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The Next Step?

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***COVER:** Apollo 15 astronauts photographed the Aristarchus–Prinz region of the Moon from their command module. Crater Aristarchus, about 40 kilometers in diameter, is at upper right. In the foreground are the lava–drowned, ruined ramparts of the ancient crater Prinz and the mysterious network of rilles believed to result from more recent volcanic activity.*

Photograph AS15–2607 courtesy JPL/NASA

Letters to the Editor

We encourage our members to write to us on topics related to the goals of The Planetary Society: Continuing planetary exploration and the search for extraterrestrial life. Address them to: Letters to the Editor, 65 N. Catalina Avenue, Pasadena, CA 91106.

Going to Mars is a great idea, but to stress cooperation between the United States and the Soviet Union may not be. I agree with The Planetary Society's view that a joint mission is the only sane way to go; however, there are still many people (including lawmakers, I'm sure) who do not. Cooperation in space is possible and it will probably happen since both nations are well aware of the advantages. In the meantime, The Planetary Society may be alienating potential supporters who would wholeheartedly support a Mars venture of a more nationalistic nature. I'm not suggesting that you dilute your ideals, but simply that you change your focus a little.

Perhaps the Society should try harder to rekindle the fiery enthusiasm and adventurousness that consumed America during the Space Age. Of course, part of that enthusiasm was driven by political competition, but there was more than that. Just look at the science fiction of the 1950s—it was positive, limitless and arrogant in its depiction of human potential. These attitudes led us into the Space Age. As a nation, our attitude was still young, brash and wild–eyed with the sense of adventure—and of wonder. Things are not so simple anymore, but we could learn a lot from those pioneers of 30 years ago.

The Planetary Society and *The Planetary Report* have done an excellent job of bringing the public and the space science community together. Now that you have established your scientific credibility, maybe you can afford to stress this purely human side of the issue a little more. The important thing is to gain all the support possible for the Mars mission and to get this country determined to *go* in the first place. Human beings have always been eager to accept the challenges that fire their souls and stir their imaginations. They just need someone to do the stirring.
TERRENCE CHURCHMAN, *Monrovia, California*

As a science fiction writer, I am disturbed by the present administration's relative indifference to space exploration and non–military space research. After watching Neil Armstrong set foot on the Moon in 1969, many of us believed that the coming decades would, at least, see lunar space stations and explorations of Mars. We had proven that there was no limit to our vision, our inventiveness and our courage. What ever happened to our pioneering spirit?

I believe, however, that the public's passion for space is still very much alive and needs only the means for its articulation. I propose that The Planetary Society lobby Congress to include a line on the income tax return form next to the line "Presidential Election Campaign Fund" inviting taxpayers to contribute $1 to $5 in tax credits to space exploration.

This would serve not only as a source of much needed revenue for the space program but would provide the American public with a ballot for directly expressing its concerns for the advancement of space exploration.
DANIEL BRAWNER, *Inglewood, California*

The report by Clark Chapman in "News and Reviews" (see the September/October1987 *Planetary Report*) on the Meteoritical Society meeting at Newcastle–upon–Tyne, England in July was very interesting.

However, Louis Alvarez, although the first to "prove" (in my view) the theory of catastrophic impacts as the cause of mass extinctions, was not the original proponent of the idea. I refer you to "Cataclysm and Evolution," *Popular Astronomy,* May, 1942, by Harvey Nininger, co–founder of the Meteoritical Society.
ROBERT D. NININGER, *Rockville, Maryland*

Thirty Years of SETI—
The NASA Administrator Looks at the Search for Extraterrestrial Intelligence

On October 12, 1987, Dr. James C. Fletcher, Adminstrator of NASA, spoke to the 38th International Congress of the International Astronautical Federation (IAF) about the possible future of the space program. Dr. Fletcher projected himself 30 years into the future and imagined what the then–Adminstrator of NASA might say to the IAF Congress of 2017. Here we reprint the section of Dr. Fletcher's remarks dealing with the Search for Extraterrestrial Intelligence (SETI).

By the mid–1980s, very few people were convinced that no other life exists in our galaxy. The consensus that there must be intelligent life on worlds beyond our solar system emerged because we had learned a great deal about the physical universe since its birth.

We learned that in our galaxy alone, there is a staggeringly large number of stars—as many as 200 billion. Astronomers believe that most of those stars, except close binary stars, have planetary systems in some stage of development. Of these, about five percent, or on the order of 10 billion, are called "good suns." These are stars not so large as to burn up before advanced life could develop on one or more of their planets and not so small that one of their temperate planets would stop rotating because of its proximity to the star.

If our solar system is typical of most, the chance is fairly good that about half, or 5 billion, of those "good suns" would have "good Earths"—planets at the right distance from their respective suns to allow life to develop.

Now, on what fraction of these "good Earths" would life begin? The Administrator would find it hard to answer that, even though we know that the ingredients for carbon-based life either already exist in the universe, or can be readily manufactured by natural processes.

But by no means can we say we know all there is to know about the chain that connects life with the first instants of the universe, the formation of matter, the universe's evolution, galaxies, stars, the solar system, the planets, organic molecules, and so on. Because there are still many gaps in that chain, we have only a sketch. As these gaps continue to be filled, an in–depth picture begins to emerge.

Even more uncertain is the fraction of those "good Earths" on which intelligent life may have developed. The Administrator would remind the audience that our own Earth is only 4.5 billion years old. Yet paleontologists and geologists have found microfossils dating back 3.7 to 3.5 billion years. Clearly, they developed as soon as Earth was ready—as soon as the proper molecules developed in sea water and the proper temperature had been reached. And that was in a relatively brief geologic time span.

On Earth, life developed into ever–more complicated and intelligent forms, and there is a strong tendency to believe it would evolve in that fashion elsewhere as well. But we do not know for sure.

The puzzles remain. What *is* clear, though, is that in order to fully understand our origins and destiny, to fully comprehend the human race's place in our galaxy, it is necessary to know whether we are alone there.

So the Administrator of NASA in 2017 will talk about progress in the search for extraterrestrial intelligence in our galaxy since the first effort, Project Ozma, was initiated in 1960 at the United States' National Radio Astronomy Observatory.

The speaker will discuss the increasingly sophisticated techniques employed to eavesdrop on our galaxy—techniques that allow radio astronomers to search tens of millions of channels at the same time and to distinguish between possibly valid messages and terrestrial radio frequency interference.

He or she will explain how a NASA project begun in the 1990s searched the galaxy, using a multichannel spectrum analyzer linked to several radio telescopes and to the antennae of NASA's Deep Space Network.

The Administrator will then turn to plans for a follow–on SETI program to be conducted from the far side of the Moon. He or she will remind the audience that the search for that elusive needle—intelligence beyond Earth—in this cosmic haystack we call the Milky Way will result eventually in one of two things happening. Either we find what we are looking for, or some evidence of it; or we will go on for a long time and decide there is no one else out there, because we find no reasonable evidence to the contrary.

If we were to discover extraterrestrial intelligence, it would be inevitable that we would want to do something about it. Perhaps we would want to communicate with the beings whose signals we intercept. Perhaps we would determine how to go out and meet them, or how to occupy our immediate neighborhood so as to be prepared to meet them on a more equal basis.

Perhaps we would debate the merits of doing nothing, out of fear that a technologically advanced civilization would pose an unalterable threat to our institutions; indeed, to our very lives. Were that debate to take place, I believe the speaker would recommend that we should take a chance on communicating. The Administrator would argue that such communication could lead to the equivalent of another intellectual renaissance and maybe even could change our perception of our Earth instantly from one of competing states and super–states to a single, precious home for the human family.

On the other hand, if we decide that we are, after all, alone in our galaxy, then, I believe your speaker would conclude that we must decide what we want to do about it. And then another debate would begin. Some would be relieved that there is no one else out there. Others would feel terribly isolated and fragile on this one planet, given all the ills that planets are heir to, including the realities of continuing population growth and diminishing natural resources.

The Administrator would point out that most people would be in a very difficult philosophical position. Few among us could conjure up the kind of religious position that easily reconciles the notion that God created other worlds just for us, unless there was something intended for us to do about them.

Nevertheless, the speaker would conclude that if we are alone, then we are all valuable. And if we are valuable, we must ask ourselves whether it is really reasonable to be sitting here on our own planet, when we could be extending the future of the human race on new worlds beyond. □

Going to Mars–by Way of the Moon

THE ROLE OF A LUNAR BASE IN MARS EXPLORATION

by Michael B. Duke

AS THE IDEA OF A HUMAN PRESENCE off Earth is gradually accepted in society at large, we can expect a widening debate over ways and means. In the interview on pages 8–11, John Aaron, who heads NASA's new Office of Exploration, presents a view of the agency's present approach to planning for lunar and martian missions. In the accompanying article on pages 4–7, a distinguished lunar scientist, Michael Duke of NASA's Johnson Space Center, describes some of the objectives of a lunar base.

In the December 1987 issue of Discover, Society Advisor Isaac Asimov found other compelling reasons for humanity to reside on the Moon, and even suggested that Moon–dwellers might be the first to lead humanity to Mars. Others have suggested that the Moon, far from being an essential stepping–stone, may even be an obstacle on the road to Mars, because the huge resources needed for a lunar base—coming out of annual budgets—would delay the martian expeditions.

Either way, building the needed new infrastructures of transport, life support, communications and operating experience will take time. During that time, disputes will inevitably occur. In the world today, as the engineering community brings forward proposals and the rest of the populace tries to comprehend them, confusion and delay are normal. People educated in the arts, sciences and humanities try to grapple with the implications of new technology, and, as a result, we endure episodes such as the growth and atrophy of American nuclear power utilities, abortive nuclear airplane and rocket projects, the sudden collapse of Apollo, the start, stop and restart of NASA's Search for Extraterrestrial Intelligence (SETI) program, and the continuing debate over "Star Wars." Even as the space station struggles to become a reality, a new argument is starting over what is to come next; working out the needed decisions for NASA will be another example of the US's untidy, but precious, freedom.

Meanwhile, what of the US's great past competitor and possible future companion at Mars, the Soviet Union? Already similar long–range lunar and martian plans, bolstered by the Soviets' unrivaled experience with humans in low Earth orbit, are being discussed by Soviet commentators. In Los Angeles on March 29, 1988, The Planetary Society will sponsor a lecture on the Soviet view of a lunar base by Dr. Vladimir Shevchenko of the Shternberg State Astronomical Institute of the University of Moscow — JAMES D. BURKE

Is a permanent base on Earth's Moon an essential step in the human exploration of Mars, or is it a step that we can bypass on our way to Mars and beyond? Although many believe that a lunar base is justified on its own merits, others ask how a commitment now to a lunar base would affect our ability to explore Mars.

Answers to these questions are complex, requiring us to ask further questions. For example, can lunar base development contribute technology or operational experience to improve our strategy for exploring Mars? Can lunar resources stimulate Mars missions? Will expenditures for a lunar base divert funds and people from Mars missions?

Over the next few years, the newly created NASA Office of Exploration (see pages 8–11) will seek answers to these questions, and will evaluate the scenarios suggested by Sally Ride and her group in 1987 (*Leadership and America's Future in Space*). This new office will work with other program offices in NASA to address the agency's goals of advancing knowledge of the planet Earth, the solar system and the universe beyond. The Moon/Mars questions will greatly affect these plans.

The time scales for a lunar base and human exploration of Mars do not coincide. Proven technology for piloted Mars missions, the ability in low Earth orbit to support these missions, experience with hu-

A COMET AMONG STRANGE WORLDS?
An interstellar spaceship entering a dusty star system? No, this is just another photo of the lunar surface from Apollo 15. The plain is peppered with small craters a few kilometers in diameter. The object at center right is the extended boom of the command module's gamma-ray spectrometer, pointed straight down toward the Moon. The photo illustrates a beautiful lunar phenomenon known as the backscatter peak of the photometric function. When the Sun is exactly behind the viewer, the dark lunar surface suddenly brightens. Why is this? Decades before there was any possibility of getting pictures such as this one, lunar scientists knew the answer: The lunar surface is fantastically rough at microscopic scale, with tiny structures that astronomer Thomas Gold of Cornell named "fairy castles" interspersed with deep cavities. When such a surface is illuminated at an angle, most of it is in shadow. But when the light source and the eye or camera are exactly aligned, one sees to the bottom of each of the myriad tiny holes and the reflection suddenly brightens. From Earth, this is seen as the steep brightening of the exactly full Moon, which is eleven times as bright as the half Moon. This observation, taken together with the polarization properties of moonlight as observed by the French astronomer Audouin Dollfus, enabled scientists to predict that the lunar soil would be fluffy and soft. Indeed Gold (and some eminent science fiction authors) thought landing modules might sink out of sight; their worries were ended in 1966 by Luna 9 and Surveyor 1.

Photograph AS15–2134 courtesy JPL/NASA

man adaptation to long spaceflight, and an adequate knowledge of the martian environment will probably not be available until the early 2000s.

Experience on the Moon allows us to confidently plan a lunar base right now, and to build it around the turn of the century. If plans for lunar and martian exploration are not directly competing for scarce resources, we can discuss questions of strategy with equanimity. However, if an early human mission to Mars is advocated strongly, we will have to competitively evaluate the merits, costs and risks of lunar base and Mars missions, and the risks of Mars exploration will loom large in that analysis.

Three major aspects of lunar base development directly affect the risks of the first human outpost on Mars: One, we could gain experience in a low–Earth–orbit facility in an environment similar to, but much less demanding than that of a piloted Mars mission; two, we could develop mining technologies, closed life–support systems, and other capabilities that we would need to "cut the umbilical to Earth;" and three, the lunar base could be a test bed for the ability of humans to survive in fractional gravity.

In recent studies of lunar bases and piloted Mars missions, we have identified how we might store and transfer cryogenic propellants. Flight to the Moon to set up habitats and laboratories will require about 160 metric tons of cryogens. A single launch of an Earth–to–orbit heavy–lift tanker could carry this amount. To sustain a program, we could plan flights every other month. If we could store 160 tons in orbit, we could buffer the system against an aborted Earth–to–orbit supply mission. Missing a launch window to the Moon could force us to reschedule a flight, but the maximum delay would be only two months.

To send a single piloted mission to Mars we would need between 700 and 2,000 metric tons of propellant. If delivered with the same Earth–to–orbit tanker, we would need several missions. The fuel would probably be stored on board the Mars spacecraft itself. The 160–ton stor-

Soviet Lunar Initiatives

With the great success of the international *Vega* missions to Venus and Halley's Comet and the continuing achievements of cosmonauts in the *Mir* space station, the USSR is increasingly willing to discuss future space programs. Soviet spokesmen have already described their plans, beginning with *Phobos–88* (see the July/August 1986 *Planetary Report*), for a reinvigorated scientific exploration of Mars. Now they are beginning to talk about lunar missions as well.

In one lunar scenario, remote sensing orbiters would be followed by automated, mobile surface prospectors, then by a human reconnaissance, several logistics flights, and finally a base operating crew. This plan may be a part of the USSR's "Star Peace" proposal being presented to the world community via the United Nations.

In response to our inquiry, Dr. Vladimir Kopal, chief of the UN's Outer Space Affairs Division, sent us the texts of Soviet proposals published in 1985, 1986 and 1987. While much of this material relates to low Earth orbit, and expresses the Soviet political reaction to the United States' Strategic Defense Initiative (and has been reported as such in the world press), parts of it point more directly to the exploration and human settlement of deep space.

In particular, the proposals include a phased development leading to "...orbital stations and platforms for scientific and commercial undertakings, interplanetary manned spaceships for practical exploration and use of the Moon even in the first decades of the 21st century, which could also be used as a base for flights to other planets." —*J.D.B.*

THE REGION OF THE Apollo 15 landing site was photographed from the command module in orbit overhead. The lunar module's landing and the astronauts' surface expeditions took place near the crook in the Hadley Rille at center right. At upper right and lower left are shown shallow cracks, which geologists call graben, resulting from extensional motions of the lunar surface around the edge of Mare Imbrium. This landing site was selected because it offered a variety of observations and samples within a small region. The small impact crater that interrupts (hence is younger than) the Hadley Rille is about six kilometers across.

Photograph AS15–0587 courtesy JPL/NASA

MARE TSIOLKOVSKI appears in this photograph taken from the Apollo 15 command module. This magnificent impact crater on the Moon's far side was discovered by Luna 3 in 1959 and named for the modest Russian schoolteacher who, at the end of the nineteenth century, first set forth the mathematical foundations of astronautics and then went on to design spaceships. After the giant collision that formed the 180-kilometer crater, dark mare lava welled up from inside the Moon and partly filled the basin. Still later, small impacts pocked the lava sea—a clear example of the stratigraphic relations that have enabled lunar geologists to build up the story of the Moon's history.

Photograph AS15–0688 courtesy JPL/NASA

age capacity could buffer the system against an aborted supply mission. However, launch windows to Mars occur every two years, so if we missed a window for any reason, it would be a long wait until we could try again.

We see that an important capability for any piloted mission to Mars is a service station that flawlessly performs on–orbit storage and transfer to meet narrow launch windows. Two to four years of experience in a lunar base program would assure us that the system could meet the Mars launch windows.

Mining resources on Mars will be quite different and in some ways less demanding than working on the Moon. Extracting oxygen from lunar rocks is technically feasible, although it requires lots of power. Mining oxygen from Mars' atmosphere is much simpler and has lower power requirements. However, before we use extraterrestrial resources to support human life or mission operations, we must be confident of our technology to do so; we can't rely on untested systems. If we demonstrate that we can extract lunar resources, we can be more confident that we can do the same on Mars or on a martian moon.

We must also be confident of the closed life–support systems, which must operate reliably, without resupply or ground maintenance for at least a year—and more likely for two to three years for human Mars missions. If it is to support humans for a long time, the lunar base has the same requirements. However, it will be much simpler to repair and resupply the equipment in the more forgiving environment near Earth. And it will be easier to develop the technologies and to gain experience there than on a mission to Mars.

Our current understanding of what happens as the human body adapts to weightlessness indicates that missions of a year or more will expose a crew to significant hazards. This has led us to consider two possibilities: One, a quick "sprint" mission to Mars would reduce the total travel time, and so the risk, to about one year; two, a spacecraft with artificial gravity would alleviate the hazards.

But there are problems with both options. To fuel the sprint mission, with a spacecraft capable of great speed, we will have to lift very large amounts of propellant to low Earth orbit. We probably couldn't sustain such a program beyond the initial mission. Before an artificial–gravity spacecraft could be developed, we would have to examine in depth the behavior of humans in reduced gravity. This could be done, in a limited way, in the space station. However, to study the effects of long periods of reduced gravity on the body,

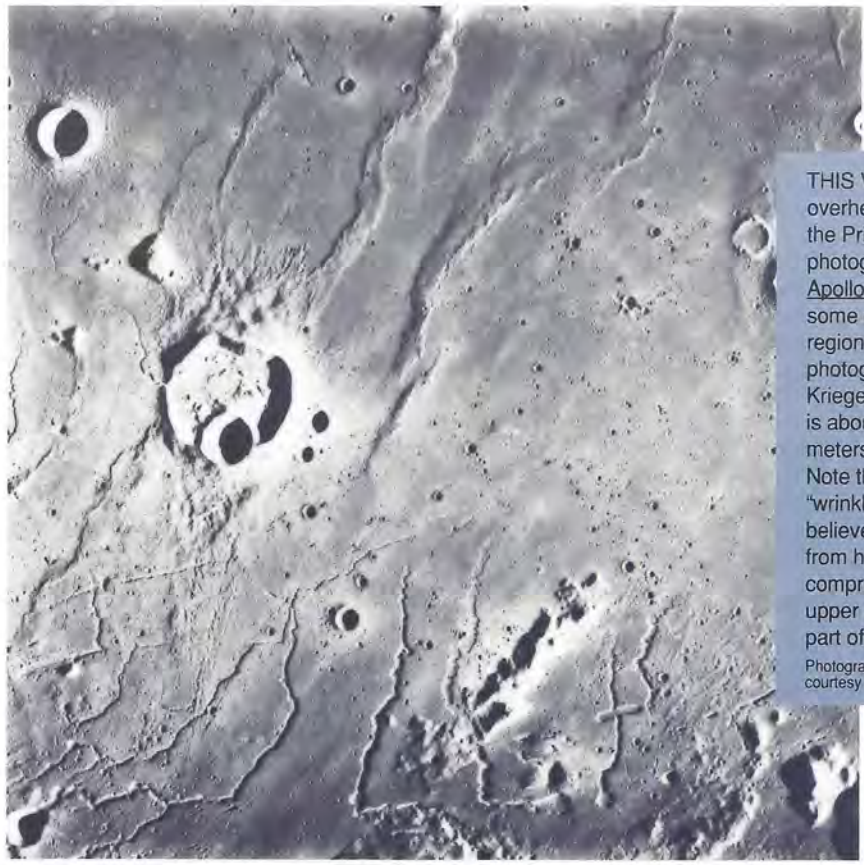
we will have to expose many people to such conditions for extended times.

A lunar base could be a test bed for studies of reduced gravity; the Moon's gravity is one–sixth that of Earth, so it is a natural laboratory for investigating fields from one–sixth to one "g." And while experimenting on humans and gravity, we can also conduct useful research on the Moon, and develop technologies and techniques for living on another world. A lunar base can be justified on many grounds, and it could be more cost–effective to study variable gravity there than building a special-purpose experimental facility in Earth orbit.

These arguments suggest that a lunar base is important to the future of humans on Mars. However, a lunar program could be even more important in helping us to find totally new approaches to Mars exploration. For example, a transportation node built at an Earth–Moon libration point (a point where an orbiting body can maintain a nearly constant position between two other orbiting bodies with a minimum of propulsion) could provide critical transportation and communication services for a lunar base. It could also be a staging point, providing lunar propellant for Mars missions at much lower energy costs than bringing the propellant from Earth. Although it now looks as though we shouldn't depend on lunar resources for early Mars exploration, such a cislunar (on this side of the Moon) infrastructure is probably needed for a long–term Mars program.

Over the next few years we will work out the lunar base's role in Mars exploration. I have not addressed here the scientific and technological arguments for a lunar base used for planetary and life science, for astronomy and other disciplines, and for the exploitation of indigenous resources. Many inside and outside of the American space program strongly support a lunar scientific outpost for these reasons, independently of any Mars initiative.

But unless space program funding increases greatly, an early lunar base program could compete for funds with piloted missions to Mars, and so delay that program. However, if lunar experience is a necessary step on the path to Mars, it adds to the many arguments for a lunar base. If a lunar base is chosen as an earlier goal than the human exploration of Mars, then we must take care that its development addresses the issues of a Mars program. While building a lunar base we will develop the technologies and infrastructure to make Mars exploration easier, and thus to speed up the achievement of a lasting human presence on Mars. □



THIS VERTICAL overhead view of the Prinz rilles, photographed from Apollo 15, covers some of the same region as the cover photograph. Crater Krieger, left center, is about 30 kilometers in diameter. Note the low mare "wrinkle ridges," believed to result from horizontal compression, in the upper (northern) part of the photo.

Photograph AS15–2339 courtesy JPL/NASA

The Next Goal for NASA — The Moon or Mars?

In recent months, many people involved with the American space program have concocted a debate that could be called "the Moon vs. Mars" over the next objective in the human exploration of the planets. This article by Michael Duke, and the interview with John Aaron on pages 8–11, show that there is no uniformly agreed upon answer to the question of which horizon we should seek next; rather there is a set of complex questions about the reasons we should go to the Moon or Mars. No one seems to question that Mars is the eventual goal of human space exploration. The reports of the Paine (*Exploring the Space Frontier*) and Ride (*Leadership and America's Future in Space*) commissions affirm that goal. And the US has already been to the Moon; there must be an extremely persuasive reason to return. The Moon's proponents must convince the nation of the importance of establishing a human base on Earth's nearby satellite.

I am skeptical that they will be able to do it. Clearly, a base would be expensive. The Moon is not a particularly desirable place to live; it has no atmosphere, no climate, and probably no water. A telescope built on the Moon might be nice, but is it worth 5 to 10 similar instruments on Earth or in Earth orbit? We don't know what usable resources we might find on the Moon, but even if we find them, what will we do with them? Export them to Earth? Use them to construct enormous structures in space? And do we need to practice on the Moon before we set out for Mars? Or could we test our systems more effectively and efficiently in Earth orbit or on Earth itself?

My skepticism doesn't presume that I am right or that I don't like the Moon. The technical and scientific questions will get sorted out once NASA is again given a mandate to explore and a goal to strive toward. I don't doubt that NASA can find the technical answers once they are given direction and support from the people it serves. Many of us believe the goal that can rekindle the American public's passion for space is Mars.

The Planetary Society welcomes other views about these questions and the continuing discussion about whether the Moon is a stepping–stone or a detour on the route to Mars. —*LOUIS D. FRIEDMAN*

A TALK WITH
John Aaron

In an attempt to determine NASA's future in space, Administrator James Fletcher appointed astronaut and Planetary Society Advisor Sally Ride to lead a study of the goals the agency might pursue in trying to re–establish its leadership in space. Dr. Ride presented her report, "Leadership and America's Future in Space," to Dr. Fletcher in August, 1987.

*The report suggests four candidate initiatives: **1)** Mission to Planet Earth—to use space–age technology to better understand our home planet; **2)** Exploration of the Solar System—to continue the reconnaissance of the planets with automated spacecraft; **3)** Outpost on the Moon—to return to Earth's satellite and establish a permanent base; **4)** Humans to Mars—to send human crews to the nearest planet accessible to our species.*

Dr. Ride's report also recommended that NASA establish a new Office of Exploration to lead the agency's hoped–for resurgence as a power in solar system exploration.

Dr. John Aaron, formerly space station manager at NASA's Johnson Space Center, was chosen to lead the new office. Last December he discussed his job, the state of NASA and the future with the Society's Executive Director, Louis Friedman.

Louis Friedman: *Why was the Office of Exploration set up?*
John Aaron: It was set up to focus advanced planning for long–range human exploration of space. Previously such planning was shepherded from a lower level of the Office of Space Flight. With NASA's emphasis on developing a more structured approach to strategic planning, it was appropriate to set up this office. This new emphasis came from the Ride Report's recommendation that NASA formalize its planning for advanced missions. Last year NASA published specific new goals [stated by the NASA Senior Management's Strategic Planning Council]; one was to extend human exploration beyond low Earth orbit into the solar system. This office will orchestrate the activities throughout the agency to fulfill that goal.

Friedman: *What do you think the human role in space should be?*
Aaron: The most visible part of the space program is centered around humans in space. It's certainly not the only reason we have a space program. But in terms of a balanced, viable space program that appeals to a broad constituency, having humans in space is important to the civil space program. It also fulfills the sense of destiny to explore. Although we plan to explore with both robotic and human missions, to fulfill that sense the human element must be a major component.

Friedman: *That's not quite the question I was asking. I meant: Lately the human role has been to transport cargo to space. During the* Apollo *program the role was exploration. Do you think the role of humans in space will continue to be in transportation?*
Aaron: I don't know. Certainly on *Apollo* you are right; the role there was not viewed as transportation. I think you are referring to the shuttle era of the late 1970s and 1980s. I guess when you go to and from Earth orbit it would be easy to just characterize that as transportation. The future role is more analogous to *Apollo*, where transportation is certainly a part and a routine role in the future. The emphasis should be back on exploration.

Friedman: *Let's go a little further. Do you think the transportation role was a mistake in any way?*
Aaron: No. In fact that's not a proper characterization of what we do today with shuttle. We need to look at the fact that delivery of systems, checking out those systems, servicing and repair, conducting basic scientific research, for example, as in the Spacelab missions, is more than transportation. Certainly the transportation development was an appropriate part. But transportation should become more routine and will not be the focal point of what we do with humans in space in the future.

Friedman: *How will your office work with industry, scientists and the public? In what special ways will your work with those people differ from working with those inside NASA?*
Aaron: In this office we are trying to increase the interaction we have with the various communities and disciplines outside of NASA. The reason is twofold. One, when you talk about setting up a lunar base or human exploration of Mars, those missions have not been analyzed in detail in terms of their scientific potential. It takes specific effort with the scientific community to seek out ideas and concepts and to understand the potential of these missions. So although NASA has looked at a lunar base and at a human mission to Mars in summary terms of what science could be done, that also requires us to seek out and develop in detail the various ideas that have been proposed. I envision setting up a very active program to reach science disciplines that you wouldn't necessarily think of when you think of planetary exploration.

INSET: Exploring outward from a growing base complex, climbers investigate the rim of a large, ancient lunar crater. Military, arctic and undersea experience on Earth will provide the background skills for such expeditions, whose safe conduct will require the same discipline and planning that went into the Apollo traverses.

RIGHT: Lunar workers unload a module after its delivery to the lunar surface by a descent rocket stage. In the early build–up of a lunar base, it will be very important to make maximum use of every item sent, at vast effort and expense, from Earth. This painting suggests how space–station modules may serve as prototypes for habitats and laboratories on the Moon.

Paintings:
Pat Rawlings,
Eagle Engineering

NASA will use the normal mechanisms to deal with industry, particularly the aerospace industry, for the normal space functions.There are new development functions associated with these initiatives. Let's take the lunar base as an example. As we analyze the lunar base scenarios, as well as outposts on Mars; construction, resource acquisition, mining and processing, we must seek out industries that we haven't used before, such as construction and chemical processing industries. There are also other government agencies that we need to seek out, such as the Army Corps of Engineers, the Bureau of Mines, and so forth.

Friedman: *Do you see this as relevant soon?*
Aaron: It's relevant within the next two years.

There's a third constituency category: The public, including the education system. Since our major endeavors require major resources and rationales, we have to have a very good public information program that can articulate the reasons for undertaking these major exploratory voyages: What are the benefits to humankind, in terms of raising the standard of living, competitive spinoffs into the world marketplace, as well as how they satisfy our desire to explore? We have an opportunity here, since these missions take years. Not only should we reach out to universities and colleges, we should also target information to stimulate the scientific and engineering awareness of our children in elementary and secondary schools. I've asked Alan Ladwig in my organization to concentrate on how we can do that. We ought to make sure that within 10 or 15 years we have enough scientists and engineers to undertake these kinds of voyages.

We also have to keep in touch with the political imperatives and desires of the administration and Congress. I envision that we will set up groups to use the expertise of informed people with scientific and commercial experience. Early in 1988 I plan to set up an oversight committee of probably 20 people, a mixture of various backgrounds of importance, to consider in these initiatives.

Friedman: *Do you see any way that The Planetary Society, as a public interest group, can help your initiatives?*
Aaron: You certainly can. You already have helped considerably in heightening the awareness of why human exploration is important to this country and to this planet. I hope that we can continue a good relation-

ship because what your organization advocates is synergistic with what NASA is trying to do. I know that sometimes your organization gets a little impatient with NASA's studying so many alternatives, or taking as much time as we do on details. But the system, particularly in its current environment, demands that we do that. Before we go forward, we have to know, with quite a bit of fidelity, the cost of these programs, and have a good idea of the benefit. All of that contributes to our studying many things in parallel over a period of time to reach a mature decision. That contributes, sometimes, to a little impatience on your part. NASA's trying to be responsive to the constituency.

Friedman: *The Ride Study picked four initiatives. Are you going to pick one or two?*
Aaron: That was one of the first questions I had to deal with when I came on board. Sally hoped she could analyze and understand the degree to which those four initiatives would contribute to leadership. After all, the name of her report is "Leadership." Two of those initiatives were unmanned and two were manned. What I have worked out is this: We should not, as part of this office, advocate the two unmanned initiatives per se, out of context with the other scientific and exploratory themes of NASA. There's six or seven scientific themes that the Office of Space Science advocates and defines missions for, including the two unmanned initiatives contained in the Ride Report.

Friedman: *You're not worried that they'll get lost?*
Aaron: No, because I think that, in the end, this office will plan for some combination of initiatives. I don't think that NASA will simply study and then announce one endpoint, and pursue that single objective. Of the six or seven themes of science and exploration within NASA, such as the great observatories, robotic planetary exploration, the international solar terrestrial program, or the use of the space station for scientific purposes, five are in the Office of Space Science and Applications and two are in the Office of Exploration—the latter having to do with long-range human initiatives. The crux of the problem is: Of those seven themes, what combination makes sense for the agency to pursue? So the responsibility lies with the two offices, with the Office of Exploration taking the lead. Each theme will be developed individually in terms of its potential. The result is not simply to pick one as a primary goal. The right answer is to pick a combination to give the right balance of near-term and far-term objectives in unmanned as well as manned exploration.

Friedman: *Why not pick one, as we did with* Apollo, *to put a man on the Moon and return him safely by the end of the decade? That led to a very broad planetary program—Earth, Mercury, Venus, Mars, Jupiter, Saturn, Uranus, Neptune—and dozens of lunar spacecraft, lots of launch vehicles and communications satellites. Why not pick just one goal? Isn't that a better way to get on with the program instead of endlessly trying to blend things and please more constituencies?*
Aaron: But what you reeled off there was a broad combination.

Friedman: *It was driven by one goal:* Apollo. *That was the only goal enunciated for NASA.*
Aaron: It was enunciated as one member of a very rich program. The scientific return has never been as rich as it was in that time. Maybe I'm not articulating the plan right. I don't think we ought to focus singularly on one initiative to the exclusion of all others. The right model is centered around some primary objective. These human exploration initiatives are major in terms of dollars and talent required. We are trying to return to what you were talking about. We picked the primary goal of extending human exploration into the solar system. We are working out intermediate points along the way. Meanwhile, we do have very important scientific themes already that we will pursue in addition to human exploration.

Friedman: *One of those initiatives is the lunar base. What is a lunar base? Is it a goal in and of itself, or is it a step to something else?*
Aaron: In the context of the way you asked the question, I don't think it is a goal. It's a step. Remember the second goal of NASA: To extend the human presence into the solar system. If a lunar base is chosen as a path, we don't envision that we would stop at the Moon. The lunar base is an exciting intermediate step. As we expand outward, to what degree do we need to stop at the Moon to gain operational experience, to understand how to live and work on a remote body in the solar system, is the question. Using that experience to move on outward, including explorations to Mars, that's the proposed reason for a lunar base in the context of your question.

Everyone's aspirations are to go to Mars. You won't find anyone who says we shouldn't go to Mars eventually. To what degree we need to use the lunar base to do that is a question. Maybe we might find resources to export commercially. We are also thinking of lunar resources to maintain a base or to leverage further exploration into the solar system.

On the Moon we are only three days from home. That appeals to us. In addition to doing planetary science on the Moon, it is exciting as a natural base for major scientific instruments to learn more about the cosmos as well as the solar system.

Friedman: *Why shouldn't NASA get out of manned space flight and have a more inexpensive robotic goal?*
Aaron: That would be very exciting, but to a smaller constituency. However, I don't believe a country will be judged as a leader in the space program without human exploration as a component. I reject the idea that we are paying too much for the space program. We are really paying nothing; the return exceeds the cost. It comes in science, economics, technology, competitiveness, prestige and so on. That wouldn't come from a robotics-only program. As long as Mars is out there humans will want to go—and they will. The United States might not, but humans will. We at NASA want the US to do it.

Friedman: *Many have commented that NASA has weakened lately. Is the agency capable of organizing a successful Mars pro-*

A module has landed on Mars. Designs such as this are already contemplated in studies of human missions to the Red Planet—studies that have gone on sporadically for many years as the prospect of a martian future for humanity continues to beckon us.

Painting: Pat Rawlings, Eagle Engineering

gram with all of the attendant needs: A space station, long-duration life support, larger launch vehicles, a 10– to 20–year–long supporting science and technology program, and so on?

Aaron: NASA is up to it. It will require national will and support. Given that, NASA's spirit will be revitalized and the goal will bring the best to work on the program.

Friedman: *If the nation finds the will, do you think NASA can sustain a 10– to 20–year program? Has the country gotten overburdened with bureaucracy?*

Aaron: That is one thing that has changed since we took on the *Apollo* program. We live with more oversight, more micromanagement, and so forth. But a lot of that is because we are trying to be all things to all people. Because we don't have an imperative invites a lot of micromanagement.We can do it.

Friedman: *Looking ahead to a successful NASA program as it is now constituted, I'm worried about reaching 1995 with no more launch capability than the US has now; a space station no closer to giving us long–duration flight capability or the ability to launch greater masses to the planets; no new exploratory missions (sample return from Mars might still be eight years in the future, which is where it has been since* Viking*); and a continuing debate about the goal of NASA. That's the state of NASA's program now, and it might very well be the same in 1995, even without a single budget cut.*

That's a comment. Can you tell me if it is unfounded?

Aaron: Let's talk about that scenario. If we pursue recent business as usual, then you are right. The worst case is that we can wind up in a situation where we haven't made these investments in advancing transportation or technology, in understanding the human question, or in delivering planetary spacecraft. If we wind up like that, it could be because NASA pursued major pieces of infrastructure without proper resources to develop missions and to exploit that infrastructure. Then NASA will have failed in that context. If we don't successfully build up resources to pursue infrastructure support, and at the same time bring other missions and technologies along to reap the benefits, then clearly we will have made a mistake.

One thing that NASA must do is to keep its infrastructure and its missions in proper balance. The agency shouldn't build major pieces of infrastructure on line if the country hasn't the will to provide the budget to use the infrastructure.

Friedman: *That is a key point.*

Aaron: So NASA's taking the following course: We're laying out what it takes to do those initiatives, as well as what investments one needs to enable the initiatives. We're going after the budget to do the job, as opposed to assuming a level budget and seeing what we can do.

Friedman: *And then we'll see whether or not your statement that otherwise NASA shouldn't pursue the infrastructure is adhered to. I remember that the materials–processing budget went down dramatically—50 percent or more in two or three successive years—because of the shuttle's funding. Yet the justification for the shuttle was that it could support materials processing in space. There are many other examples. That's the trap.*

Aaron: You get into those traps incrementally. You don't wake up one morning and suddenly decide to do a dumb thing. I hope we at NASA are able to recognize that, if we are not successful in advocating a budget to do the missions, we then stop and pursue what it is we should do differently, instead of getting trapped incrementally into these ever–decreasing, zero–sum budget discussions. You can't be all things to all people without adequate resources.

Friedman: *The Ride study did not consider international cooperation in human initiatives and the report ignored the Soviet activity in space exploration. What about this office? Are you also going to ignore international cooperation?*

Aaron: No, I believe personally, as opposed to a particular agency position at this time, that the best way to pursue these initiatives may be with international cooperation. These are major investments that require major systems. From the practical view, there's a lot to be gained. Our approach is that as we lay out these initiatives, in terms of what it takes to do them unilaterally, we also keep in mind that international partners could bring leverage. So, as political agendas and climates change and the mission concept matures, there will be many chances to entertain cooperation.

Friedman: *Will you be talking to potential partners to see how they fit?*

Aaron: I will take whatever opportunity I have to keep abreast of their programs and to keep them abreast of ours. To have a formal dialog requires that the administration set the agenda for our country compatible with cooperation. Although there is currently an agreement on unmanned Mars missions, there has not been a similar arena opened up formally for human exploration. But there is no reason to be chagrined because, as we lay out these initiatives, there will be plenty of opportunities to match our programs.

Friedman: *Should space science and exploration be the main focus of NASA? Does the United States lack a commitment to it?*

Aaron: That has been the main focus of NASA, and to a large degree it should be. I don't know that there is a conscious lack of commitment. The commitment has eroded over time. Maybe we're pursuing too many specific and short–term agendas. I am hopeful if we present a focused set of goals and articulate them well, over the coming years we could revive that commitment in this country. □

Using heat to extract volatile materials, astronauts mine Phobos for rocket propellants and life support. In 1989, Soviet spacecraft will begin investigating the little martian moon to find out whether or not it offers such a resource for the future.

Painting: Pat Rawlings, Eagle Engineering

World Watch

by Louis D. Friedman

WASHINGTON—The Reagan administration's budget request for NASA did not contain the hoped–for new start of the Comet Rendezvous Asteroid Flyby (CRAF) mission.

NASA's overall budget was up by about 20 percent, with the space station, the space shuttle and several other areas of space science receiving increases. Details of the budget and support for new missions were not yet available as we went to press; we will discuss them in the next issue of *The Planetary Report*.

MOSCOW—In December 1987, Soviet and American planetary scientists met in Moscow to discuss ways to implement the new space cooperation agreement between their two nations. The most immediately significant move was NASA's agreement to consider an antenna on the *Mars Observer* spacecraft to relay data transmitted by the balloon probes to be launched by two Soviet spacecraft early in the next decade. (See the May/June 1987 *Planetary Report*.)

American scientists, led by an ad hoc committee of The Planetary Society, believe that data from the Mars balloon probe can provide important information about that planet's surface to help the much–planned rover and sample return mission.

At the Moscow meeting, the space scientists also discussed cooperation on data analysis from other Mars and Venus missions, and future mission objectives.

WASHINGTON—NASA's continuing problems with the space shuttle program are lessening the agency's support in Congress and in the press. During a test firing of the solid–fueled rocket, a redesigned nozzle assembly failed, forcing a return to an earlier design. Such engineering problems are to be expected in a complex program such as the shuttle, and the spotlight on them makes NASA's task all the more difficult. The agency is criticized for going too slow, too fast, spending too much, and too little.

The problem, as we've said before, is not the shuttle itself, but NASA's total reliance on it. It is an experimental, not operational, vehicle. The agency should be allowed to fix and develop it leisurely and carefully. In the meantime, NASA should use expendable launch vehicles, such as the proven *Titan* rockets, to lift regular science and applications payloads.

WASHINGTON—In December, NASA awarded $5 billion in contracts to build their space station, despite strong criticism from the National Research Council (NRC) of the National Academies of Science and Engineering, increasing cost estimates, budget cuts from Congress and the administration, scaling down of the structure, and government and private industry support of a different station concept.

Within two weeks of these awards, Congress reduced the space station's 1988 budget by 45 percent, as part of the federal deficit reduction program. This cut was made to an already scaled–down program, which was to orbit a "Block I" station by 1996.

The NRC panel asserted that NASA had underestimated the cost of this station. The agency estimates the cost at about $18 billion; NRC says the true costs are closer to $32 billion. The panel also noted that the space shuttle is insufficient to launch space station hardware; much more powerful launch vehicles should be developed before the planned station can be placed in low Earth orbit.

More significantly, the NRC panel criticized the stated microgravity materials processing goals of the station program. The panel suggested that the proposed "Block II" for applications planned for the late 1990s might be "better used as a biological research center and staging area for space travel" (*Science* magazine, September 18, 1987). They did say, however, that the Block I stage could accomodate such a redirection and should continue.

NASA's enthusiasm for microgravity processing has not been met with commensurate interest from private industry. Johnson and Johnson dropped out of their commercial venture with McDonnell–Douglas, citing more promising Earth–based techniques. In addition, the first post–*Challenger* meeting of potential space station users was poorly attended, and participants concentrated more on space science from automated platforms.

A new player has now entered the arena: the Industrial Space Facility (ISF). Designed as a private venture by Space Industries, Inc., led by Maxime Faget—the former chief engineer at NASA's Johnson Space Center, and designer of the *Mercury, Gemini* and *Apollo* space capsules—the ISF is proposed as an automated platform to be periodically tended by astronauts, with no need for a permanent human presence.

Space Industries claims that the ISF would cost less than $1 billion. Its main applications would be in materials processing and microgravity research. The US Department of Commerce and several private companies, including the Boeing, Westinghouse and 3M corporations, are encouraging the ISF. The White House Cabinet Level Economic Policy Council has recommended that the government support it.

This astronaut–tended facility could be operational as early as 1991, Faget asserts. He proposes to develop it with private money. However, the plan requires government guarantees in the form of leasing.

NASA opposed the ISF, seeing it as a competitor to the space station. But is it? The station's only competitor is itself. With weak public and congressional support, no customers, escalating costs and dependence on the shuttle, the station is its own worst enemy. But if it were freed of the early microgravity requirement and the current technological competitiveness and economic shibboleths, then suddenly it offers a promise for the revitalization of the US space program.

According to the NRC report, Block I station development could be easily redirected. NASA's real love is human exploration, with the ultimate goal of Mars. (See the Ride Report, *Leadership and America's Future in Space*.) With the ISF or similar approaches handling industrial work, the space station could be freed to become a base for Mars exploration. Research in orbit could begin in the late 1990s, with a mission setting out early in the next century. That station could also build on the lower cost automated platform experience.

Redirecting the space station toward those goals would reaffirm NASA's charter. Balanced with expendable launch vehicle development, robotic planetary exploration, space science and biological research in orbit, the space station would be worth the cost.

WASHINGTON—In December, Planetary Society President Carl Sagan and Advisor Paul Newman were among a group of Americans who met with Mikhail Gorbachev while the Soviet leader was in Washington, DC for the summit meeting with President Ronald Reagan. Mr. Gorbachev spoke to the group about many topics in American–Soviet relations, including cooperation in space. He specifically mentioned cooperation in the exploration of Mars, and stated that he supported a joint human mission to the Red Planet.

Louis Friedman is the Executive Director of The Planetary Society.

News & Reviews

by Clark R. Chapman

It has been nearly two decades since a human being first set foot on the Moon. Then the *Apollo* program was cut short and the American space program began its inexorable decline. Perhaps 1988 will see a rebirth of interest in the Moon, as NASA struggles to find a goal for itself.

Editorialists, commentators and cartoonists around the nation have been bemoaning NASA's failure to maintain American space leadership. For example, a January editorial in the *Tucson Citizen* decried the "Vietnamization" of the US space program. Mincing no words, the editorial writer found an analogy between NASA's malaise and the Pentagon's self-deception back when we lost our sense of purpose and became mired in Indochina: "Like our generals in Vietnam, NASA's brass has covered up failure with technology and lies. An orbiting space station NASA wants now may not benefit science any more than defoliation helped American troops.... NASA exaggerated shuttle launch frequency the way the military boosted body counts, 'cooking' data to make the awesomely complex shuttle look as cheap and practical as a pickup truck."

The editorial is overwrought and unfair, but it is symptomatic of the frustration felt by many citizens. NASA continues to build a space station at a lethargic rate and with no clear purpose. But what about our quest to explore, our thirst for knowledge about our cosmic environment?

Commentators on the tragic situation say that what is needed is a plan, some meaningful new goals. Actually, there is a plan. Indeed, many sensible, forward-looking plans have been articulated by NASA committees, by scientists, and by groups such as The Planetary Society: Sally Ride's report is only the latest. It calls for a lunar base, then a push toward Mars, while augmenting scientific studies of the solar system and our own planet.

The *Citizen* editorialists put the onus where it belongs, on the shoulders of the President, calling on him to rise to the challenge and articulate a new, imaginative goal for NASA. *Aviation Week & Space Technology* for January 18 says Reagan adopted some of Ride's goals in a new space policy. But then he was silent about space in his State of the Union address. If and when Reagan commits to a big goal for the space program, I believe it must be implemented without further strangling the other good things NASA has been trying to do.

It is a lesson Reagan and NASA have yet to learn. Once again the long-planned Comet Rendezvous Asteroid Flyby (CRAF) mission is not proposed for a "new start" in Reagan's budget. According to *Aviation Week*, NASA didn't even appeal the Office of Management and Budget's deletion of the mission. Instead, it accepted a three-year further delay, so it will be past the year 2000 before we get to a comet. We will probably hear that there is a new light-at-the-end-of-the-tunnel if we only wait until next fiscal year. But an agency that continually fails to honor its plans and commitments to explore the solar system can hardly expect all planetary enthusiasts to rely on its new promises. There have been some positive changes in NASA, but I feel it is time to turn to Congress to save planetary exploration from extinction in the 1990s. Congress, not the lame-duck Reagan administration, seems to be the only hope for getting CRAF started in the fiscal year 1989 budget.

Yes, We've Been to the Moon Before

How easily we forget how much we learned about the Moon in the 1960s. As the astronauts landed, scientists were still debating whether the Moon remained unaltered from the beginning of solar system history. Dating of the returned Moon rocks clinched the matter: The Moon suffered heavy impact bombardment during its first half-billion years of waning volcanism as it cooled into its present inert state.

The geological history of the Moon is presented in excruciating detail, and in beautiful format, in a new soft-cover book by Don E. Wilhelms, *The Geologic History of the Moon*. Its intimidating subtitle is "US Geological Survey Professional Paper 1348;" available from the USGS Book Section, Federal Center, Box 25425, Denver, CO 80225. It might be an impressive addition to your coffee table. The comprehensive, rigorous text is full of jargon, since Wilhelms wrote it for geologists to summarize two decades of research on lunar geology. But the large-format book is replete with handsome photographs, color maps, and a wealth of descriptions that any lunar enthusiast would enjoy dabbling in. Serious readers should be aware of what is missing, too: Wilhelms does not deal with the origin of the Moon, nor with questions of its chemistry. This is a book about lunar stratigraphic geology—the layers upon layers of rocks, exposed at the surface of the Moon, that record aeons of impacts, faults and lava flooding.

The Variety of Explosive Stellar Deaths

Astronomy's February cover story on Supernova 1987A, written at an elementary level, guides us through the sequence of nuclear reactions within stars of various sizes, to the point where—in the most massive stars—a supernova explosion results. The author notes that the progenitor for 1987A was a blue supergiant, not the kind of star experts thought would explode.

The *Astronomy* article is a good warm-up for *Scientific American*'s more comprehensive treatment of supernovae in general (November, 1987). Lightcurves and spectra of distant supernovae show that they come in many flavors. While 1987A—the closest supernova in centuries—didn't quite fit any of the other unusual types, authors Craig Wheeler and Robert Harkness put its differences into context. Fundamental predictions, such as the bursts of neutrinos recorded hours before 1987A was first seen, prove that astrophysicists have a good handle on their subject. But the complexities of stars of different sizes, compositions and configurations (such as the nature of the companion star if a supernova is part of a binary) make for a bewildering variety of observed phenomena. Scientists are trying to unravel the data to understand more about the birth and life processes of stars. Supernovae are important for planets, indeed, for life, because these stupendous stellar explosions release into space the heavy elements, manufactured in stellar interiors, of which planets and life-forms are made.

Clark R. Chapman is beginning to plan for Galileo*'s expected encounters with Venus, Earth, the Moon, and the asteroids Gaspra and Ida.*

SOCIETY Notes

VOLUNTEER NETWORK GROWS

The Planetary Society's Volunteer Network continues to grow. These members are working actively toward the Society's goals of encouraging planetary exploration and the search for extraterrestrial life, and fostering cooperation among spacefaring nations.

We are now selecting volunteer coordinators for each state and country. These coordinators will put local members in touch with each other and will supervise local activities.

We encourage members of the volunteer network to plan events, set up displays, and tell others about The Planetary Society, our goals and accomplishments.

MARS DECLARATION GAINS

The Planetary Society's Mars Declaration, a petition to document popular support for human exploration of Mars, has received a tremendous response. The declaration was circulated to prominent Americans and then published in the November/December 1987 *Planetary Report*.

At press time, we've received over 10,000 signatures in support of the declaration, with hundreds more arriving daily.

Many members copied the form from the magazine and sent in dozens of additional signatures. New Millennium Committee member George Awad of New York City sent in 73 signatures. Jerry D. Eisner, MD, of Mt. Vernon, Washington sent in 10 signatures from his medical center. Ronald Ripko of Colorado Springs sent in 16 signatures. Hundreds of members sent in three or four signatures from friends and family. Albert Wappler of St. Petersburg, Florida explained that because of his age (86) and illness he couldn't circulate the petition, but he sent in his own signature to support our effort.

If you haven't signed the Mars Declaration, get a copy from *The Planetary Report* or write to our office, ATTN: Mars Campaign, for a copy.

SOCIETY FUNDS DOLPHIN STUDY

If intelligent life is someday discovered on another world, will humans be able to communicate with it? To help us learn more about interspecies communication, The Planetary Society is helping to fund Project Circe to understand more about dolphin communication. Diana Reiss of San Francisco State University and the Marine World Foundation will explore any implications for possible human communication with extraterrestrial intelligences.

FINANCIAL STATEMENT COMPLETED

The Price Waterhouse audit of The Planetary Society's financial statement resulted in an unqualified opinion finding our statements in conformity with generally accepted accounting principles. A copy is available upon request.

SETI CONFERENCE BEING PLANNED

From October 7-9, 1988, The Planetary Society and the Ontario Science Centre will hold an international conference in Toronto on the search for extraterrestrial intelligence (SETI). There will be a two-day scientific conference with a day of public sessions. For more information, write to our Pasadena office, ATTN: SETI.

WATCHING MARS IN '88

Mars, the Red Planet, has intrigued humans for centuries. This year Mars will be closer to Earth than it has been for 17 years, and viewing should be excellent. The Planetary Society is taking advantage of this event by sponsoring a year-long program, Mars Watch '88, to excite the public imagination about the exploration of Mars. Stephen Edberg, a scientist at the Jet Propulsion Laboratory, is coordinating the program.

Mars Watch parties, held in cooperation with amateur astronomy groups and planetaria, will give people many chances to see the Red Planet through telescopes during September when viewing will be best. Teaching materials will be available for classroom use.

Scientists will be particularly interested in changes in the polar caps and dust storm formation on Mars. Both phenomena will affect future exploration. Amateur astronomers can participate in this vital research, which is being coordinated with the help of the Association of Lunar and Planetary Observers (ALPO).

If you would like more information about Mars Watch '88 and how you can get involved, write to the Society's offices, ATTN: Mars Watch.

SAN FRANCISCO MARS WATCH A SUCCESS

The Mars Watch '88 symposium, held February 7 and sponsored by The Planetary Society in cooperation with the University of California, Berkeley's Lawrence Hall of Science, was a big success, with 500 people attending. The symposium reprised our Mars Watch program held in Pomona last summer. Baerbel Lucchitta of the US Geological Survey in Flagstaff compared Mars to our planet in a series of stunning slides. Christopher McKay, coordinator of the Society's Mars Institute, talked about Mars exploration. Mars Watch coordinator Stephen Edberg told the audience how they could get involved in Mars Watch '88.

Barbara Bowman, volunteer coordinator for Northern California, and her dynamic crew did a magnificent job of putting the event together. Kudos to Barbara and her volunteer network organizers: Mary Pea, Garry Easop, Dan Cobb, Paul Lake, Lonny Baker, Dario Oakley and Buddy Nelson.

SOCIETY COSPONSORS ASTRONOMY DAY

The Planetary Society is joining with 12 amateur and professional astronomy organizations in cosponsoring Astronomy Day on May 9 (May 2 in Northern California).

During Astronomy Day celebrations, telescopes will be set up in shopping malls, schools, parks and even open fields and street corners. People who have never had the opportunity to look through a telescope will be able to view the planets, the Moon, nebulae and galaxies. Many teachers will include special activities in their classrooms.

Countries that will celebrate Astronomy Day include: Great Britain, Mexico, the United States, Canada, New Zealand, Finland, New Guinea, Malaysia, Argentina, the Philippines and Sweden.

For more information about Astronomy Day events, contact your local planetarium, science museum, college astronomy or physics department or astronomy club.

The Solar System in Pictures and Books

• Books

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