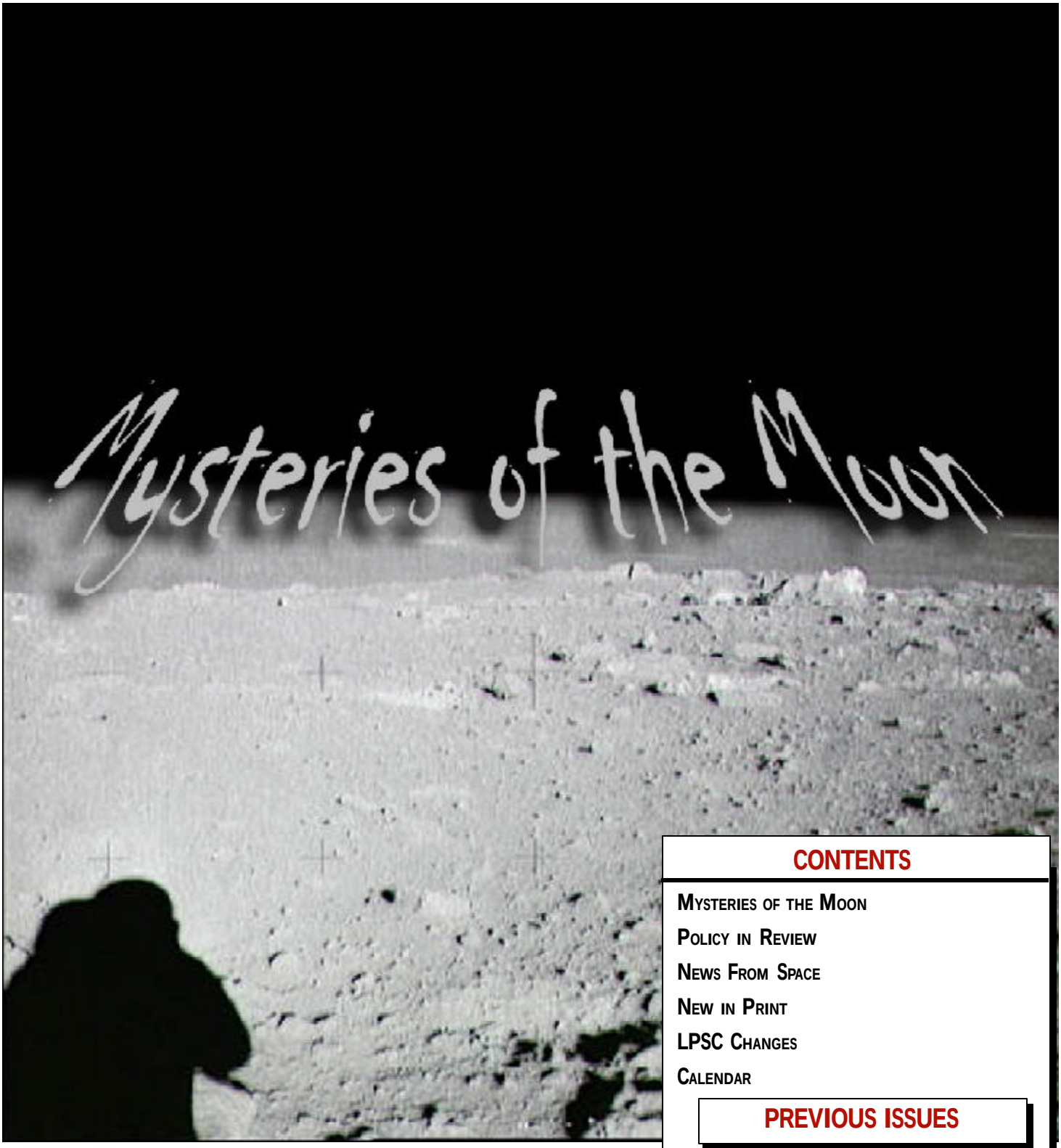
Lunar and Planetary Information
BULLETIN

Spring 2001/NUMBER 90 • LUNAR AND PLANETARY INSTITUTE • UNIVERSITIES SPACE RESEARCH ASSOCIATION



CONTENTS

PREVIOUS ISSUES

Mysteries of the Moon

A Moon by Any Other Name

Native American Full Moon Names

January	*Old Moon, Moon After Yule*
February	*Snow Moon, Hunger Moon, Wolf Moon*
March	*Sap Moon, Crow Moon, Lenten Moon*
April	*Grass Moon, Egg Moon*
May	*Planting Moon, Milk Moon*
June	*Rose Moon, Strawberry Moon, Flower Moon*
July	*Thunder Moon, Hay Moon*
August	*Green Corn Moon, Grain Moon*
September	*Harvest Moon*
October	*Hunters Moon*
November	*Frosty Moon, Beaver Moon*
December	*Before Yule Moon, Long Night Moon*

Other Moon Names

A *Blue Moon* is a rare occurrence, as in "once in a blue moon." Some say this came from the term for a second full moon in one month, an event that occurs every two or three years.

A *children's moon* is a moon that appears during daylight.

A recent lurid television program posed the question, "Did NASA really go to the Moon or was it all a hoax?" Most viewers rightly scoffed at the program, which nonetheless gathered top ratings. These high ratings were probably more an indication of the public's continuing high interest in the Moon rather than a cynical statement on what people are willing to believe in these allegedly unenlightened times. While the fact that Apollo astronauts did visit the Moon is easily proved, not by television images but by the many samples brought back and the testimonials of those involved, there do remain many unanswered or at least widely misunderstood aspects about the Moon. This short guide will attempt to answer several of the most frequently asked questions about the Moon, our nearest neighbor, lifetime companion, and neverending source of inspiration and inquiry.

Why doesn't the Moon have a "real" name, like the moons of Jupiter?

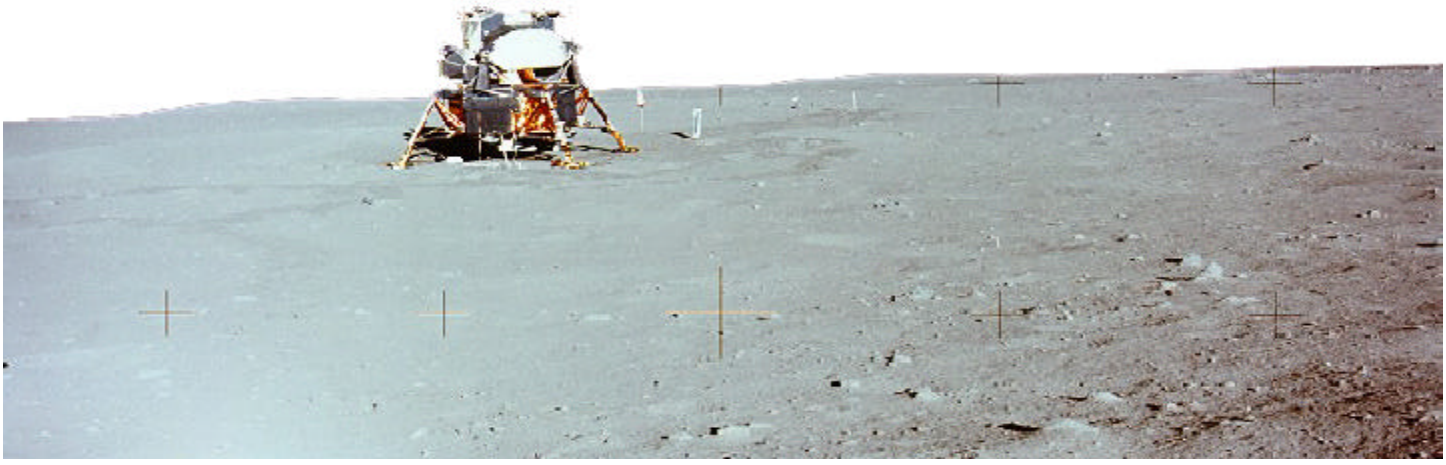
The Moon has been called "the Moon" for centuries. The modern English word derives from the Old English name, Mona. When Galileo first discovered satellites around Jupiter, they were called "moons" after our own natural satellite, and the designation stuck.

Why does a full Moon appear bigger on the horizon?

This very convincing effect is known as the "Moon illusion," and it is in fact an optical illusion. The size of the image the Moon casts on your eye is the same no matter where in the sky it is. This can be tested by even the most casual observer using a paper clip bent into a measuring device held at arm's length. Measure the image of the Moon both when it is high in the sky and near the horizon, and the measurement will be the same, despite the fact that the Moon appears so much larger at the horizon. Since optical illusions are essentially psychological tricks played on the brain, it is difficult to explain exactly why this phenonomen takes place. Some have argued that the presence of objects on the ground (trees, buildings) make the Moon seem larger by comparison.

Did NASA claim the Moon as property of the United States when it planted a flag on the Moon, like Columbus did when he landed in America?

When a NASA astronaut placed the flag on the Moon, the action signified that, "America went in peace for all Mankind." Acquisition in outer space is prohibited under the United Nations Treaty on Outer Space signed in 1967. Some companies have attempted to sell "real estate" on the Moon, but such deals have no legal standing in any country.



Further reading on the Moon

Lunar Sourcebook: A User's Guide to the Moon. By Grant H. Heiken et al. Cambridge and LPI, 1991.

The Once and Future Moon. By Paul D. Spudis. Smithsonian Institution, 1998.

Origin of the Earth and Moon. Univ. of Arizona, 2000. (See p. 7, this issue.)

The Moon and the Western Imagination. By Scott L. Montgomery. Univ. of Arizona, 1999.

Websites about the Moon

Moon Nomenclature. Describes origins of names for lunar features.

http://wwwflag.wr.usgs.gov/USGSFlag/Space/nomen/moon/moonTOC.html

Collecting Moon Rocks. Describes the tools and procedures used by the Apollo astronauts to collect lunar samples.

http://www.lpi.usra.edu/expmoon/Apollo11/A11_Samples_tools.html

Exploring the Moon. LPI's extensive site describing the lunar missions and their accomplishments.

http://www.lpi.usra.edu/expmoon/lunar_missions.html

Lunar Sample Laboratory. Johnson Space Center site that provides a virtual tour of the Lunar Sample Laboratory.

http://www-curator.jsc.nasa.gov/curator/lunar/Lun-fac.htm

National Space Science Data Center's Moon Fact Sheet.

http://nssdc.gsfc.nasa.gov/planetary/factsheet/moonfact.html

Consolidated Lunar Atlas. A collection of the best photographic images of the Moon, complete with data.

http://www.lpi.usra.edu/research/cla/menu.html

Is there a dark side of the Moon?

Because the same side of the Moon always faces the Earth, we only see one side of the Moon and thus used to speak of a "dark side." That side, now referred to in scientific circles as the "farside," is not cast in a permanent state of darkness, however. When we experience a new Moon on Earth, for instance, and the dark side of the Moon is facing the Earth, the farside is bathed in sunlight. So, although the Moon may have a "dark side," it is not always the same side.

Is there water on the Moon?

In March 1998, scientists asserted that the amount of water ice found on the Moon may be in the range of 11 million to 330 million tons. This was based on data returned by the *Lunar Prospector*, on the presence of large hydrogen deposits, and on more unknown scientific factors such as theoretical models about the Moon's atmosphere, the rate of cometary impact, and how these factors affected the regolith mixing ratio over time. At the end of the *Prospector*'s mission in 1999, NASA scientists intentionally crashed the probe in the lunar polar regions where the ice was thought to exist, in the hopes of liberating a cloud of water vapor. Although no direct evidence of water ice was detected initially by the crash, the data is still being sifted through.

Does the Moon make people crazy?

Although the word lunatic and its derivatives come from a supposed connection between the Moon and mental illness, no connection has been established with any scientific veracity. Furthermore, no connection has been established, although many people mistakenly believe it has, between the appearance of a full Moon and supposed rises in crime, erratic behavior, or general mayhem. Although some social scientists have explored this problem statistically, reasoning the light of the full Moon possibly could have an effect on the human psyche, they have failed to turn up any such evidence.

What does the Moon look like in other parts of the world?

For practical purposes, the phases of the Moon and how much of it appears to be illuminated are independent of the location of the observer on Earth, although the precise fraction of the Moon that appears to be illuminated will vary slightly. One interesting thing to note, however, is that an observer in Australia sees an "upside-down" version of the Moon compared to what somebody would see in North America.

Some of this information was culled from NASA websites.

POLICY IN REVIEW

The following letter, directed to Jay Bergstralh, Colleen Hartmann, and Scott Hubbard of NASA Headquarters, presents the most recent findings of the Solar System Exploration Subcommittee of the Space Science Advisory Committee, which met February 28 through March 1, 2001, to discuss the future of solar system space exploration. Dr. Michael J. Drake, chair of that committee, has submitted this letter to this forum for public review. The layout and some emphases (italics and bold) were changed for publication purposes.

March 16, 2001

Dear Jay, Colleen, and Scott:

The Solar System Exploration Subcommittee (SSES) of the Space Science Advisory Committee (SScAC) met from February 28 to March 1, 2001, in Washington, D.C. The purpose of this letter is to summarize the findings and recommendations of that meeting.

A general briefing on the state of the Planetary Program was given by Dr. Bergstralh and on the state of the Space Science Program by Dr. Weiler. In addition, the President's preliminary budget was released at noon on February 29.

Discovery

The SSES notes that the cost cap on the Discovery Program has not been adjusted in recent years for inflation, increase in launch vehicle cost for technical reasons, and increased costs associated with the re-evaluation of the acceptable degree of risk. The SSES endorses raising the cost cap to an appropriate level.

Research and Analysis

Dr. Gunter Riegler briefed the SSES on the state of the Research and Analysis Program. Severe understaffing at NASA Headquarters, compounded by the need to respond very rapidly to the recommendation of the SSES to compete the Pluto-Kuiper mission through an AO, drained personnel from grant processing. This reassignment of personnel led to serious delays in awarding of grants. The SSES commends Dr. Riegler for recognizing this problem of slow processing of grants and has confidence in his stated plans to solve the problem rapidly and prevent its recurrence.

The SSES strongly urges the hiring of more civil servants and IPAs at NASA Headquarters. The current personnel are clearly spread too thin.

Near-Earth Objects (NEOs)

The SSES is concerned that some proposals to study NEOs are "falling through the cracks" for programmatic reasons. Specifically, there appears to be a lack of balance between discovery of NEOs and their physical characterization. The SSES notes that the study of NEOs is mandated by Congress and that their physical characterization is clearly directed in the baseline recommendation of the National Research Council's 1998 report on NEOs [ref. 1]. Further, satisfying the congressional requirement for the discovery of 1 km NEOs requires physical characterization to transform magnitudes into physical sizes, i.e., if you don't know the albedo, you cannot estimate a mean size.

The SSES recommends restoring balance to the study of NEOs, either by supporting physical studies within the NEO program or by ensuring that the Planetary Astronomy Program considers physical studies as part of its peer-reviewed science program.

[1] "The Exploration of Near-Earth Objects". Space Studies Board, National Research Council. National Academy Press, Washington, D.C. (1998).

Outer Planets

The current status of the Outer Planets Program was reviewed by Dr. Colleen Hartmann. It was reiterated that OMB and the Congress had not approved an Outer Planets Program, even though both OMB and the relevant congressional committees had supported the release of the Pluto AO. Even the Europa Orbiter mission is far from assured, given technical challenges and budget constraints.

During the meeting, the President's FY02 "mini-budget" was announced. It cancelled the Pluto AO. By the end of the SSES meeting, majority and minority members of the Senate Appropriations Subcommittee had made clear that they expected the Pluto AO to go forward, with a funding decision to be made by Congress as part of the FY02 budget process, and NASA agreed to comply. The situation with respect to outer planets missions remains uncertain. A major task of the SSES is to articulate a compelling Outer Planets Initiative that is intellectually sound and publicly appealing. See below.

Further, the SSES strongly recommends that outer solar system advanced mission studies be tightly focussed to respond to the specific recommendations of the SSES.

Cassini

Bob Mitchell, Cassini Project Manager, provided an update on the Cassini mission. The failure to account adequately for the Doppler shift between Cassini and the Huygens probe was discussed. Final decisions must await the Huygens Recovery Task Force report at the end of June. It appears, however, that there are solutions related to mission operations that can compensate for this oversight. In particular, delaying deployment of the probe for a few orbits seems plausible. The SSES recommends that any solution maximizes overall mission science return, even if it involves delaying deployment of the Huygens probe.

The SSES expresses concern that science is underfunded by ~50%. ***The SSES recommends that all efforts be made to find adequate science funding by examining the balance between mission operations and data analysis.***

Mars Exploration

The SSES received reports from Scott Hubbard and Jim Garvin. The Mars Program appears to be in good health, although concern about the pace of the Program persists. During the SSES meeting, the President's "mini budget" demonstrated support of a "robust" Mars Program. This position, if adopted by Congress, indicates the Mars Program is on track for a more aggressive course.

The SSES noted the need to define the scope of the Mars Scout program, specifically the inclusion or exclusion of missions primarily focussed on the martian moons Phobos and Deimos.

The SSES is also concerned about the tight development schedule for the 2007 Scout mission under the current plan of holding a "San Juan Capistrano-style" Workshop, followed by a two step approach to final mission selection involving extensive phase A studies of several mission options***. The SSES recommends simplifying the 2007 Scout mission selection by reducing steps and increasing development time for the selected mission.***

Extended Missions

The Solar System Exploration Program does not budget for extended missions. Yet terminating an expensive, viable spacecraft that still has high quality peer-evaluated science to conduct is an unconscionable squandering of the Nation's resources. Every planetary mission in recent memory has conducted one or more extended missions, stretching the Solar System Exploration Program severely as the Director reprograms funds. Recent examples of the investment of small amounts of money compared to the overall cost of the missions in which new high-quality data of great scientific importance have been or will be returned are Galileo, Mars Global Surveyor, and NEAR-Shoemaker.

The SSES has three recommendations:

1. Fund a final extended Galileo mission that will return high quality Io data ending with an inevitable Jupiter impact.
2. Develop a plan to fund extended mission(s) for the Cassini spacecraft. It would be irresponsible to turn off a functioning $3B spacecraft if peer-reviewed science remains to be done.
3. For all future missions, plan in advance for MO&DA funds for extended missions.

Roadmap Planning

The SSES began preparing for the next Road Mapping exercise. The Road Map tasks will be split into two parts.

1. The Committee on Planetary and Lunar Exploration (COMPLEX) of the National Academy of Sciences has agreed to write an introduction covering the "big picture" — a holistic and global framework for future planetary exploration.
2. The SSES will work on the implementation of the COMPLEX introduction. Specifically, those elements of the last Road Map that have been successful will be retained. Those areas that were unsuccessful — "The Outer Planets Program" and "To Build a Planet" — will be revisited.

Two SSES subcommittees were chartered. The first subcommittee, chaired by Bill McKinnon and consisting of Jakosky, Stevenson, Cuzzi, and Zolensky, will focus on the outer solar system. It is suggested that "Exploring Organic-Rich Environments" remains a useful intellectual theme, although the mission set will probably be different from the last Road Map. Europa Orbiter is the approved mission, with the view of ultimately seeking if life started on Europa. Pluto/Kuiper is of high priority, as witnessed by the Senate Appropriations Subcommittee directing that the Pluto AO remain open and OMB proposing technology funds for advanced propulsion in support of a "sprint" to Pluto by 2020. Pluto is also unique in that its orbital elements lead inexorably to the conclusion that a mission must be flown in the next few years or else we will wait for a quarter of a millennium. Cassini/Huygens will produce (unknowable, in advance) new knowledge about Titan. Studying prebiotic chemistry at Titan is a essential element to unraveling the origin of life, and is a likely third mission option. Studying cometary nucleus material formed in the region of the outer planets gives us insight into the fundamental building blocks, organic and inorganic, that may have led to life on Europa and to possible prebiotic chemistry on Titan. Comet nucleus sample return, informed by the results of the Stardust mission, is a likely fourth mission in this mission set, which could be titled "Exploring Organic Rich Environments."

The second subcommittee, chaired by Ellen Stofan and consisting of Grinspoon, Jakosky, and Leshin, will focus on the inner planets. The SSES notes that Venus, while a compelling target of scientific enquiry, is "orphaned" at present. A possible strategy for the exploration of Venus might be to address the question, why have Venus, Earth, and Mars, so similar in many respects, arrived at such different evolutionary states 4.55 b.y. after their formation. A possible mission set might fall under the title, "Evolution of a Habitable Planet."

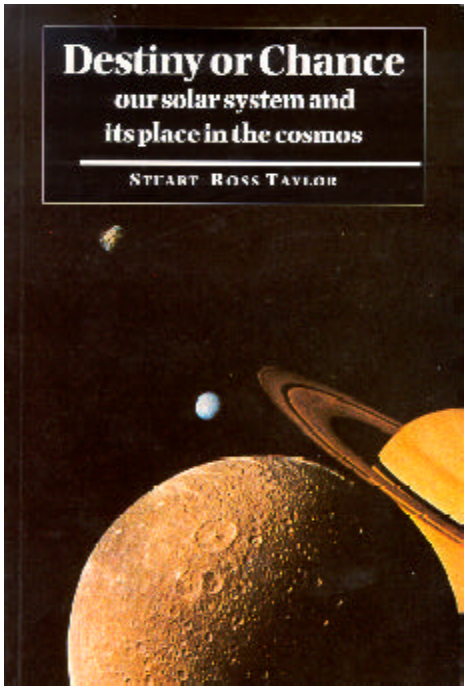
With kindest regards.

Sincerely,

Michael J. Drake, Chair
Solar System Exploration Subcommittee

NEW IN PRINT

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



REVIEW

DESTINY OR CHANCE: Our Solar System and Its Place in the Cosmos
By Stuart Ross Taylor. (Cambridge University Press, 1998, 2000). 229 pp. Hardback $27.95, paperback $14.95.

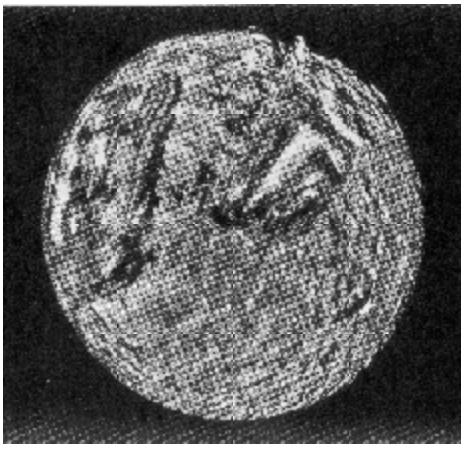
This is just a wonderful book. I read it when it first came out three years ago, and the occasion of this review is its recent availability in paperback at a truly affordable price. It has of course been reviewed in several places already, but many of those reviews seemed to me to miss the point somewhat, including those that are quoted on the back of the paperback edition itself. This is not just another descriptive book about the solar system, but a book that explores the implications of that description. This book does describe details, or "facts," of the solar system and of its planets, but it is the implications that are brought to the front. The details are shown to be local and unique, though important and enlightening. The book can be profitably read, I would think, by anyone from motivated high school students to professional scientists. It can most profitably be read by those who don't already understand the historical sciences.

Ross Taylor explores a theme that we in historical sciences accept and has been used in biological evolution by such as Steve Gould: If we play the tape again, we won't get the same result. The conclusion is one that is also foremost in Peter Ward's and Don Brownlee's recent book *Rare Earth* (reviewed in the LPI Bulletin #89 by Brian Anderson). To quote Ross Taylor (p. 204) "*The message of this book is clear and unequivocal: So many chance events have happened in the development of the solar system that any original purpose, if it existed, has been lost.*" That sentence puts it all in terms of purpose, and indeed purpose of life, but it also reads in terms of physical predictability. The solar system is really very varied, each planet and moon is unique, and we cannot take one out and expect somebody to figure out quite what was in that space.

The emphasis is on variety, and how that variety arose. We see the solar system as it is now, and have to infer how it appeared and evolved. It is clear that complex movements of solid objects of tiny to larger sizes early in the solar system's history, and subsequent impacting, accretion, and fragmentation, lie underneath much of this. This is the story pursued in the book. We cannot retrodict all the details of what happened in this specific case. We cannot take a particular set of conditions and then predict exactly what happens, any more than we can look at the Devonian Period of Earth's history and predict the Triassic Period in any detail, or even in generalities. How much of the generalities of our solar system can be applied to other systems; for instance, does it follow that all or even most systems will have rocky solid bodies closer to the star and bigger, gassier planets further out? We know a lot now about what our solar system's variety is, a lot less about why it is quite that way. We can come up with some proximal causes, but there are no prototypes.

One thing this book brings out is the radical change that has occurred in the planetary sciences over the last 30 years, where the planets are now the purview of Earth scientists and their more planetary kin, and much less the purview of astronomers. A comparison with a similar-sized book from 1973, *The Solar System* by Zdenek Kopal (Oxford University Press, 152 pp.), makes this clear. Kopal was an astronomer, and little was known about the planets, at least in terms of their surface processes, at the time that book

NEW IN PRINT



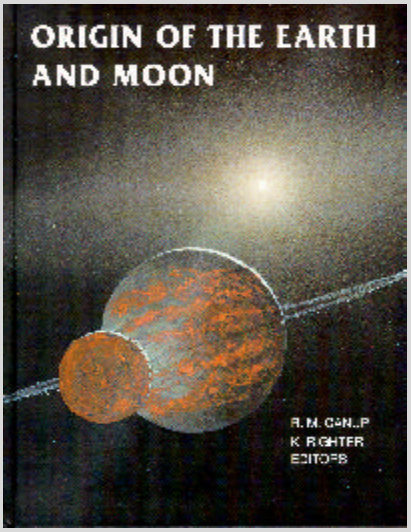
The strange, mangled surface of Uranus' moon Miranda has led some scientists to speculate that the satellite was broken up in a collision and then reassembled.

appeared. Kopal's book reads almost as a search for general laws, rather than understanding variety, although it indeed claims to stress the discoveries of the space age (Apollo had already brought back its samples, and this is treated in the book).

One review, by Sir Bernard Lovell in *Nature* (v. 395, pp. 453–454), suggests that "Many readers may feel that this last section, with its anti-religious undertones, is an unnecessary and unworthy conclusion to an otherwise easily readable account of the formation of the Solar System." (I had the pleasure of meeting Lovell on a high school trip to Jodrell Bank many many years ago.) I doubt if many readers would feel this way, and I am certainly not one of them. Scientists are in the business of understanding the universe, and showing others the way that they infer that it is. The concluding section — about the unique nature of this (and of course, every other) solar system — is both necessary and worthy. Without it, maybe the point would still be lost on many readers, despite the continual battering they get throughout the book about the role of chance in both the details and the generalities.

Some reviewers have noted that Ross Taylor is qualified to write his book, but much more than that, he is one of very few who could have written on this theme at all comprehensively and comprehendably. He is a fine writer — the essay-style prose runs easily, the accompanying images play their part, and the text is interwoven with fine interesting asides, especially historical ones (not too many planetary texts can fluently bring in notes about Haydn). The book is written to be clear, and thus references are by tiny non-intrusive numbers, the references themselves collected at the end. For a more technically written volume that covers some of the same themes, the reader can do no better than Ross Taylor's own *Solar System Evolution: A New Perspective* (Cambridge University Press, 1992, 307 pp.).

—Graham Ryder
(Graham Ryder is a staff scientist at the Lunar and Planetary Institute.)



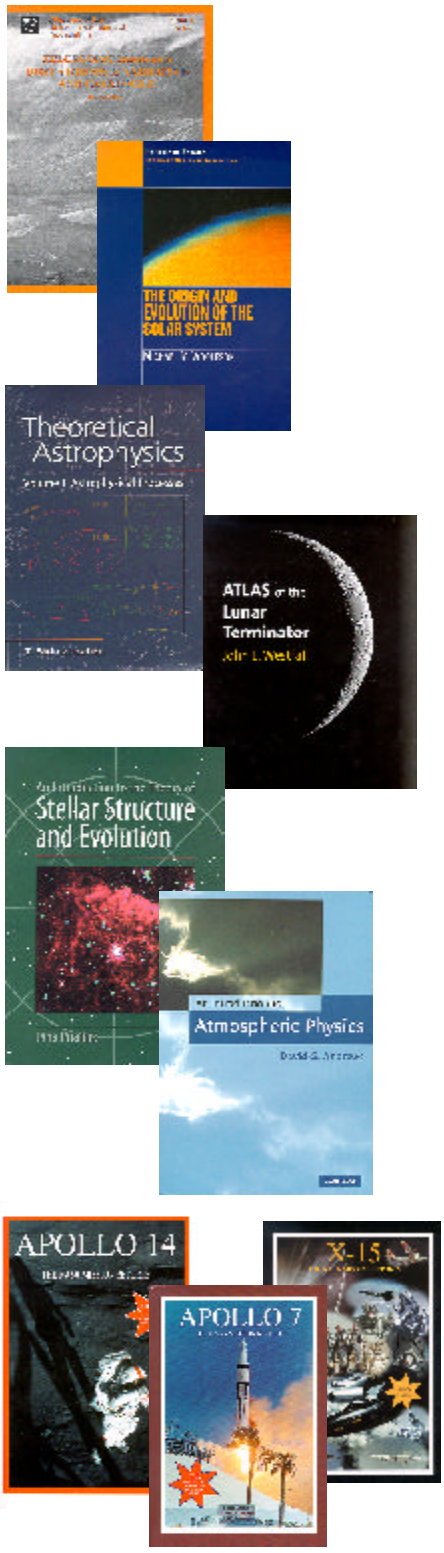
Now available

Origin of the Earth and Moon. Edited by Robin M. Canup and Kevin Righter. 555 pp., $50.

New from the University of Arizona's Space Science Series, this book is intended to serve as a resource for those scientists working closely in the field of Earth and Moon origins. At the same time, it provides enough balance and depth to offer an introduction for students or technically minded general readers. Its thirty chapters address isotopic and chemical constraints on accretion, the dynamics of terrestrial planet formation, the impact-triggered formation of the Earth-Moon system, differentiation of the Earth and Moon, the origin of terrestrial volatiles, and conditions on the young Earth and Moon.

Published in collaboration with the Lunar and Planetary Institute, this book can be ordered online at the University of Arizona Press Web site (www.uapress.arizona.edu).

NEW IN PRINT



RECENTLY PUBLISHED

Telescopic Martian Dust Storms: A Narrative and Catalogue. Memoirs of the British Astronomical Association, Volume 44, June 1999. By Richard McKim. British Astronomical Association, 1999. Softcover, $32. Catalog of the frequency, location, and duration of martian dust storms, drawn from data and literature ranging from 1659 to the 1990s.

The Origin and Evolution of the Solar System. Graduate Series in Astronomy. by Michael M. Woolfson. Institue of Physics, 2000. Softcover, $49. Begins by describing historical theories and illustrating why they became unacceptable. The main focus of the book examines five current theories to determine how well each fits with accepted scientific principles and observations.

Theoretical Astrophyics — Volume 1: Astrophysical Processes. By T. Padmanabhan. Cambridge Univ. Press, 2000. Softcover, $44.95. An introduction to and reference on all of the physical processes needed to do work in astrophysics and cosmology. Designed for graduate students and researchers with an undergraduate background in physics.

Atlas of the Lunar Terminator. By John E. Westfall. Cambridge Univ. Press, 2000. Hardcover, 292 pp. $49.95. Based on high-resolution electronic images of the terminator area of the Moon under 47 different illuminations. Each image is displayed across two or three pages. Features as small as 1–2 kilometers can be discerned in these images. The text describes and illustrates the techniques of lunar observing and the types of landforms. Includes graphs and tables.

An Introduction to the Theory of Stellar Structure and Evolution. By Dina Prialnik. Cambridge Univ. Press, 2000. Softcover, $24.95. Provides students with an introduction to the structure and evolution of stars. The book assumes only basic physics and mathematics on the level of first- and second-year undergraduate studies, and no prior knowledge of astronomy.

An Introduction to Atmospheric Physics. by David G. Andrews. Cambridge Univ. Press, 2000. Softcover, $28.95. 230 pp. Textbook presenting a broad coverage of atmospheric physics. Targeted at intermediate and advanced undergraduates studying atmospheric physics and graduate students studying atmospheric physics for the first time.

NASA Mission Reports. Apogee Books, 2000.

Each softcover volume collects techincal reports and other relevant documents. An accompanying CD-ROM features hundreds of still images, animations, and films. The most recent volumes include:

Apollo 7, 272 pp., $16.95
Apollo 14, 232 pp., $16.95
X-15, 408 pp., $21.95

The High Frontier: Human Colonies in Space, 3rd edition. By Gerard K. O'Neill. Apogee Books, 2000. $19.95. Republished edition, with a new preface and introduction, of the classic 1977 book by physicist Gerard K. O'Neill. The book lays out a possible road map for human settlement beyond Earth. An accompanying CD-ROM includes video presentations by the author.

The Universe Unveiled: Instruments and Images through History. By Bruce Stephenson, Marvin Bolt, and Anna Felicity Friedman. Cambridge Univ. Press, 2000. Hardcover, $29.95. Extensively illustrated and attractive coffee-table book on the history of stargazing equipment, including many oddities and intricately designed art objects.

Observing the Moon: The Modern Astronomer's Guide. By Gerald North. Cambridge Univ. Press, 2000. Hardcover, $39.95. Offers viewing advice for novice to expert stargazers, including discussions of relevant equipment. Extensive information the techniques and technicalities of lunar photography.

Our Cosmic Origins: From the Big Bang to the Emergence of Life and Intelligence. By Armand Delsemme. Cambridge Univ. Press, 2000. Softcover, $14.95. A wide-ranging survey of the theories and facts of the evolution of the universe and solar system, with input from the disciplines of cosmology, astronomy, geology, biochemistry, and biology.

Also Received

Cambridge Dictionary of Astronomy. By Jacqueline Mitton. Cambridge Univ. Press, 2001. Hardcover, $52.95, Softcover, $18.95. 468 pp.

Basic Physical Chemistry for the Atmospheric Sciences, 2nd edition. By Peter V. Hobbs. Cambridge Univ. Press, 2000. Hardcover, $69.95, Softcover, $24.95.

Accretion Processes in Star Formation. By Lee Hartmann. Cambridge Univ. Press, 2000. Hardcover, $74.95, Softcover, $39.95.

Molecular Hydrogen in Space. Cambridge Contemporary Astrophysics Series. Edited by F. Combes and G. Pineau des Forets. Cambridge Univ. Press, 2000. Hardcover, $69.95.

Catalogue of Meteorites. By Monica M. Grady. Cambridge Univ. Press, 2000. Hardcover, $150.

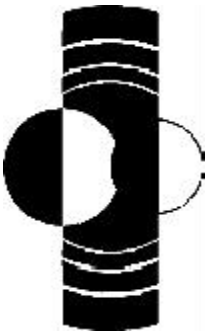
Glorious Eclipses: Their Past, Present and Future. By Serge Brunnier and Jean-Pierre Luminet. Cambridge Univ. Press, 2000. Hardcover, $39.95.

Introduction to Atmospheric Chemistry. By Peter V. Hobbs. Cambridge Univ. Press, 2000. Hardcover, $69.95, Softcover, $24.95.

Very Low-Mass Stars and Brown Dwarfs. Edited by R. Rebolo and M.R. Zapatero-Osorio. Cambridge Contemporary Astrophysics Series. Cambridge Univ. Press, 2001. Hardcover, $69.95.

Ionospheres: Physics, Plasma Physics, and Chemistry. By Robert W. Schunk and Andrew F. Nagy. Cambridge Univ. Press, 2000. Hardcover, $100.

Changes announced for 33rd LPSC, March 4–8, 2002



This notice contains two significant changes regarding the 33rd Lunar and Planetary Science Conference. One concerns changes in schedules and the other concerns a change in policy regarding abstracts. The former is driven by the fact that the Bayou Building at the University of Houston–Clear Lake, which is currently the only viable location for the poster sessions, is only available the first week in March. Therefore, we will have the LPSC the first week of March.

Holding the conference earlier in the year necessitates a number of changes that will be of critical importance to attendees. Due to a number of factors, not the least of which are the dates of the traditional winter holidays (Christmas, New Year's, etc.), the **DEADLINE** for electronic submission of abstracts will be **December 5, 2001,** 5:00 p.m. U.S. Central Standard Time. (The deadline for hard-copy submission will be November 28.) We realize that this deadline is considerably earlier than it has been in recent years, so we're getting the word out now so you can write that date on your calendar and plan accordingly.

The second critical change is necessitated by the fact that the LPSC is a major success. Attendance, and more importantly, abstract submission has increased at a rate of roughly 10% per year for the past four years. A number of other major annual conferences limit the number of abstracts to one per first author. We have never before had to institute similar rules for this meeting. However, the LPSC has earned a well-deserved reputation as one of the world's leading planetary science meetings. With that measure of success understandably comes a number of logistical problems. We are limited in the number of available oral presentation slots, limited in the number of available poster spaces, and limited in the sizes of files that can fit on a single CD-ROM. Because of these limitations, we have arrived at a critical juncture for the future of this conference. In order to continue the long-standing tradition of convening an outstanding meeting that is accessible to the greatest number of participants, the time has come to make some difficult decisions.

Therefore, beginning with the 33rd LPSC, the following abstract submission policies will be implemented:

There will be a limit of TWO abstracts per first author for oral or poster presentation requests. Because this is an interdisciplinary meeting, and many members of our community have more than one field of research, we felt that it was important to not force those for whom this is the case to choose one field over another. If you submit two abstracts, you will be asked to rank them in order of preference.

In an effort to promote the dissemination of research from members of the community who may not be able to attend the meeting, print-only abstracts will still be allowed, but ONLY from those authors who are **NOT** submitting an abstract for oral or poster presentation. In other words, if you're requesting a print-only abstract, you cannot submit an abstract for any other type of presentation. Authors are limited to ONE print-only request.

The program committee will strictly enforce the above policies. Abstracts submitted in violation of these policies will be rejected. The only exception will be for those who are invited to give a talk at a special session (e.g., the Masursky Lecture, or a special topical session). Those abstracts will not be counted against authors as one of the two abstracts they are allowed to submit.

Our goal is to continue to make the LPSC experience a beneficial one for the entire community while facing the realities of the task at hand. As always, we encourage and welcome any constructive suggestions from those of you who participate in this annual event.

Carl B. Agee
Co-Chair, LPSC

David C. Black
Co-Chair, LPSC

PUBLICATIONS FROM LPI

QUANTITY	CODE	TITLE	PRICE	TOTAL
		EDUCATIONAL PRODUCTS **You can preview all our educational products by visiting http://www.lpi.usra.edu/education/products/products.html**		
	S-IMPACT	TERRESTRIAL IMPACT CRATERS **(40 SLIDES) (Revised)**	$25.00	
	S-SOLAR	THE SOLAR SYSTEM IN 3-D **(40 SLIDES)**	$25.00	
	S-VENUS	IT'S A DRY HEAT: THE GEOLOGY OF VENUS FROM MAGELLAN **(40 SLIDES)**	$25.00	
	S-LIFE	ANCIENT LIFE ON MARS??? **(40 SLIDES)**	$25.00	
	S-RED	THE RED PLANET: A SURVEY OF MARS, SECOND EDITION **(40 SLIDES)**	$25.00	
	S-WINDS	THE WINDS OF MARS: AEOLIAN ACTIVITY AND LANDFORMS **(30 SLIDES)**	$23.00	
	S-STONES	STONES, WIND, AND ICE: A GUIDE TO MARTIAN IMPACT CRATERS **(30 SLIDES)**	$23.00	
	S-VOLC	VOLCANOES ON MARS **(20 SLIDES)**	$22.00	
	S-HUMAN	SHUTTLE VIEWS THE EARTH: HUMAN IMPRINTS FROM SPACE **(40 SLIDES)**	$25.00	
	S-OCEANS	SHUTTLE VIEWS THE EARTH: THE OCEANS FROM SPACE **(40 SLIDES)**	$25.00	
	S-CLOUDS	SHUTTLE VIEWS THE EARTH: CLOUDS FROM SPACE **(40 SLIDES)**	$25.00	
	S-GEOL	SHUTTLE VIEWS THE EARTH: GEOLOGY FROM SPACE **(40 SLIDES)**	$25.00	
	S-CLEM	CLEMENTINE EXPLORES THE MOON, SECOND EDITION **(35 SLIDES)**	$25.00	
	S-TOUR	A SPACECRAFT TOUR OF THE SOLAR SYSTEM, SECOND EDITION **(40 SLIDES)**	$25.00	
	S-HAWAII	VOLCANIC FEATURES OF HAWAII AND OTHER WORLDS **(40 SLIDES)**	$25.00	
	TG-3DTOUR	TEACHER'S GUIDE TO THE 3-D TOUR OF THE SOLAR SYSTEM **(HARD COPY)**	$50.00	
	TG-3DTCD	TEACHER'S GUIDE TO THE 3-D TOUR OF THE SOLAR SYSTEM **(CD-ROM)**	$20.00	
	C-ATLAS	3-D TOUR OF THE SOLAR SYSTEM **(CD-ROM) (NEW VERSION 2.0)**	$15.00	
	C-SSRG	SPACE SCIENCE REFERENCE GUIDE **(CD-ROM) (NEW)**	$20.00	
	P-3DSTORM	THUNDERSTORMS IN 3-D **(3-D POSTER)**	$10.00	
	P-3DVOLC	VOLCANO IN 3-D **(3-D POSTER)**	$10.00	
	R-SPEC-2	ALTA REFLECTANCE SPECTROMETER **(VERSION 2 , 11 COLORS) (NEW)** A simple classroom instrument designed to help students learn about light, color, and spectroscopy. The ALTA handheld spectrometer weighs only 9 ounces. **(SCIENTIFIC INSTRUMENT)**	$160.00	
	B-RSPECTG	ALTA REFLECTANCE SPECTROMETER CLASSROOM LESSONS **(BOOK)**	$25.00	
	C-RSPECTG	ALTA REFLECTANCE SPECTROMETER CLASSROOM LESSONS **(CD-ROM)**	$10.00	
	R-SPEC	ALTA REFLECTANCE SPECTROMETER **(VERSION 1)**	$130.00	
		OTHER PUBLICATIONS **AVAILABLE FOR THE COST OF SHIPPING AND HANDLING**		
	P-MOON	ONCE AND FUTURE MOON **(POSTER)**	$0.00	
	CB-954	TRACES OF CATASTROPHE: HANDBOOK OF SHOCK-METAMORPHIC EFFECTS IN TERRESTRIAL METEORITE IMPACT STRUCTURES **(BOOK)**	$0.00	
	CB-969	WORKSHOP ON THERMAL EMISSION SPECTROSCOPY AND ANALYSIS OF DUST, DISKS, AND REGOLITHS **(BOOK)**	$0.00	
	CB-979	SECOND ANNUAL HEDS-UP FORUM **(BOOK)**	$0.00	
	CB-1053	CATASTROPHIC EVENTS AND MASS EXTINCTIONS: IMPACTS AND BEYOND **(BOOK)**	$0.00	
	CB-1057	SECOND INTERNATIONAL CONFERENCE ON MARS POLAR SCIENCE AND EXPLORATION **(BOOK)**	$0.00	
	CB-1062	CONCEPTS AND APPROACHES FOR MARS EXPLORATION **(BOOK)**	$0.00	
	CB-1063	THIRD ANNUAL HEDS-UP FORUM **(BOOK)**	$0.00	
	CB-1084	FORUM ON INNOVATIVE APPROACHES TO OUTER PLANETARY EXPLORATION 2001-2002 **(BOOK)**	$0.00	
	C-32	LPSC XXXII ABSTRACTS **(CD-ROM)**	$0.00	

PUBLICATIONS FROM LPI

BALANCE FROM PREVIOUS PAGE $ _____

	C-971	NINTH ANNUAL V. M. GOLDSCHMIDT CONFERENCE **(CD-ROM)**	$0.00	
	C-972	THE FIFTH INTERNATIONAL CONFERENCE ON MARS **(CD-ROM)**	$0.00	
	C-1088	ELEVENTH ANNUAL V. M. GOLDSCHMIDT CONFERENCE (CD-ROM)	$0.00	
		(PRICES EFFECTIVE THROUGH AUGUST 2001)		

Shipping and Handling Charges

	U.S.	Canada Foreign Surface	Foreign Air Europe/S. Am.	Foreign Air Pacific Ocean
One Slide Set or CD-Rom	$6.00	N/A*	$9.00	$9.00
Ea. Additional, add:	$1.00	N/A*	$5.00	$5.00
One Book or Poster	$6.00	N/A*	$12.00	$15.00
Ea. Additional, add:	$1.00	N/A*	$5.00	$6.00
Each Spectrometer	$8.00	N/A*	$40.00	$40.00
Each Teacher's Guide (hard copy)	$8.00	N/A*	$40.00	$40.00

*Foreign air is the only shipping service available for slide sets and CD-ROMs.

SUBTOTAL $ _____

SHIPPING AND HANDLING $ _____
(SEE CHART AT LEFT)

ADD 8.25% SALES TAX $ _____
FOR TEXAS DELIVERY

(APPLY TAX TO SUBTOTAL AND SHIPPING)

TOTAL AMOUNT ENCLOSED $ _____

PRICES EFFECTIVE THROUGH 8/2001

Method of Payment

☐ Check (in U.S. dollars drawn on U.S. bank) **MAKE CHECKS PAYABLE TO: UNIVERSITIES SPACE RESEARCH ASSOCIATION (USRA).**

☐ Money Order

☐ Credit Card
VISA, American Express, MasterCard, Discover

Account Number

Expiration Date

Print exact name appearing on credit card

Signature _____

Phone (____) _____ FAX (____) _____

PLEASE INDICATE BUSINESS HOURS PHONE.

PLACE ALL ORDERS WITH:

Order Department
Lunar and Planetary Institute
3600 Bay Area Boulevard
Houston TX 77058-1113
Phone: 281-486-2172
Fax: 281-486-2186
E-mail: order@lpi.usra.edu

MAKE CHECKS PAYABLE TO:
UNIVERSITIES SPACE RESEARCH ASSOCIATION (USRA)

FOREIGN ORDERS MUST BE PREPAID

Ordered By

Organization _____

Name _____

Address _____

_____

City _____

State _____ Zip _____ Country _____

Phone (____) _____ (required to process order)

PLEASE INDICATE BUSINESS HOURS PHONE.

Ship To All domestic orders must ship to a street address only.

Organization _____

Name _____

Address _____

_____

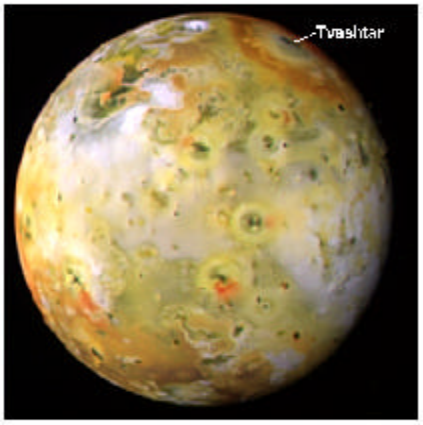
City _____

State _____ Zip _____ Country _____

Phone (____) _____ (required to process order)

PLEASE INDICATE BUSINESS HOURS PHONE.

NEWS FROM SPACE



Jet Propulsion Laboratory

Galileo image of Tvashtar Catena near Io's north pole.

Two Spacecraft Watch a Towering Inferno on Io

Two NASA spacecraft jointly observing Jupiter's moon Io this winter captured images of a towering volcanic plume never seen before and a bright red ring of fresh surface deposits surrounding its source.

Combined information from images taken by the *Cassini* and *Galileo* spacecraft indicates the new plume is about the same size — nearly 400 kilometers or 250 miles high — as a long-lived plume from Io's Pele volcano. Pele's plume and ring are also seen in the new images.

The new plume originates from a volcanic feature named Tvashtar Catena near Io's north pole. Scientists were astounded to discover so large a plume so near the pole, because all active plumes previously detected on Io have been over equatorial regions and no others have approached Pele's in size, said University of Arizona planetary scientist Dr. Alfred McEwen.

Galileo might pass right through the Tvashtar plume in August, if the plume persists until then. The spacecraft will be flying over that part of Io at an altitude of 200 kilometers (124 miles). Material in the plume is tenuous enough to present little risk to the spacecraft, and passing through it could give an opportunity to analyze the makeup of the plume, said Dr. Torrence Johnson, Galileo project scientist at JPL.

NASA

A Saturn rocket propels an Apollo module into space.

NEO could be Saturn space trash

Back in November of 2000, the recently discovered Near Earth Object 2000 SG344 was thought to be headed for a possible collision with Earth in the year 2030. That collision was soon ruled out, and scientists came to another startling conclusion: 2000 SG344 might not be an asteroid at all, but rather a piece of manmade rocket debris.

"The orbit of SG344 is so Earth-like, it makes you wonder if came from our own planet," said Donald Yeomans, manager of NASA's Near Earth Object program at the Jet Propulsion Laboratory.

In 1971, the last time 2000 SG344 was in the vicinity of Earth, NASA's Apollo program was in full swing. 2000 SG344 may well be debris from an Apollo-era rocket masquerading as a space rock.

"Initially we thought it was too bright (and thus too large) to be a rocket fragment, but it's possible that this is the S-IVB stage from a big Saturn V," said Yeomans.

"S-IVBs" were booster rockets that propelled Apollo Command and Service Modules toward the Moon from their parking orbits around Earth.

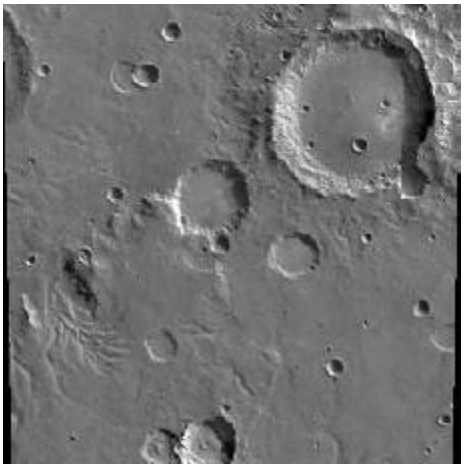
"Many of those boosters were targeted to hit the Moon, but the S-IVBs from Apollo 8 through 12 went into orbit," Yeomans said.

If SG344 is a derelict rocket booster, it's probably no larger than 15 meters and wouldn't pose much of a threat even if it did strike Earth. An incoming S-IVB would burn up in the atmosphere as a dazzling but mostly harmless fireball.

On the other hand, if 2000 SG344 is a bona fide space rock, it's likely to be bigger and more dangerous. Typical near-Earth asteroids reflect about 3% to 20% of the sunlight that falls on them. The apparent brightness of 2000 SG344 corresponds to such an asteroid 30 to 70 meters across.

"Whatever it is, 2000 SG344 is certainly no dinosaur killer," Yeomans added, referring to a 10-kilometer space rock that may have triggered mass extinctions when it hit Earth 65 million years ago.

NEWS FROM SPACE



NASA Ames Research Center

A sample image from the Ames Clickworkers project.

Crater-or-Not.com

In February, NASA's Ames Research Center unveiled its Clickworkers project, an online study that allows volunteers to study *Viking*-era photos of Mars and help to classify craters.

According to Ames, the study is designed to answer the following questions: (1) Are people interested in volunteering their free time on routine scientific work, and (2) Does the public have the training and motivation to produce accurate results in a scientifically important task?

Because of the press attention given to the project so far, the number of individual volunteers contributing to the project has climbed to over 30,000, with a steady 7000 crater-marking entries and 1000 crater-classification entries being submitted every day. According to an Ames press release, every crater on Mars larger than 10 kilometers and within 30° of the equator has been gone over two or three times by now.

Volunteers spot possible craters and use a mouse to make four clicks around the rim. For those seeking more of a challenge, crater-classification tasks are also available. Volunteers are shown a crater and asked to decide if it is a fresh, degraded, or "ghost" crater.

"The whole idea is to see if non-scientists can help with the 95 percent of the task that requires only basic human abilities like recognizing pictures," Bob Kanefsky, a software engineer for Ames who spearheaded the project, told Space.com. "If you know a mountain from a hole in the ground, you can be a crater-marking clickworker."

The site also offers an opportunity to mark craters in the 20,000 recently released high-resolution images taken by the *Mars Global Surveyor* camera (MOC) in addition to the *Viking*-based image maps. This is the first time that subkilometer Mars craters have been systematically cataloged. The first few thousand crater entries have already been received.

The project officially began in November 2000. As of press time, volunteers had contributed 1,670,411 crater-marking entries and 234,438 crater-classification entries. Volunteers can learn more about the Clickworkers project and begin training sessions by visiting the Web site at http://clickworkers.arc.nasa.gov/top.

NASA Selects Two Investigations for Pluto-Kuiper Belt Mission Feasibility Studies

In the first step of a potential two-step process, NASA has selected two proposals for detailed mission feasibility studies as candidates for a Pluto-Kuiper Belt (PKB) mission to explore the only planet in our solar system yet to be visited by a spacecraft from Earth.

The President's fiscal year 2002 budget request does not contain development funding for a Pluto mission. The Congress requested that NASA not do anything precipitous that would preclude the ability to develop a Pluto-Kuiper mission until the Congress could consider it in the context of the FY 2002 budget. If funding is provided in the 2002 budget and either proposal is ultimately selected, the agency could select a proposal for development to ultimately fly a spacecraft to Pluto and beyond. If a PKB mission is developed, launch would be in the 2004–2006 time frame and the spacecraft would arrive at Pluto before 2020.

Both proposals are for complete missions, including launch vehicle, spacecraft, and science instrument payload.

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

Brian Anderson, Editor

Editorial and production support are provided by the LPI Publications and Program Services Department.

The Bulletin welcomes the submission of articles and essays dealing with issues related to planetary science and exploration. Please send articles or announcements to: B. Anderson, 3600 Bay Area Boulevard, Houston TX 77058-1113. Copy deadline for the next issue is August 1, 2001.

Phone: 281-486-2164, fax: 281-486-2125
E-mail: lpibed@lpi.usra.edu
Online version: http://www.lpi.usra.edu/publications/publications.html

CALENDAR 2001–2002

AUGUST

6–10

Conference on the Geophysical Detection of Subsurface Water on Mars, Lunar and Planetary Institute, Houston.
Contact: PPSD, Lunar and Planetary Institute, 3600 Bay Area Boulevard, Houston TX 77058-1113.
Phone: 281-486-2151; fax: 281-486-2160
E-mail: taylor@lpi.usra.edu
http://www.lpi.usra.edu/meetings/geomars2001

SEPTEMBER

10–14

64th Meteoritical Society Meeting, Rome, Italy.
Contact: PPSD, Lunar and Planetary Institute, 3600 Bay Area Boulevard, Houston TX 77058-1113.
Phone: 281-486-2151; fax: 281-486-2160
E-mail: taylor@lpi.usra.edu
http://www.lpi.usra.edu/meetings/metsoc2001/

17–19

New Views of the Moon, Europe: Future Lunar Exploration, Science Objectives, and Integration of Datasets, Berlin.
Contact: Dave Heather, ESTEC, SCI-SO, Keplerlaan 1, Postbus 299, 2200 AG, Noordwijk, The Netherlands.
Phone: 31-071-565-3388; fax: 31-071-565-4697
E-mail: dheather@so.estec.esa.nl
http://solarsystem.estec.esa.nl/~dheather/nveurope.htm

OCTOBER

4–5

Mercury: Space Environment, Surface, and Interior Workshop, Chicago, Illinois.
Contact: PPSD, Lunar and Planetary Institute, 3600 Bay Area Boulevard, Houston, TX 77058-1113.
Phone: 281-486-2151; fax: 281-486-2160
E-mail: taylor@lpi.usra.edu
http://www.lpi.usra.edu/meetings/mercury01

20–27

Martian Highlands Field Conference, Death Valley, California.
Contact: PPSD, Lunar and Planetary Institute, 3600 Bay Area Boulevard, Houston, TX 77058-1113.
Phone: 281-486-2123; fax: 281-486-2160

NOVEMBER

5–8

Geological Society of America Annual Meeting and Exposition, Boston.
Contact: GSA, P.O. Box 9140, Boulder, CO 80301-9140.
Phone: 303-447-2020; fax: 303-447-0648
E-mail: meetings@geosociety.org
http://www.geosociety.org/meetings/2001/index.htm

27–Dec. 1

33rd Annual Meeting of the Division for Planetary Sciences, AAS, New Orleans, Louisiana.
Contact: DPS Chair Mark V. Sykes
E-mail: sykes@as.arizona.edu

FEBRUARY 2002

3–7

Space Technology and Applications International Forum, Albuquerque, New Mexico.
Contact: Regents' Professor Mohamed S. El-Genk, Univeristy of New Mexico, Room 239, Albuquerque NM 87131-1341.
Phone: 505-277-4950; fax: 505-277-2813
E-mail: isnps@unm.edu
http://www-chne.unm.edu/isnps

MARCH

4–8

33rd Lunar and Planetary Science Conference, Houston.
Contact: PPSD, Lunar and Planetary Institute, 3600 Bay Area Boulevard, Houston TX 77058-1113.
Phone: 281-486-2123; fax: 281-486-2160
E-mail: perry@lpi.usra.edu
http://www.lpi.usra.edu/meetings/33rdlpsc.html

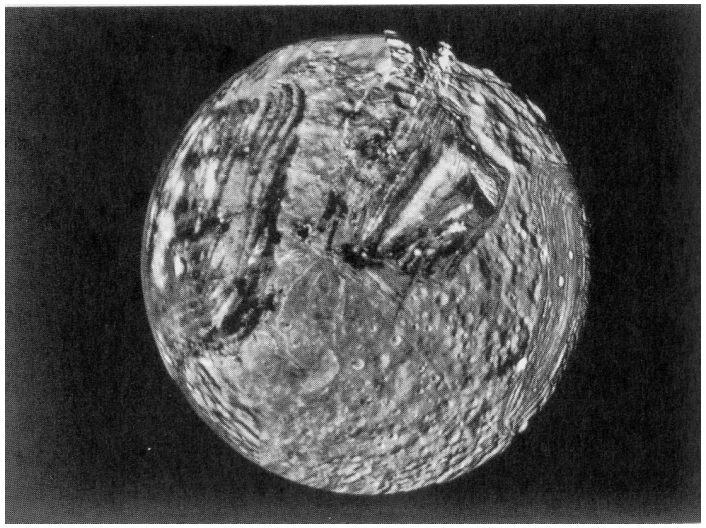
AUGUST

18–23

12th Annual V. M. Goldschmidt Conference, Davos, Switzerland.

Please send calendar items to Anderson@lpi.usra.edu.

INSIDE



The Solar System: Destiny or Chance?
See Page 6

Universities Space Research Association

LUNAR AND PLANETARY INSTITUTE
3600 Bay Area Boulevard
Houston TX 77058-1113

ADDRESS SERVICE REQUESTED

NON-PROFIT
U.S. POSTAGE PAID
PERMIT NO. 600
HOUSTON TX