

Worlds Beyond

The Thrill of
Planetary Exploration
as told by Leading Experts

Edited by
S. ALAN STERN

 **CAMBRIDGE**
UNIVERSITY PRESS

PUBLISHED BY THE PRESS SYNDICATE OF THE UNIVERSITY OF CAMBRIDGE
The Pitt Building, Trumpington Street, Cambridge, United Kingdom

CAMBRIDGE UNIVERSITY PRESS
The Edinburgh Building, Cambridge, CB2 2RU, UK
40 West 20th Street, New York, NY 10011-4211, USA
477 Williamstown Road, Port Melbourne, VIC 3207, Australia
Ruiz de Alarcón 13, 28014 Madrid, Spain
Dock House, The Waterfront, Cape Town 8001, South Africa
<http://www.cambridge.org>

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First published 2002

Printed in the United Kingdom at the University Press, Cambridge

Typefaces Hollander 10/15pt and Vectora System QuarkXpress [TB]

A catalogue record for this book is available from the British Library

Library of Congress Cataloguing in Publication data

Worlds beyond : the thrill of planetary exploration, as told by experts / edited by S. Alan
Stern. p. cm.

Includes bibliographical references and index.

ISBN 0-521-81299-2—ISBN 0-521-52001-0 (pbk.)

1. Outer space—Exploration. 2. Solar system. I. Stern, Alan, 1957—

QB501 . W667 2002
523.2—dc21

2002025623

ISBN 0 521 81299 2 hardback
ISBN 0 521 52001 0 paperback

Contents

	<i>Preface</i>	ALAN STERN	<i>ix</i>
	<i>Welcome home</i>	ALAN STERN	<i>1</i>
1	Dateline: the planets	7	
	J. KELLY BEATTY		
2	Planetary science with a paintbrush in hand	26	
	WILLIAM K. HARTMANN		
3	Chasing new meteorites, or finding heaven on earth	40	
	MICHAEL ZOLENSKY		
4	Mercury: the inner frontier	57	
	ROBERT G. STROM		
5	Return to the Moon!	76	
	HARRISON H. SCHMITT		
6	Making moons	85	
	ROBIN CANUP		
7	To rove on the red planet	102	
	MATTHEW P. GOLOMBEK		
8	To the asteroids, and beyond!	121	
	RICHARD P. BINZEL		
9	Titan: a moon with an atmosphere	138	
	CHRISTOPHER P. MCKAY		

Contents

10 Seasons at the edge of night 149

ALAN STERN

Color sections facing pp. 84 and 85

1

Dateline: the planets

J. Kelly Beatty, *Sky & Telescope Magazine*



Kelly Beatty has been writing about planetary science and astronomy for 28 years, and he is widely regarded as the best insider planetary sciences journalist in the business. I first met Kelly in 1987, just as I was preparing to enter graduate school, and then, as always, he impressed me as a scientist in journalist's clothing. Kelly grew up in Madera, California. He holds a Bachelor's degree in geology from the California Institute of Technology and a Master's degree in science journalism from Boston University. In 1986 he was chosen one of the 100 semifinalists for NASA's Journalist in Space program. Kelly and his wife, Cheryl, live outside Boston.

Tucked away in a corner of my office is an unmarked but bulging manila envelope. Inside, in no particular order, are nametags issued to me over a quarter century of scientific meetings, press conferences, and space-exploration spectaculars. I am not much for collecting souvenirs, mind you, but when I joined the editorial staff of *Sky & Telescope* (*S&T*) magazine in 1974 saving those mementos just seemed like the right thing to do. After all, there I was, at the tender age of 22, jetting off to legendary space places like the Jet Propulsion Laboratory (JPL) in California and Cape Canaveral in Florida. I was hobnobbing with famous scientists and high-flying astronauts, telling the world about their exploits, and getting paid for the privilege. What a job!

I did not set out in life to be a science writer – few of us in this journalistic niche do. No, I wanted to be an astronomer. Back in the early 1960s the space age was young, and like so many of my generation I was determined to be a part of it. I grew up on the outskirts of a small town in central California, under the kind of pitch-black skies that are now sadly so rare. No one yet knew what the Moon or Mars really looked like, and while skygazing through my backyard telescope I was free to imagine those landscapes untainted by what spacecraft images would later reveal. That zeal carried me through high school and on to Caltech, where the road to the mountaintop got pretty bumpy.

Becoming an astronomer was going to require more prowess with calculus and physics than I could muster, so I opted instead for a degree in geology. Besides, I rationalized, astronomers were more interested in stars than the Solar System – and I was in love with planets.

My first in-the-flesh exposure to science writers came in 1971, just about the time I started working for planetary scientist Bruce Murray. A specialist in Martian geology, Murray had been chosen by NASA to help analyze images of the red planet taken by Mariner 9. One minor role of that assignment called for him to participate in press conferences at JPL's von Karman Auditorium, and I often trailed along out of curiosity. The space-chasing press corps was an interesting mix of a few reporters who had a good grasp of things astronomical and a great many who did not. "I could do this," I remember telling myself, and thus was my fate cast.

The first nametag in my collection dates from 1976, but my first junket for *S&T* actually took place a couple years earlier. I had only been on the staff a few months when Mariner 10 made its first flyby of Mercury in September 1974. The pictures radioed to Earth showed a cratered world that looked outwardly Moonlike but which, on closer inspection, bristled with geologic enigmas. Murray headed Mariner 10's camera team, and at his suggestion I flew out to JPL to pick through the returned images to find some good ones for use in the magazine. So there I was, seated at a long table brimming with eight-by-ten-inch glossies fresh from Mariner 10's camera. I headed back to Massachusetts with a dozen or so that formed the basis of a "special report" for *S&T*. Meanwhile, the chosen images quietly ended up among those released to the general press. NASA's "fairness police" would never allow a lone reporter this kind of privileged access today, but it definitely impressed my new bosses.

Early on I learned that planetary scientists are very approachable. This was a great relief for someone trying to grasp the nuances of atmospheric dynamics, magnetospheric physics, and orbital mechanics. No question was too naïve or absurd to ask. These folks really wanted me to understand the concepts, to appreciate the subtleties, and to get the science right. Scientific endeavors rarely provide pat, black-and-white answers, nor do they lend themselves to quick sound bites. More often,

they are works in progress that add incrementally to our collective knowledge, small brush strokes often painted in uncertain shades of gray.

Of course, exploring the Solar System via spacecraft often splashes the scientific canvas with a rush of pure discovery and high drama. Consider 1976's Viking mission, for example. In what ranks as NASA's most gutsy planetary mission to date, two spacecraft reconnoitered Mars from orbit, and two landers plopped down on to its surface. A team of geologists picked the locale for each touchdown, based on its inherent scientific interest and apparent smoothness. But in the end the chosen sites were only best guesses, and, as soon became obvious, the safe arrival of each lander proved a minor miracle. Pictures radioed to Earth revealed landscapes littered with huge boulders, any of which would have been a mission-ending obstacle had the automated descent sequences culminated a little bit this way or that.

Mars did not have the "magnificent desolation" of astronaut Buzz Aldrin's Moon. Instead, as seen through electronic eyes that painstakingly recorded their surroundings one thin scan line at a time, we discovered a world that seemed strangely familiar. In its Sun-drenched rocks and windswept ochre sands, we all recognized some familiar patch of desert in the American Southwest, a spot where we had scurried around rattlesnakes and clawed at the Earth. In fact, initially the Martian scenery seemed just a little *too* familiar: the first color image from Viking 1's lander showed a hazy, blue-hued sky. But a revised color adjustment revealed the sky to be more salmon than sapphire – a revision that drew hisses and boos from the press corps assembled in Von Karman. "Typical Earth chauvinist response," quipped Carl Sagan in reply.

The overriding reason for landing on Mars was to search for life, and once the suite of miniaturized incubators aboard each lander failed to find clear evidence of microbial inhabitants, public interest waned. They seemed to grow weary of seeing the planet's towering volcanoes, mammoth floodplains, deep canyons, and delicately layered polar caps. A news-media buzz followed the discovery of a hauntingly face-shaped mesa, but as the months dragged on it almost seemed that the mission had lasted too long. Only a handful of journalists camped out

at JPL for more than a few weeks, and I was not one of them. In fact, due to *S&T's* spartan travel budget back then, I never made it to Pasadena at all. So I covered the mission *in absentia*, hoping the day's mail would bring a fat envelope from JPL stuffed with images around which to frame my next story. And those stories continued for an unexpectedly long time: Viking 1's lander kept sending data until November 1982, more than six years after touching down. By then my attention had shifted outward from Mars to more distant worlds in our Solar System, and to a pair of intrepid spacecraft that were making astounding discoveries about them.

Voyager and "instant science"

If Viking qualifies as NASA's riskiest planetary mission ever, then Voyager must surely rank as its greatest planetary-exploration adventure. Launched in 1977, the mission's twin spacecraft were equipped to take a close look at Jupiter, Saturn, and whatever else they encountered on their long and winding road out of the Solar System. The first of these meetings played out in March 1979, as Voyager 1 swooped close to Jupiter and its quartet of large, "Galilean" moons. The flyby would reveal much about the planet, of course, but the geologist in me was itching for the close-ups of Callisto, Ganymede, Europa, and Io. Discovered in 1610 independently by Galileo Galilei and Simon Marius, two of these satellites are the size of our own Moon and two the size of Mercury. It is no stretch to think of them as "worlds." Yet despite centuries of telescopic observation (and some cursory scrutiny by Pioneers 10 and 11), we knew very little about them. The Voyager flybys would change all that.

Voyager 1's rendezvous with Jupiter was a bona fide media event, and JPL literally teemed with hundreds of reporters. There were big-time television personalities, newspaper veterans, space cadets who had snuck in as stringers for their college newspapers, local radio and TV reporters, and a galaxy of foreign correspondents from Europe, Japan, and Australia. Production trucks lined the street leading up to von Karman Auditorium, their roofs bristling with microwave antennas and myriad cables snaking into them. In his book *Distant*



Figure 1.1

Geologist Larry Soderblom has a captive audience of reporters as he describes Voyager 1's images of Rhea and Dione, two of Saturn's satellites, in November 1980. He and other mission scientists had expected to see little more than impact cratering, but they were hard pressed to explain the wide range of unusual terrains found on the moons' surfaces. (JPL image P-25139).

Encounters, writer Mark Washburn dubbed this spectacle the “attack of the space gypsies.”

Each day the horde would assemble for a press conference, at which project scientists would dispense pictures and other data beamed to Earth only a day or so earlier. This show-and-tell approach was unfamiliar territory for the mission's researchers. Accustomed to spending months, even years, wringing results from their observations, they were being asked by NASA to leap into the rarefied air of “instant science,” with no safety net and, literally, all the world watching. Moreover, when it came to the most newsworthy results, there was a fine line between releasing exciting, front-page images and holding something back for later publication in professional journals. After all, many on the team had devoted the better part of a decade to the Voyager mission, and to give all their hard-won results away in a flurry of press conferences just did not seem fair.

Not everyone was comfortable with these arrangements. It did not help that television monitors throughout the pressroom showed us Jupiter's swirling clouds, the enigmatic cracks on Europa, and other eye-widening vistas as soon as they were received. We gypsies speculated freely among ourselves about what the images showed. Moreover, this was not the largely uninformed press corps of the Mariner era. Spurred by new popular magazines like *Discover*, *Omni*, and *Science 80*, a new generation of reporters with solid scientific credentials was filling the chairs in Von Karman. The questions were more pointed, and our collective appetite for technical detail more voracious, than JPL's media-relations team had ever seen.

The engagement never became adversarial, however, due in no small part to the mission's spectacular discoveries. The first flyby revealed the Great Red Spot, Jupiter's signature cloud feature, to be a cyclonic maelstrom with a voracious appetite for smaller clouds trying to skirt along its periphery. Io surprised almost everyone with the ferocity of its volcanic activity, and Callisto bore an enormous impact whose concentric rings looked like expanding ripples frozen in place. Voyager 2, which called on the planet four months later, found even more eruptive activity on Io and revealed Europa to have an exterior that bore more than a passing resemblance to a heavily cracked eggshell.

By the time everyone returned for Voyager 1's sweep past Saturn in November 1980, the scene at JPL had the air of a college reunion. Scientists and reporters were mingling freely, renewing acquaintances, and consequently the press conference patter became more genial and less guarded. Once again, there was plenty of dazzle to go around. The rings of Saturn defied all predictions, resolving under Voyager's scrutiny into thousands of individual ringlets that left everybody at a loss for answers. When confronted by the discovery of mysterious dusky "spokes" in the rings, Bradford Smith, the mission's imaging-team leader admitted, "I don't think there is anything that has kept us puzzled for so long." Theorist Jim Pollack quipped, "We're still pretty much in the gee-whiz phase." And so it went.

Despite some infirmities, Voyager 2 reached Uranus in 1986 and Neptune in 1989, thus completing a "grand tour" of our Solar System's four largest planets. Dynamicists first realized in the 1960s that a



Figure 1.2

An exciting moment for scientist A. Lonnie Lane (at end of computer printout) during Voyager 2's flyby of Saturn in August 1981. His photopolarimeter (a sensitive light-measuring device) had malfunctioned on Voyager 1, but the one on Voyager 2 performed superbly. The printout shows how a star's light varied as it passed behind the thousands of individual strands that make up Saturn's rings. The author stands behind Lane at extreme upper right. (JPL image 24022).

spacecraft could carom across the outer Solar System in just 12 years, using a boost from one world's gravity to speed to the next. The planetary alignment needed for these slingshots would occur in the late 1970s – and not be repeated for another 176 years – so it was an opportunity not to be missed. Mission designers had equipped the Voyagers as best they could for a four-planet trek, even though Uranus and Neptune were always technical and political long shots (in fact, they were not official mission objectives when the spacecraft left Earth). Thus we were all grateful that Voyager 2 survived long enough to reach them. Upgrades to NASA's receiving network here on the ground greatly enhanced the aging spacecraft's scientific return, and the hits just kept on coming. Uranus proved as remarkable for its climatic blandness as

did Neptune for its storminess. Triton, a large moon circling Neptune in a retrograde (“backward”) direction, revealed itself to be geologically young and still smoldering with activity.

There is a little-known footnote to this celebrated mission. By design, Voyager 1’s planetary objectives would end with Saturn, whereas its twin would try to press on to Uranus and Neptune. Their respective trajectories were such that Voyager 2 had to be launched first, and its Titan-Centaur rocket performed flawlessly on August 20, 1977. But during the launch of Voyager 1 two weeks later, on September 5, the Titan booster shut down prematurely. The Centaur upper stage barely compensated for the shortfall, reaching Earth’s escape velocity a scant three seconds before exhausting its fuel. Voyager 1 barely had enough oomph to reach Jupiter. By pure chance, Voyager 2 got the better rocket – had it been paired with the underachieving Titan instead, its encounters with both Uranus and Neptune would have been lost.

Culture shock

Although NASA has been in the thick of space exploration since its creation in 1958, Americans have occasionally had to stand aside while other nations’ efforts took the spotlight. Such was the case with the return of Halley’s comet in 1986, when the United States opted not to send a spacecraft to intercept this infrequent but celebrated visitor. It is commonly thought that NASA passed on this opportunity for lack of money, but the real reason was a lack of desire. In 1981 the planetary exploration committee of the National Academy of Sciences’ Space Science Board ranked such a mission “of markedly lower priority” than other planetary projects awaiting approval. Neither NASA nor the newly installed Reagan administration chose to overrule that position, despite an intense, vocal lobbying effort mounted by Bruce Murray, who by then had become director of the Jet Propulsion Laboratory.

Part of the Space Science Board’s reluctance to endorse JPL’s Halley Intercept Mission was that other nations were already well along in building comet chasers of their own. Soviet scientists took a couple of their standard-issue deep-space chassis, added cameras and other instruments, and formulated a plan that would swing the craft past Venus en

route to the comet. This duo came to be called Vega, a contraction of the Russian words Venera (“Venus”) and Gallei (“Halley”). Meanwhile, the European Space Agency’s directors were pressing ahead with a spacecraft called Giotto, whose compact drum shape and special shielding would help it survive a plunge deep into the comet’s dusty coma and close to its icy, hidden nucleus. Even the Japanese joined the Halley armada, with two craft – Suisei (“Comet”) and Sakigake (“Pioneer”) – that would take measurements from afar.

For an American press corps that had grown fat on NASA’s near-perfect string of success stories (*Challenger* had not yet been lost), the prospect of covering missions whose control centers lay across the Atlantic and Pacific oceans – not to mention on the far side of the Iron Curtain – was a little daunting. Among other things, in 1982 the Reagan administration had allowed a scientific-exchange agreement between the US and USSR to expire, so contact with Soviet space officials had all but ceased.

But, as it turned out, my curiosity about the “Venus” portion of the Vega mission paid an unexpected dividend. At that time the Soviet Union’s civilian space science program was controlled by Roald Z. Sagdeev, a plasma physicist with near-fluent English and numerous colleagues in the West. I contacted Sagdeev (by telex!) through one of these intermediaries, asking whether I might come to Moscow to cover the Vegas’ arrival at Venus in June 1985. OK, he replied. But given America’s strained relations with the “evil empire,” getting to Moscow would still prove complicated. First, I needed an official invitation from the Soviet Academy of Sciences, essential for obtaining an entry visa. Only after getting the visa could I then arrange for transportation and lodging. Somehow it all worked out, and on the morning of June 11 I took a seat in the main auditorium of the academy’s Space Research Institute, known widely by its Russian acronym IKI. Among the dozens of assembled scientists I was the only American – *and* the only reporter.

By then, 100 million kilometers away, a spherical canister dropped off by Vega was plunging into the hot, murky atmosphere of Venus. Some 60 kilometers up, a small parachute opened, and the top half of the probe cleaved away as its heavier bottom continued in the dark toward the planet’s hellish surface. Dangling from a parachute, the

discarded cap disgorged a small package that quickly inflated into a balloon some three meters across. In a few minutes this buoyant bubble was floating free, its French-built instruments dangling below from a 12-meter-long tether.

Back in Moscow, the *mood* of the event – more than the language – was foreign to me. I had become accustomed to the spirited hubbub that accompanied major space events at NASA centers. But at IKI that day there was hardly any conversation, let alone hubbub. A large projection screen displayed flight parameters like elapsed time, the balloon's altitude, and the temperature of Venus's sulfurous atmosphere. When word came that data from the instrumented balloon had reached Earth, as heralded by an anonymous voice booming out of some speakers, no one applauded. In fact, the scientists continued their passive vigil right through the announcement that the large descent probe had landed safely on Venus's surface. From atmospheric entry to touchdown, the first Vega encounter lasted 65 minutes. Then the auditorium emptied.

Vega 1's triumph made the front page of *Pravda*, and four days later the sequence of events played out again for Vega 2. With one success already assured, this time the mood was more celebratory. The French ambassador was on hand, as were a handful of Soviet reporters. At a press conference later that day, team members described a few early results, including results from the two balloons. But no one mentioned (as I learned later) that the first lander's drill had failed to obtain a surface sample for analysis, or that two experiments on Vega 2 had malfunctioned.

I did not realize it at the time, but my modest involvement at IKI that June would carry over to the following March, when the Vegas made their long-awaited dashes through Halley's dusty coma. This time Sagdeev allowed reporters from several American publications to attend, though he asked *me* to select them on his behalf – an “honor” that I politely declined. Once our troupe arrived in Moscow, I was further embarrassed to learn that the Academy had appointed me, together with Rick Gore of *National Geographic* (who had also previously visited IKI), to head the journalist “delegation.” For that I endured months of good-natured teasing from my colleagues.

Both Vega spacecraft survived their 79-kilometer-per-second dash through Halley's coma, the mission scientists were more relaxed about revealing what had worked and what had not, and we all got our stories. Then our little entourage quickly left town for the small German town of Darmstadt, 25 kilometers south of Frankfurt, from which the European Space Agency (ESA) would guide its Giotto spacecraft to Halley's nucleus.

A veritable circus greeted us there. The Halley encounter still stands as the grandest space adventure (and largest media event) in ESA's history. Television trailers beamed news of the mission to 50 nations and an estimated billion viewers. Giotto carried ten experiments, most to study the coma and its interaction with the solar wind, but in the eyes of the world there was only one: its camera. The first images, obtained early on March 14, about three hours prior to the moment of closest approach, bore little resemblance to telescopic views of the comet. That is because the camera team had chosen to display them in a garish rainbow of computer-generated colors, perhaps to captivate the worldwide television audience. But, if that had been the hope, it backfired, instead causing great confusion as to how the nucleus really looked.

Giotto pressed on, slicing through the coma at nearly 250,000 kilometers per hour. Then, just nine seconds before zipping to within 600 kilometers of the nucleus, the screens went blank. A grain of dust, perhaps as small as 0.1 gram, had whacked the spacecraft and caused it to wobble. Battered but not beaten, Giotto righted itself and reestablished its radio link with Earth a half hour later. (It undoubtedly heard the applause still echoing through the quiet streets of Darmstadt.) The best of its 2,000 images certified that Giotto had come face to face with the heart of Halley, a hulking iceberg some 15 kilometers long and eight kilometers wide whose surface was as black as coal. Giotto had confirmed what telescopic observers had already suspected: Halley was large by cometary standards, far surpassing the one-to-two kilometer diameter commonly found among its siblings.

The success of Giotto catapulted ESA to the status of major player among space powers, but the agency also learned that its press relations needed work. It did not help that the individual experiment teams, rather than ESA itself, controlled the release of their results.

I remember walking the control center's deserted corridors on March 16, a Sunday, just one day after the sole post-encounter press conference. I was looking for someone – *anyone* – to interview, but by then most everyone had already left town. A rare holdover was Harold Reitsema of Ball Aerospace, one of just two Americans on the camera team. Sensing my desperation, he handed me the most precious keepsakes of my entire two-week odyssey: three unambiguous, unadulterated, unbelievable black-and-white images of the comet's nucleus. It was a sympathetic gesture I have never forgotten.

In the years since Giotto, ESA continued to develop wonderful and highly productive space science missions. And today the rainbow graphics are a distant and amusing memory. ESA's public relations office has morphed into a well-honed, media-savvy information machine. Ironically, NASA's efforts have trended in just the opposite direction: its current space-science missions are *required* (not just encouraged) to develop their own plans for public outreach. The result, unfortunately, is a decentralized mishmash of Web sites where the PR wheel is constantly being reinvented.

The “Great Crash”

Astronomical discoveries are usually made far from our purview, at some isolated control center or from a remote mountaintop observatory or by a spacecraft dashing somewhere in the Solar System. Rarely are we afforded front-row seats to these discoveries – let alone to some event that changes the course of science. But that is exactly what happened in July 1994, when the fragments of a shattered comet named Shoemaker-Levy 9 slammed into the planet Jupiter. For once, anyone with a decent backyard telescope could witness history in the making.

This cosmic saga began in March 1993, when the observing team of Eugene Shoemaker, his wife Carolyn, and long-time collaborator David Levy, along with visiting French astronomer Philippe Bendjoya, settled in for a night of asteroid hunting using a modest research telescope at Palomar Observatory in California. But soon thickening clouds forced them to call it a night. Two days later, while examining what little film they had shot, Carolyn found a fuzzy streak not far

from Jupiter. “I don’t know *what* this is,” she said, bolting upright. “It looks like . . . like a squashed comet.” Larger telescopes later revealed the streak to be a line of little comets arrayed like pearls on a string, each sporting its own tail.

In time, astronomers realized that a single object had strayed too near Jupiter and been torn apart by the planet’s gravity – and that the comet’s remains were destined to strike Jupiter itself. No one could predict the outcome with certainty, though a cruel twist of geometric fate had placed the target zone on Jupiter’s far side, just out of sight from Earth. Computer-aided simulations tried to anticipate what would happen during each high-speed splash into Jupiter’s atmosphere. Some modelers assumed that the fragments were large, at least a mile across, and would strike with the kinetic-energy equivalent of 100 billion tons of TNT or more. Others thought Jupiter might swallow the shards without a trace.

The “Great Crash” played out over six days, beginning July 16, as a score of large fragments bombarded the planet at 40 miles per second. Never before had such an event been witnessed, and never before had so many of the world’s telescopes turned their gaze to the same spot of sky. Yet the news media focused the lion’s share of attention on the Space Telescope Science Institute in Baltimore, Maryland, which serves as the clearing-house for observations from the orbiting Hubble Space Telescope. It was there, during a news conference on the evening of July 16, that television cameras captured one of the most exuberant and spontaneous displays of scientific joy ever recorded.

As the comet’s discoverers offered cautious predictions for what would be seen when the first chunk of comet smashed into Jupiter’s atmosphere, observer Heidi Hammel rushed in with a near-infrared image fresh from Hubble’s camera. A huge dark feature stained Jupiter’s southern hemisphere, marking a titanic splash of impact debris. Hammel uncorked a bottle of champagne and exchanged high-fives with the Shoemakers and David Levy, as the assembled press corps roared its approval.

In the days that followed, several impacts created fireballs thousands of miles high, tall enough to peek around the planet’s limb and be spotted by the Hubble telescope. As each of these atmospheric wounds

rotated into full view, still fresh and hot, they looked like titanic flares when recorded by infrared detectors on ground-based telescopes. Most of the crash zones lingered as huge, dark stains in the Jovian atmosphere (some larger than the entire Earth) that took weeks to fade away.

In hindsight, the “Great Crash” proved to be a watershed event for astronomers. Eager to share their results with their colleagues worldwide, and keenly aware of public interest in the event, many observers threw their telescopic images onto Internet web sites almost as fast as they were taking them. They realized that the tedious analysis of these data would consume many months, if not years. Writing up their results, and waiting for scientific journals to accept and publish them, would take even longer. But for once the peer review and the nit-picking conference debates could wait – it was enough to let the dramatic pictures speak for themselves.

This was not the first time that scientists had exploited the power of the Internet to sidestep the traditional routes for distributing results, and certainly it would not be the last. In an era when good publicity can boost one’s chances of getting funding, astronomers and other researchers continually wrestle with how best to announce their findings. The urge to “publish” electronically is strong, and professional journals are struggling to maintain their relevancy. Some have already moved wholesale into the Internet arena; eventually I suspect they all will do so.

Comet Shoemaker-Levy 9 may also represent the last big science story for which news coverage followed traditional paths. That is, people learned about it by and large from periodicals and broadcasts – the Internet had not quite emerged as a news machine. *Sky & Telescope* was right in the thick of it too, but, because it is published monthly, we could not provide up-to-the-minute crash reports. Instead, we adopted an editorial plan that would provide our readers with a “behind-the-scenes” perspective.

So I hit the road, heading first to Palomar Mountain in California, then to Mauna Kea in Hawaii, to watch teams of observers in action. Visiting Palomar was, in itself, an exciting event. Enraptured as a boy by my first view of the legendary 200-inch telescope, I was thrilled to stand beneath its massive frame at last and to touch the housing for its

hallowed mirror. It was a religious experience. Hawaii, by contrast, was a letdown: the weather had turned nasty, and none of the mountain-top telescopes could open their domes to observe. Eventually, I retreated to my hotel room, pounding out a story while other staffers back in our editorial office scoured the Internet for the latest images.

We moved Heaven and Earth to get nine pages of coverage into our readers' hands four weeks later. All things considered, it was a worthwhile effort. Yet had the Great Crash occurred just two years later, in 1996 instead of 1994, our approach would have been very different: most of our resources would have been diverted to getting the story on to our Web site as soon as possible. Filling the magazine's pages would still have been important, of course, but we would likely have taken a slower, more measured "what-does-it-all-mean" approach.

The road less traveled

Such heady, dramatic events are the exception, not the rule. Most of the nametags in my collection have been gathered at rather ordinary meetings of professional researchers – one day spent at a workshop in Providence; a weeklong affair in Tucson; and everything in between. I really thrive on these, mostly, I suppose, because it is one small way that I get to participate as the scientist I have always wanted to be. In that environment I work on my own, without the safety net afforded by press conferences and spin doctors. Instead, I must bring to bear all my technical and journalistic savvy in search of newsworthy results.

The key (for me, at least) is to become attuned to the lingo of research. Sometimes the title of a presentation is enough to pique my interest. One recent example was "Meteor Storm Evidence Against the Recent Formation of Lunar Crater Giordano Bruno," presented as a simple poster by a University of Arizona graduate student named Paul Withers. There has long been speculation that in the year 1178 medieval monks witnessed the collision of a small asteroid into the Moon, a wallop that purportedly blasted out a 22-kilometer-wide crater. But Withers had deduced that the whole idea was preposterous, because such an event would have showered the Earth with ten million tons of fragments – creating perhaps a trillion bright meteors – in the

days thereafter. And no mention of such an awesome display appears in English, European, Arabic, or Asian chronicles of the era. It made for a very satisfying story: a little history, a little observational astronomy, and the can't-miss appeal of a catastrophic impact (even if it never occurred).

Sometimes researchers cloak newsworthy results in obscure terminology. Consider, for example, this prosaic talk title from a recent meeting: "Spectral Feature Mapping with Mars Global Surveyor Thermal Emission Spectra: Mineralogic Implications." Geologists Roger Clark and Todd Hoefen had used spacecraft data to compile a map of minerals exposed on the Martian surface, and they had found widespread evidence for a particular mineral called olivine. Olivine is rather common on Earth, but it weathers away easily in the presence of water. So the upshot is this: if olivine exists all over the Red Planet, water could never have been widespread on its surface. You would never guess that from the title, nor even from the authors' published summary. Now, in fairness, not everyone believes that those spacecraft maps are being interpreted correctly. But if they are, the implications for the climatic history of Mars are profound.

Results aside, one of the great joys of attending professional meetings is getting to meet scores of graduate students and post-docs. Much like the medical profession, it takes many years to turn someone into a proper "scientist." But planetary work has the advantage in that eager, up-and-coming students can often make lasting – even significant – contributions to our knowledge. So I make a point to get to know as many of them as I can. And, having now done this for a couple decades, I have watched a generation of them grow up. Some become "leading experts" in their field; others leave the profession behind, for their families' sakes, for greener pastures, or sometimes out of discouragement.

If covering space exploration for a quarter century has taught me anything, it is this: despite the stereotypes about astronomers forced upon us by television and movies, most planetary scientists are not geeks. In fact, quite the opposite is true. They are generally a lot more well rounded and talented than my everyday friends. I know Solar System specialists who are competitive runners, who perform in opera

companies or rock bands, and who are accomplished cooks. They get married, have children, and move from job to job, just as we all do. These very human qualities are rarely seen or appreciated by the public at large.

In fact, the public gets precious little exposure to the real work of science at all. For most of us, first-hand experience with chemistry or biology or astronomy ends well before high-school graduation. After that, our scientific awareness is largely in the hands of the news media, whose representatives pass on to us those salient topics considered timely and that have enough news value to compete with the daily pot-pourri of other headlines. Before these stories can reach you, in whatever medium, those of us who create them must convince our higher-ups that the stuff is worth publicizing.

No question about it, Mars landings, Voyager flybys, and comet crashes rise to an interest level high enough for even grizzled newspaper editors to take notice. When a spacecraft discovers ancient rivers on Mars, or a probe makes a risky dash through the dust-choked coma of a comet, the news value is so obvious that the stories practically write themselves. And if it is a NASA mission, a small army of media-relations personnel will be on hand to make sure reporters are handed stacks of fact sheets, or get pictures to publish, or arrange for interviews with key personnel. It is almost like walking in with a bucket and having the news generously ladled into it. (“One scoop or two, Mr. Beatty?”)

The problem is that fewer and fewer space-exploration stories qualify as “big.” For starters, these days most interplanetary missions are headed for places we have already visited at least once. The rush of pure discovery has largely passed. Moreover, we live at a time when various distractions are vying for the public’s scientific attention. Today astrology is as popular as ever, pseudo-science has been legitimized by television, and “government conspiracies” lurk around every corner. Compared to all that, real astronomy can sometimes seem downright boring.

Example: on September 22, 2001, an aging, crippled spacecraft called Deep Space 1 dashed through the coma of a big comet called Borrelly at more than 16 kilometers per second. Moving at that speed, a mote of dust packs the punch of a bowling ball. Against the odds, Deep

Space 1 survived, and it radioed to Earth incredible pictures of the comet's coal-black nucleus. I wrote four different stories about this encounter in one week for *S&T* and its associated Web site. Some newspapers saw fit to cover the story in depth. Yet the *Boston Globe*, a major daily newspaper, published just a single picture and a short caption, with no hint of the science and drama that was inherent in this risky mission. The *Globe's* readers deserved better. Granted, we were all still gripped by the horrifying terrorist attacks in New York and Washington that had occurred only 11 days beforehand.

These issues of science and journalism beg two big-picture questions: Is the exploration of our Solar System still worth doing, and is it still newsworthy?

To the first I would offer an unqualified "yes." We are far from knowing everything we would like to about our neighbor worlds. Kids still get jazzed about seeing Saturn's rings through a telescope, and scientists still get jazzed when the discussion turns to how those rings came to be and how they "work." (The Cassini orbiter should offer some important insights when it arrives there in 2004.) No matter how comprehensive or voluminous, each mission's results always prompt a new spectrum of provocative scientific questions.

However, like it or not, funding for science comes mostly from governmental agencies – whether in the US or elsewhere – that are subject to the political posturings of a given leader or national mood. When President John F. Kennedy exploited the Apollo program to earn technological bragging rights, funding for NASA and the National Science Foundation surged, and legions of Baby Boomers began dreaming of careers as space scientists and engineers. But when government leaders show indifference or set their priorities elsewhere, the pace of space exploration slows. Even scientifically provocative missions are deferred or canceled. Doing so does not render the rationale for our scientific quest invalid; it just means that we must sometimes be patient.

To the second question, I offer a more tentative "yes." Science and journalism often exist in a love-hate relationship. Researchers bemoan shallow, sensationalized stories, yet increasingly the news "buzz" created by a particular research project or space mission can play a role in setting its funding priorities – the heightened interest in

astrobiology being one recent example. Unfortunately, in an attempt to get exposure for their work, scientists (or their institutions) sometimes tout a finding as newsworthy when it really is not. NASA's public relations machine alone churns out hundreds of press releases annually, many more than can be accommodated even in a special-interest publication like *Sky & Telescope*. This shotgun approach, in itself, is nothing new; reporters have always been faced with sorting out what constitutes "news."

What has changed, however, is our ability to access not only the news stories but all the primary source material itself – press releases, press conference videos, whole scientific papers, and even raw spacecraft data are now available via the Internet. Those of us who hunger for the latest astronomical findings no longer need newspapers and the evening news as the delivery media, so we no longer clamor as loudly for their inclusion by those sources. Taken to the extreme, everyday reporting about astronomy and other sciences might someday disappear from the mass media altogether.

I, for one, do not want that to happen. We explore space for the benefit of all, not just the informed few. And as long as the majestic, mysterious universe continues to enthrall and inspire us, I am confident that we will find value in vicariously exploring its uncharted depths and savoring what we discover.

Further readings

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Sagan, Carl (1995). *The Demon-Haunted World: Science As a Candle in the Dark*, New York: Random House.

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