Internecine battles have tarnished the reputation of planetary scientists in Washington, D.C. Researchers hope they can win back respect with a consensus long-range plan

Planetary Science's Defining Moment

SOLAR SYSTEM EXPLORATION

The world's planetary science programs, centered in the U.S., Japan, and Europe, are setting ambitious goals—and facing a host of trials and tribulations, ranging from skeptical politicians to bureaucratic reshufflings to technological challenges.

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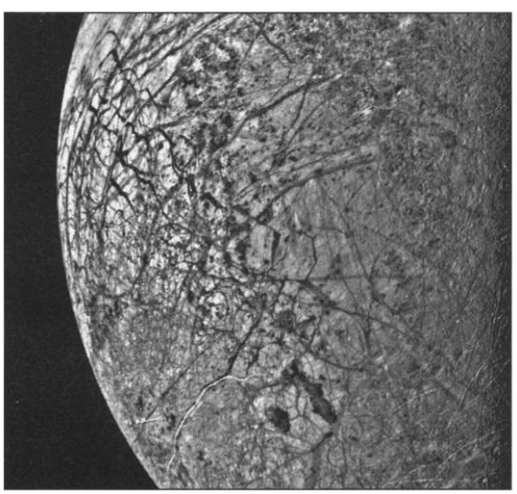
IRVINE, CALIFORNIA—The stark message from the black box on the conference table left many of the dozen or so scientists visibly shaken. "It would be very easy for this Administration to walk away from the planetary program," said the voice from Washington, D.C. The speaker was Steve Isakowitz, who oversees space and science programs at the powerful White House Office of Management and Budget (OMB). The stunned audience members were part of a National Research Council (NRC) team working on the first long-term science plan for solar system exploration. "The planetary community is fractured, and we don't have a clear vision," chimed in fellow budgeteer Brant Sponberg during the 15 November teleconference. "And that makes you guys very, very vulnerable."

The crisis in NASA's solar system effort is forcing a painful reckoning for researchers who study planets, moons, asteroids, and comets. "I shiver at the idea of this nation abandoning exploration of the outer planets," says Wesley Huntress, an NRC panel member and geophysicist at the Carnegie Institution of Washington. Ironically, the trouble comes at a time when the field is booming. Public support is strong, and flotillas of U.S., European, and Japanese spacecraft are planned, on their way, or already gathering data in the far corners of the solar system. NASA's $800 million planetary science budget is slated to top $1.3 billion by 2005. Meanwhile, many U.S. companies, private and public labs, and individual scientists are scrambling to get a piece of an area that was once the domain of a few privileged institutions and researchers.

But this expansion also comes in the midst of bitter rivalries among subdisciplines, friction between labs and their political backers, and rancor between Washington players like Isakowitz and bench scientists with their own agendas. "We're in a mess right now," sighs Andrew Nagy, an NRC panel member and space physicist at the University of Michigan, Ann Arbor. Things came to a head last fall during a successful campaign by researchers to win congressional approval to revive a Pluto mission that NASA had shelved. The $30 million appropriation, a mere down payment on what could be a $500 million effort, angered NASA officials and their political paymasters, who don't think the nation can afford such a voyage. Now both the Pluto mission and a separate trip to study Jupiter's moon Europa are on the chopping block. Unless planetary scientists make some prudent choices, say OMB officials, the future of U.S. exploration beyond Mars is highly uncertain.



On ice? The status of a Europa orbiter that would provide better closeups of the Jupiter moon is unclear.

Pluto and Pasadena

Academic researchers, NASA officials, and policy-makers alike are counting on the NRC panel to rescue the field from that uncertainty by providing a set of scientific objectives and associated missions for the next decade on which everyone can agree. The NRC previously drew up long-term plans for astronomy and astrophysics, providing clear priorities that those communities have turned into an effective lobbying tool.

In the past, planetary scientists have rather relished the rough-and-tumble sparring over NASA's budget. Just a few years ago, advocates of a Mars lander fought with those who preferred a mission to a nearby asteroid. The infighting seems inevitable, because one mission can never please everyone. "Solar system missions are the opposite of astronomy missions; they are narrowly tailored and specifically targeted," notes Mark Sykes, an astronomer at the University of Arizona in Tucson. The Hubble Space Telescope may study the birth of stars, black holes, and extrasolar planets all in the space of a week, but a mission to Mars offers little of interest to a researcher studying gas giant planets. Even within the Mars community, a mission that focuses on geology would not attract those who study atmospheric chemistry or the magnetosphere.

The stakes were raised in 2000, however, when NASA's then-new space science chief Ed Weiler learned about dramatic cost overruns on two missions—one to Pluto and one to Europa—planned by the Jet Propulsion Laboratory (JPL) in Pasadena, California. With the total cost jumping from $654 million to $1.49 billion, Weiler was forced to choose between the two. "I had no clear priority, so I used the best information I had," he recalls, and halted work on the Pluto mission. There was also heavyweight support behind the Europa mission: The Galileo spacecraft had found evidence for an ocean beneath the icy skin of the Jovian moon, and the Clinton White House was intrigued by the possibility of life there, fueled by 1996 claims—still controversial—that a martian meteorite contained evidence of fossils.

Weiler's decision infuriated backers of the Pluto mission. Public groups such as Pasadena's Planetary Society joined scientific advocates in arguing that Pluto was the more urgent target, because its orbit was taking it

CREDITS: (TOP TO BOTTOM) ESA; NASA

Lab Rivalry Spices Up Solar System Exploration

PASADENA, CALIFORNIA—The battle over who will build the next round of U.S. missions to explore the solar system is a classic match-up between the grizzled veteran and the young and hungry challenger. But the real winner, if NASA officials and scientists can be believed, will be science and the public.

To many, the Jet Propulsion Laboratory (JPL) here *is* planetary science. Its star-studded cast of nearly two dozen missions includes Mariner 2, which flew past Venus in 1962 in our first encounter with another planet; the Viking orbiters, which mapped Mars in the mid-1970s; and the Voyager 1 and 2 missions now leaving the solar system.

So when Maryland's Applied Physics Laboratory (APL) in Laurel, part of Johns Hopkins University and traditionally a Navy contractor, offered to build an asteroid-rendezvous mission in the early 1990s for less than $150 million, it was seen as something of an upstart. "Everybody laughed," recalls Tom Krimigis, APL's space chief. APL got the NASA contract, for $120 million, after JPL engineers estimated it would cost them three times as much. Although controllers had to abort the first attempt at rendezvous, the Near Earth Asteroid Rendezvous (NEAR) spacecraft began orbiting Eros 2 years ago and last year landed on its surface.

Making history. JPL's Mariner 2 to Venus (*right*) provided first closeups of another planet; upstart APL wants to get personal with Mercury.

APL's bold proposal led NASA to create a competitive planetary program called Discovery. Last year alone, APL won two contracts to explore the far corners of the solar system, from sun-hugging Mercury to distant Pluto. This summer APL hopes to launch a payload that will fly by at least two comets. That's an impressive showing for a lab where only about one-fifth of the 3200 staff members are involved in space projects.

On the other side of the continent, JPL is still struggling to cope with the new world of competition. The disastrous loss of three Mars missions during the 1990s tarnished the reputation of the lab, which is affiliated with the California Institute of Technology, and last year longtime director Ed Stone retired. NASA headquarters decided to open up portions of the Mars exploration effort to competition, and spiraling costs on the proposed Pluto and Europa missions sparked a political furor in Washington.

The crises have contributed to sagging morale and a sense of being under siege, say JPL employees. But Stone's successor, Charles Elachi, says the new competition should be seen as a sign of the lab's success, not failure. "We opened the frontiers of planetary exploration," he says. "And like anybody who opens new frontiers, other people are going to follow." Those include not just APL but also private companies such as Lockheed Martin and Ball Aerospace.

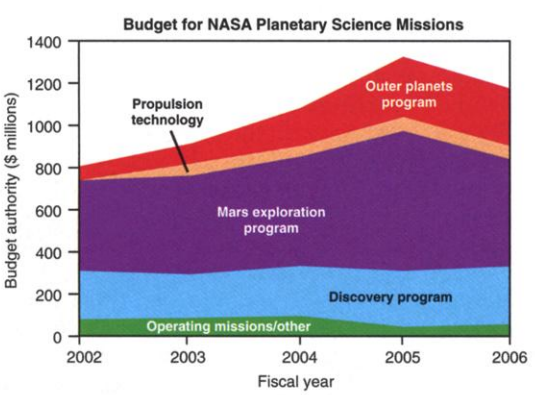
JPL can draw on its 4 decades of experience, a $1.4 billion annual budget, and some 5300 people at its sprawling facilities in the Pasadena hills. The lab has two spacecraft orbiting Mars, another on its way to Saturn, and a fourth en route to a comet with hopes of bring back material from its nucleus. It operates NASA's Deep Space Network, the critical link in every planetary mission, and loans out its crack team of navigators—even to help APL on the tricky NEAR mission. "Clearly, JPL continues to be the flagship lab for NASA's planetary exploration program," acknowledges Krimigis. "We have no plans to duplicate JPL."

NASA space science chief Ed Weiler, who has criticized the Pasadena lab for underestimating mission costs, says, "Whether or not some people want to admit it, this country needs JPL." That means building spacecraft as well as helping with navigation and communications. "I have to find ways to keep JPL doing real engineering science," he says.

Although APL and JPL are now cooperating on several missions, the underlying rivalry seems unlikely to lose its edge. That's in part because APL has strong congressional backing, thanks to Senator Barbara Mikulski (D–MD), who chairs the panel that funds NASA. Although APL director Richard Roca says he doesn't plan to ramp up the NASA-funded portion of his lab, the competition does serve as a useful tool for NASA managers to stimulate new ideas, shore up political support, and save money.

That's good news for scientists, who are eager to fly more instruments. "It's great," says one researcher who has worked with both labs. "The competition keeps people honest—and costs under control."

–ANDREW LAWLER



CREDITS: (TOP TO BOTTOM) JHU/APL; GSFC/NASA; SOURCE: OMB

Upward bound. NASA spending on planetary missions is slated to rise 50% between 2002 and 2006.

farther from the sun and its already thin atmosphere could freeze by 2020. A NASA advisory panel subsequently agreed with that assessment—if the costs of a Pluto mission could be held at $500 million. The White House refused to request Pluto money in its 2002 budget, although NASA continued preparations at the request of the Senate. Following an intensive lobbying campaign by Pluto backers, Congress added $30 million to keep the mission alive through 2002. Last month Weiler awarded a contract to planetary astronomer Alan Stern of the Southwest Research Institute in Boulder, Colorado, to run the mission, with Johns Hopkins University's Applied Physics Laboratory in Laurel, Maryland, to develop the spacecraft and instruments.

The congressional move angered OMB deputy director Sean O'Keefe, who last month took over as NASA administrator, as well as Isakowitz and Sponberg. And NASA officials say they've learned a valuable lesson. "We should not eat our own," says Colleen Hartman, NASA's solar system exploration chief. "That's what's happened with Pluto and Europa."

Weiler, meanwhile, says he has no intention of being placed in such an uncomfort-

able position again. He asked the NRC to come up with a decade-long plan that would force the science community to adopt a ranked list of projects and objectives.

Paneling together

Led by retired astronomer Michael Belton, the 16-member NRC steering group and its half-dozen panels went to work last summer and are due to complete the survey in May or June. The timing will coincide with a legislative debate on the fate of missions including Europa and Pluto. The panel's most pressing task will be to win consensus in a traditionally diverse field that lacks the hierarchical leadership of more established areas such as astronomy. "There is no planetary pope," quips Sykes. He has helped involve some 350 researchers in the NRC study, ensuring that the community has a say—and a stake—in the final report.

Nothing short of consensus will do. At the 15 November teleconference, the first one in which members talked with OMB officials, Isakowitz and Sponberg told the NRC panel that there is not enough money to go to both Europa and Pluto and that the community is undermining itself by lobbying Congress and opposing the president. "This is a free-for-all," complained Sponberg. The Pluto funding approved by Congress, he added, "may have irreparably damaged planetary funding for the next several years." Delaying Europa in favor of Pluto is "pretty unlikely," he added, and the idea of letting Congress make the cuts necessary to fund Pluto is not very appealing, either. "Probably the most likely option," he said, is to cancel funding for both Europa and Pluto.

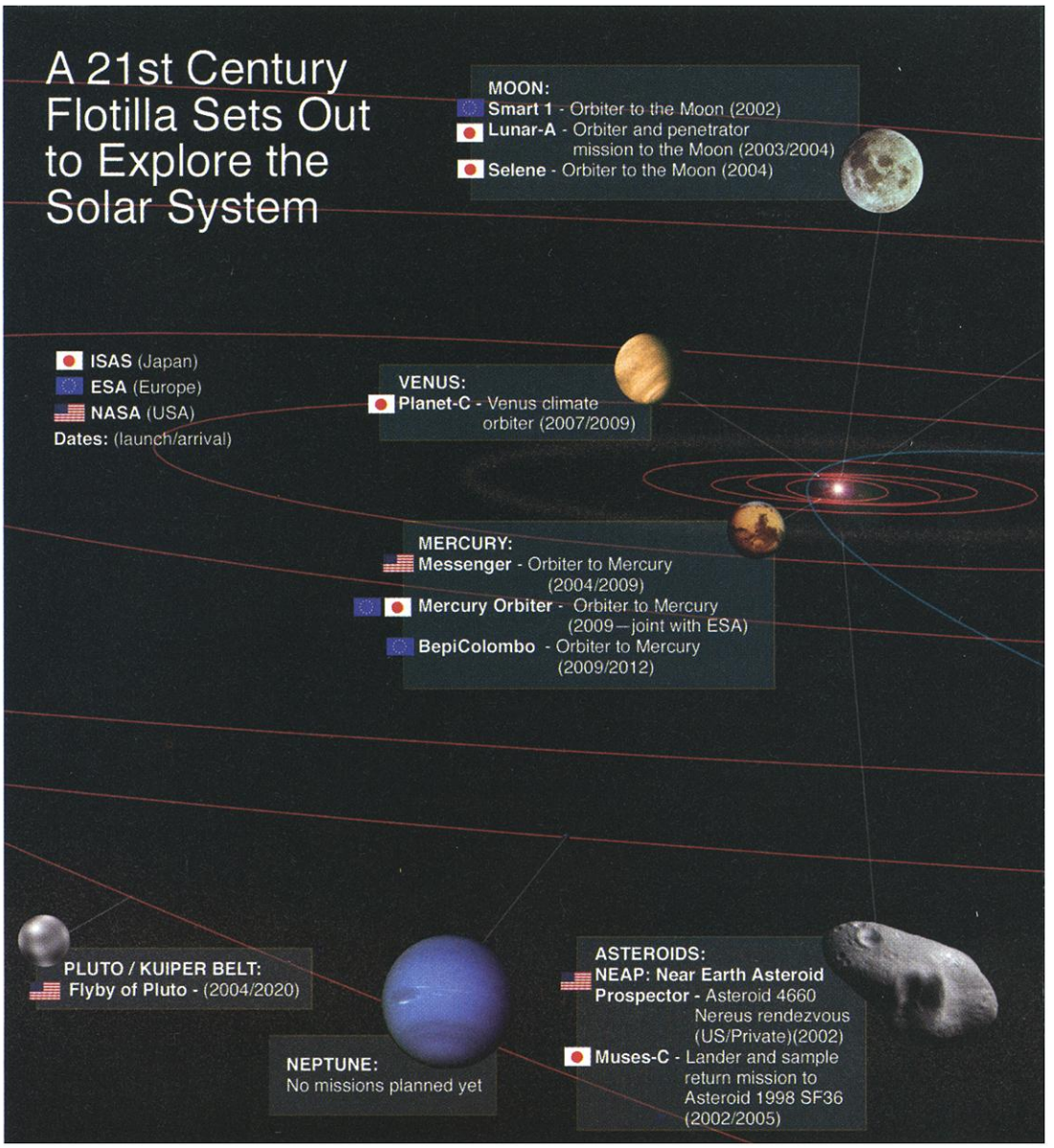
Panel members were appalled by that grim scenario. Belton tried to defend the push to fund Pluto, arguing that it was a natural response by a community that wants both missions. "What were we supposed to do," he asked the budget examiners, "roll over?" Pluto's advocates also deny that their lobbying is selfish. "This is a groundbreaking mission that NASA advisory panels have put as their top priority," says Stern, who will be principal investigator. Supporters, he notes, have simply been making use of "the democratic process."

Asteroid advantage

Duly chastised by the White House, Belton's panel now must juggle a complicated array of scientific, technical, and political issues while remaining united. The sheer breadth of solar system science alone will make for very difficult choices, and every subdiscipline has pressing questions. Radar images of Mercury show evidence of polar frost on that fiery planet. A uniform resurfacing of Venus about 500 million years ago intrigues geologists. How much water ran free on Mars, and for how long, remains a subject of intense debate. In the outer solar system, Jupiter's 300-year-old storms baffle researchers, Saturn's moon Titan shows exciting evidence of organic molecules, and Neptune's high winds are a puzzle on a planet so far from the sun. The nature of Pluto's companion, Charon, remains a mystery. The density of comets is still not known, and the composition of asteroids is more varied than imagined.

Jealousies are also aroused by the uneven distribution of past missions throughout the solar system. Some planets such as Mars and Venus have been visited frequently, prompting plans for landers and, eventually, sample returns with accompanying large costs. Other bodies such as Neptune and Uranus have only been briefly glimpsed by Voyager, and Pluto and Kuiper Belt objects—potential comets orbiting beyond Neptune—have only been observed through telescopes. Cheaper orbiters and flybys make more sense for that early stage of exploration. Meanwhile, discoveries from ongoing missions such as Cassini, due to arrive at Saturn in 2004, could open up new areas for research.

White papers from the 20-odd community groups organized by Sykes have thrown up a huge list of possible missions and objectives, while JPL—the longtime leader in overseeing planetary projects—has proposed ambitious efforts ranging from a $500



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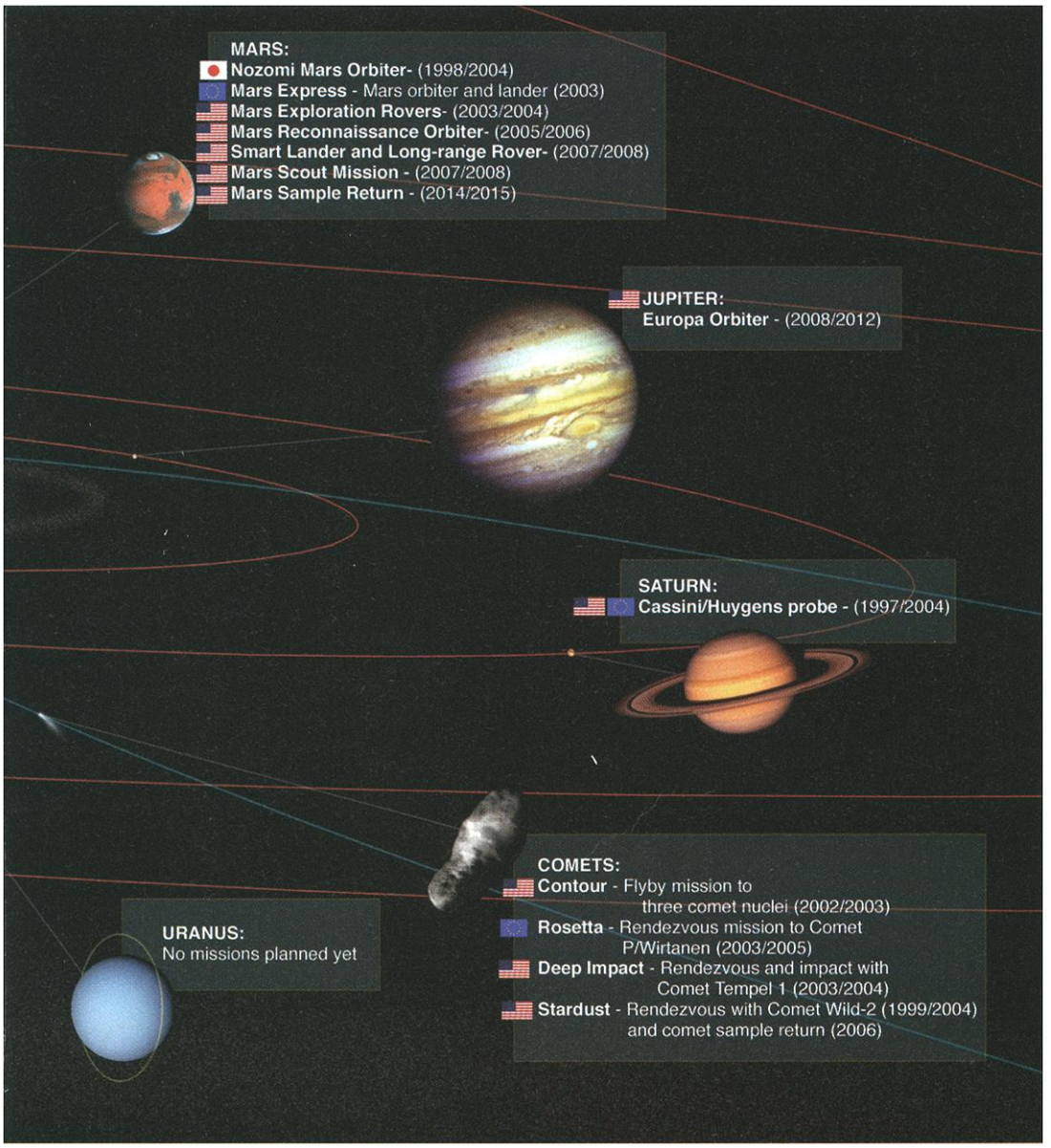


million lunar sample return to a $1 billion mission to float a balloon over the possible methane ocean of Saturn's moon Titan. Survey members aim to come up with a list of scientific objectives and associated missions. The panel also wants to create a "Discovery-plus" program for missions costing on the order of $500 million that will be chosen by open competition. Belton says this proposal is still in draft form, but "I feel it will carry the day."

Comet and asteroid studies are likely to fare particularly well in the new report, thanks to nature as much as to their scientific value. Such bodies are easier and cheaper to reach than planets and don't require complex and expensive maneuvering to get spacecraft into orbit. "It looks like cost will drive things toward missions to small bodies," says Michael A'Hearn, an NRC panel member and a comet astronomer at the University of Maryland, College Park.

The report is not expected to contain calls for huge missions, including planetary sample returns. "Those will be in our vision of the future" beyond 2013, says panel member Nagy. "For the report to have an impact, it has to be realistic." NASA's Hartman agrees: "We do not need, in the next decade, a $1 billion mission," she warned the panel in November. "I don't believe I will be able to sell it."

The astrobiology gap

To be successful, the survey team also must bridge a fundamental philosophical divide in the planetary community exposed by the Pluto and Europa dispute. Since 1996, with the backing of the White House, NASA has plowed ever larger amounts of funding—about $30 million for this year—into the nascent study of astrobiology. That field strives to combine research into life in extreme environments on Earth with study of potentially life-friendly places such as Mars and Europa.

The White House's interest in the search for life also has led directly to a stable and politically valued Mars exploration program, with a price tag in excess of $500 million annually, as well as a green light for the Europa mission. "Biocentric arguments have tended to do well, and that has pulled the rest of activities along," says Isakowitz.

But astrobiology gets little respect from many traditional planetary scientists, who see it more as a creation of Washington politicians than as a legitimate research area. That was evident at the November meeting here during an astrobiology briefing by Bruce Jakosky, an atmospheric physicist at the University of Colorado, Boulder. "This is like teaching freshman geology," he complained, as panel members leafed through newspapers or chatted quietly with other participants.

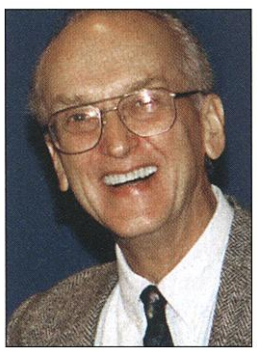
The complaint against astrobiology is that the field is heavy on hype and light on results. "Are we selling packaging or content?" asks Sykes. Briefings to lawmakers about the Europa mission, he says, "leave them with the impression that [the spacecraft] will capture caribou walking across the ice." He warns that overselling astrobiology could be disastrous.

Such skepticism seems to hold the upper hand within the NRC panel. John Baross, an oceanographer at the University of Washington, Seattle, who co-chairs the survey's astrobiology panel, says that the topic will be integrated into the whole report rather than be a stand-alone chapter. "It's a shame," Baross adds, because he believes that planetary science, now almost wholly dependent on NASA, could be enriched by funding from the National Science Foundation and the National Institutes of Health.

Administration officials make no bones about their frustration with astrobiology skeptics in academia. "Decision-makers are excited by the possibility that we could revolutionize whole areas of science and our view of the universe" through astrobiology, said Sponberg. "That's really exciting." He argues that the interest in astrobiology will benefit all aspects of planetary science. Weiler agrees. "It's really scary when OMB may have more vision than scientists," he says. "The most important scientific discovery that

could be made in this century is the discovery of life [elsewhere] in the universe."

Some researchers hope to find a middle ground that recognizes the political value of searching for extraterrestrial life without endangering the credibility of a scientific plan. "Both sides are right," says Jonathan Lunine, a physicist at the University of Arizona and co-chair of the astrobiology panel. "There is a political aspect associated with astrobiology. But we are on the threshold of bringing different disciplines together, and this is an important new endeavor." Hartman thinks that "the debate is couched incorrectly" and that astrobiology should be considered as one driver of the overall program.



Planetary pope? Michael Belton hopes NRC panel can reach consensus.

Policing the future

With the panel's survey now in full swing and Sykes collecting input from hundreds of researchers, participants are optimistic about their chances of coming up with a definitive decade-long plan. "The community is rising to the challenge," says Belton. "And we've been able to communicate with a large fraction" of its researchers. The ultimate audience, however, won't be researchers: "The prime customers are NASA, OMB, and Congress," he adds. It's an audience that scientists can't afford to ignore, Hartman warned the panel: "We're in a fight for scarce resources, a fight we are currently poised to lose."

Sykes says that the ultimate value of the survey would be to provide "long-term cover" for Washington officials like Weiler and Isakowitz, who must make tough decisions on planetary program spending. The community is not likely to respond favorably to threats or scapegoating, he notes, adding that attempts to kill healthy programs—such as Pluto—simply invite scientists to lobby influential backers. A good survey, he says, will do away with much of this tension by carving out a clear path.

Sponberg agrees that the survey will be a critical element in solidifying support for planetary science. But he warned the panel that the report is only a first step—and that maintaining consensus will be a full-time job requiring strong leadership. Sykes is confident that the field is mature enough to take responsibility for its own future. "It has taken 40 years," he says. "But now the community is big enough to do this." **–ANDREW LAWLER**

CREDITS: (TOP TO BOTTOM) NOAO/AURA/NSF; ISAS

SOLAR SYSTEM
JAPAN

Researchers Fear Merger Could Muffle Their Voice

As Japan plans to combine its two space agencies, researchers wonder how they will be heard

TOKYO—Being small has its advantages. For nearly 4 decades Japanese space scientists have been allowed to call the shots on planetary exploration—setting the agenda and running their own missions. And the results have been impressive, including a string of successful probes studying the sun, Halley's Comet, and Earth's magnetosphere.

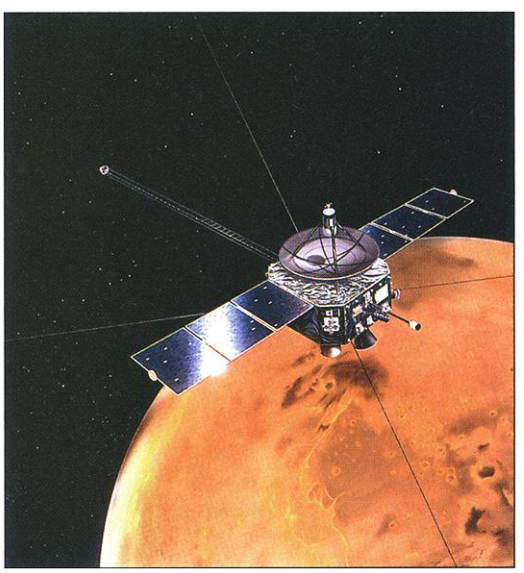
But now the Institute of Space and Astronautical Science (ISAS), whose modest budget has funded the bulk of university-based research in the field, is being merged with Japan's giant National Space Development Agency (NASDA) and the National Aerospace Laboratory (NAL) as part of a sweeping streamlining of the nation's bureaucracy. Although there will undoubtedly be benefits to being part of a larger, more powerful agency, scientists are worried that the loss of independence will put science in the shadow of the more commercial aspects of space.

"We're concerned that there will be a lack of visibility for space science once these organizations are merged," says Takeo Kosugi, who heads ISAS's solar physics program and is also chair of the Space Research Committee of the Science Council of Japan, the nation's largest association of scientists. "We worry that if bureaucrats control the decisions, budget cuts will fall especially hard on space science."

NASDA is a very different beast from ISAS. It develops heavy-lifting rockets for launching weather and communications satellites and manages Japan's contribution to the international space station. It also dwarfs ISAS in size, with a current budget of $1.7 billion and 1090 employees compared with $223 million and 325 staffers for ISAS. Including NAL, whose 410 researchers use its $166 million budget to study fluid dynamics and other more technological problems, the merger will further tilt the new agency toward applied fields.

But more troubling to researchers than NASDA's size is its culture. ISAS's missions are proposed by research groups and reviewed by committees of scientists and engineers. NASDA is run by bureaucrats charged with developing Japan's aerospace industry. NASDA has broadened its vision in recent years, using remote-sensing satellites to study long-term weather patterns and watch for signs of global warming. It is also collaborating with ISAS on the 2005 Selene mission to the moon, which will probe, among other things, its mineral composition, topography, and gravity field. But researchers still view NASDA as an organization whose priorities and missions are set at the top and are aimed at fostering commercial aerospace development.

The merger will certainly provide some new opportunities. ISAS missions will be able to take advantage of NASDA's H-IIA rocket, with four times the lifting capacity of the institute's M-V rocket. Previously, cooperation between the two agencies was extremely difficult because they were affiliated with different ministries, which rigidly protected their turf.



Slow mo. Launched in 1998, Nozomi overcame flight troubles and is set for a 2004 Mars rendezvous.

Kosugi also believes that the merger might be an opportunity to revamp space science efforts. He thinks ISAS has outgrown its committee-based decision-making process, which he says worked well when the agency had just two major research groups, one for x-ray astronomy and one studying magnetospheres. But that con-