary doctorate degrees from Stevens Institute of Technology and from the University of Houston-Clear Lake, and recipient of the American Society of Mechanical Engineers Medal.

Cohen received his Bachelor's degree in Mechanical Engineering from Texas A&M in 1952, and his Master's degree in Applied Mathematics from Stevens Institute of Technology in 1958. He and his wife, Ruth, have three children and seven grandchildren. ∅

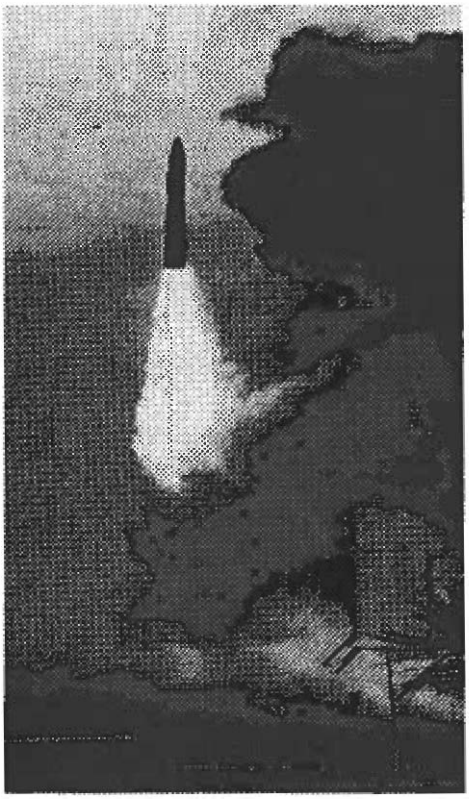
MISSLES MAY BE USED AS AFFORDABLE LAUNCH VEHICLES

Dr. Paul Coleman, President of the Universities Space Research Association and Professor of Geophysics at UCLA, recently announced plans for a pilot program of small missions using retired stategic missiles as launch vehicles. The program aims to demonstrate that good science can be done with these smaller missions and, in the spirit of the day, that it can be done "cheaper, faster, and better." It is called the "Student Explorer Demonstration Initiative" to highlight the intent to involve graduate students and entry level professionals working closely with experienced scientists and engineers to gain hands-on training as part of their university education.

Several hundred strategic missiles are being retired in compliance with the Strategic Arms Limitation Treaty (START). The pilot program will most likely use Minuteman II and III stages that will be converted through an agreement with the Air Force and will be launched from the Western Test Range at Vandenberg Air Force Base in California. The vehicles will be capable of delivering a 300-pound payload to a 500 km polar orbit or 600 pounds to an equivalent low-inclination orbit. Missions are expected to last up to one year.

The pilot program will consist of three missions to be completed within three years from go-ahead and for a total cost of 24 million dollars. NASA Administrator Daniel Goldin is seeking budget authority for FY 94 to fund the project. It is expected that approximately half the money will go to the Air Force to pay for the missile conversion, launch, and launch services. The remainder will fund the cost of the spacecraft and instrument hardware, payload integration, mission operations, and data analyses. If successful, at least six more missions could follow.

A draft announcement of opportunity is available on Internet via anonymous ftp from ftp.usra.edu in the directory /pub/cheapspace/ao. The file is available as encapsulated Postscript under the filename draftao.eps; as ascii under filename draftao.txt; and in Microsoft Word for Macintosh as draftao.msw. Seven figures are available under filenames figure?.eps in the same directory. For further information or to send comments on the AO, write or fax Kevin Schmadel, 300 D. Street SW, Suite 301, Washington, DC 20024; fax: 202-479-2613.



FRAN *continued from page 3*

had to be custom-made, such as the "coffin" designed and built to house the 9-inch by 6-ft Apollo pan photos.

Another challenge was keeping track of holdings that eventually filled 11 rooms in 3 buildings at the West mansion site. Even more challenging was guiding patrons through this maze. One solution was a color coding system that tagged every product of an individual Apollo mission—documents, books, maps, etc.,—with a particular color. "It was simple-minded, but you could follow a mission through the whole collection by following the right color."

"Moving into a new facility this last year and a half was wonderful," she exclaims of the move that put the library in one place for the first time in its history. Many observers felt Waranius resembled a general marshalling an invasion force more than a librarian during the transition.

But perhaps the biggest challenge, then and now, says Waranius, is convincing people that data is worth keeping and maintaining. "Sometimes it was rather clandestine. . .you kept what you had and kept quiet about it. . . until you could convince people of the value of archiving it," she admits. She feels that it will only be more difficult to keep records of planning and mission design in the future, as more is done through ephemeral electronic communications.

LOOKING TO THE FUTURE, THEN AND NOW

Waranius established the Lunar and Planetary Bibliography with students in mind. In the early days of lunar science, the community saw little need for such a database because the body of literature was small enough to be "knowable" by researchers. Waranius felt all along that the enterprise was worthwhile for the students who would come later. "That's what's kept me going all these years—the thought that I'm preserving this for the ones coming along now," she declares. "The Bibliography is still dear to my heart."

As the Bibliography is being transferred to a new computer database system, Waranius recalls the early forays into electronics. "We built Heathkit terminals—I sorted diodes—so that the library could have *two* terminals instead of one prebuilt! That's thrilling to me, too—to see how far we've come today in providing electronic services, from card catalogs to the Bibliography online."

With a shudder at the memory of consulting all those paper indexes, she exults, "Now, it's just *zippo*! It's all there. It's one of the most wonderful things I've seen. And this is not the end. It's still going to get better. Even CD-ROMS aren't the end. The whole idea of publications online is going to work out —somehow it is going to work! That's the wonder of it for me."

As for the challenges facing her successor, Waranius points to the astonishing rise in journal costs as an enormous one. "What with budget constraints we always face, you have to figure out what you can let go without losing the integrity of the collection." In addition, she says, there is the old problem of convincing researchers to recognize the need to archive what's being done *now* —to maintain records and data that may not seem of historical importance in the short term.

The collection she has amassed is testimony to Fran Waranius's success at preserving this heritage. Of her tireless efforts on behalf of future generations, she says, "I've loved it. I'm going to miss it."

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

Pam Thompson, Editor

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CALENDAR 1993

SEPTEMBER

20-22

Second Compton Symposium, University Park. Maryland. Contact: Sandra Barnes, Compton Observatory Science Support Center, NASA/GSFC. Code 668.1, Greenbelt MD 20771. Phone: 301-286-7780. Internet: barnes@grossc.gsfc.nasa.gov

27-28

Particle Capture, Recovery, and Velocity/Trajectory Measurement Technologies, Houston, Texas. Contact: Publications and Program Services Department, LPI, 3600 Bay Area Boulevard, Houston TX 77058-1113. Phone: 713-486-2166.

25-Oct 1

International Association of Volcanology and Chemistry of the Earth's Interior General Assembly, Canberra. Australia. Contact: IAVCEI ACTS, GPO Box 2200, Canberra ACT 2601, Australia. Phone: 61-6-257-3299; Fax: 61-6-257-3256.

OCTOBER

18-22

25th Annual Meeting of the Division for Planetary Sciences of the American Astronomical Society, Boulder, Colorado. Contact: Publications and Program Services Department, LPI, 3600 Bay Area Boulevard, Houston TX 77058-1113. Phone: 713-486-2150; Fax: 713-486-2160.

18-22

Cosmic Winds and the Heliosphere, Tucson, Arizona. Contact: Amy Schumann, Lunar and Planetary Laboratory, University of Arizona, Tucson AZ 85721. Phone: 602-621-2902; Fax: 602-621-4933. Internet: mary@lpl.arizona.edu

25-28

Geological Society of America Annual Meeting, Boston, Massachusetts. Contact: Vanessa George, GSA, Box 9140, Boulder CO 80301. Phone: 303-447-2020.

26-29

Conference on the Nature and Evolutionary Status of Herbig AE/BE Stars, Amsterdam, The Netherlands. Contact: HAEBE Conference, Astronomical Institute, University of Amsterdam, Kruislaan 403, 1098SJ Amsterdam, The Netherlands. Phone: 31 20 525 7491/7496; Fax: 31 20 525 7484. Internet: psthe@astro.uva.nl

27-28

Earth Observations and Global Change Decision Making: A National Partnership, ***Global Change: A New Direction for Decision Making,*** Washington. DC. Contact: ERIM Conferences. Phone: 313-994-1200 ext. 3453; Fax: 313-994-5123.

NOVEMBER

15-17

MSATT Conference—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: 713-486-2150; Fax: 713-486-2160.

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: (Technical Chair) Mohamed El-Genk, 505-277-5442; (Administrative Chair) Mary Bragg, 505-277-4950.

18-20

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

FEBRUARY

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

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

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: 713-486-2150; Fax: 713-486-2160.
Internet: simmons@lpi.jsc.nasa.gov

APRIL

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.

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

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.

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, SanFrancisco CA 94107-2348. Phone: 415-255-1297; Fax: 415-255-8496.

MARS EXPLORATION STUDY TEAM WORKSHOP INFORMATION ONLINE

NASA's Mars Exploration Study Team held a workshop at the Ames Research Center on May 24 and 25. The NASA team and invited consultants reviewed and critiqued the Mars exploration reference program developed during the past six months. Featured presentations focused on the areas of space transportation, surface systems, and habitat designs. Splinter discussions highlighted possible international cooperation, cost options, and dual-use technologies. Information about this workshop has been posted to the MARS bulletin board on the LPI computer.

To access the Mars Exploration Bulletin Board via the NASA Science Internet (NSI) or by direct dial:

On NSI/DECNET (formerly known as SPAN), type SET HOST LPI.

On NSI/Internet, type TELNET LPI.JSC.NASA.GOV or TELNET 192.101.147.11.

To dial direct, call 713-244-2090 or 713-244-2091 to connect to 2400/1200/300 baud.

For all three methods of access, respond to USERNAME: LPI. No password is necessary. Choose "Mars Exploration Bulletin Board," then select the file you wish to read or download from the subsequent menu. Then select "Read" to display the file, or select "Download" and follow the instructions and prompts for proper transmittal of the file to your computer.

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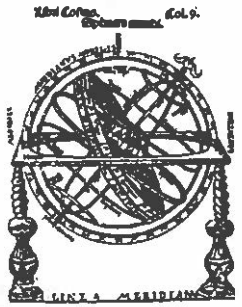

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