

# SIRTF gets go-ahead

*Design, development phase now under way; launch in late 2001*

By MARY BETH MURRILL

NASA Administrator Dan Goldin last week authorized the start of work on the JPL-managed Space Infrared Telescope Facility (SIRTF), an advanced orbiting observatory that will give astronomers unprecedented views of phenomena in the universe that are invisible to other types of telescopes.

The authorization signals the start of the design and development phase of the SIRTF project. Scheduled for launch in December 2001 on a Delta7920-H rocket from Cape Canaveral, Fla., SIRTF represents the culmination of more than a decade of planning and design to develop an infrared space telescope with high sensitivity, low cost and long lifetime.

"The Space Infrared Telescope Facility will do for infrared astronomy what the Hubble Space Telescope has done in its unveiling of the visible universe, and it will do it faster, better and cheaper than its predecessors," said Dr. Wesley Huntress, NASA's associate administrator for space science.

"By sensing the heat given off by objects in space, this new observatory will see behind the cosmic curtains of dust particles that obscure much of the visible universe," Huntress said. "We will be able to study fetal stars, detect other solar systems and study the most ancient, distant galaxies at the edge of the universe."

Conventional optical telescopes can study stars and other objects that glow brightly enough to emit light in the visible portion of the electromagnetic spectrum. But many objects, such as planets and unignited stars, do not "shine" in visible or ultraviolet light. Others that may burn brightly are still veiled from view behind the vast clouds of dust and gas that populate the universe.

Some of the most fascinating objects and processes in the universe may exist behind these cosmic curtains of dust and gas, such as black holes, quasars, regions where stars are forming in galaxies and regions where planets are forming around stars. The majority of these concealed attractions are detectable only with infrared telescopes, whose unique capability lies in their ability to sense the heat of dark, faint or hidden objects.

Infrared telescopes also provide the means to study the oldest and most distant objects at the edge of the expanding universe. Optical and ultraviolet light emitted from stars, galaxies and quasars since the birth of the universe has shifted, over time and distance, into the infrared portion of the spectrum. Recent studies of these objects made with infrared telescopes are providing important insights into when and how the first galaxies and stars formed.

SIRTF, cost-capped at \$450 million, will be  
See SIRTF, page 2

## JPL families invited May 16

*Tickets available April 6; event will precede public open house by two weeks*

Family members of JPL employees and contractors will have a unique opportunity to get a close-up view of the Laboratory and its activities during Employee Family Day, scheduled for Saturday, May 16.

The event will be held from 10 a.m. to 3 p.m. Tickets are required; they will be available from April 6 to 24 at the following locations:

- ERC (Building 114-104)
- Public Services Office (186-113)
- Emergency Preparedness Office (180-102)
- Observational Systems Division (306-416)
- Compensation and Benefits (291-214)
- Systems Division (301-230K)
- Credit Union (218)
- Environmental Laboratory (144-121)

Tickets will also be available outside each cafeteria on April 10, 17 and 24 from 11:30 a.m. to 1:30 p.m.

Visitors are restricted to immediate family members only, according to Nancy Kapell of Employee Services. Extended family and friends are welcome to the public open house May 30 and 31, she said.

See Family, page 3

Jet Propulsion  
Laboratory

# Universe

Pasadena, California

Vol. 28, No. 7

April 3, 1998

## MGS will target imaging areas

*Attempts will include Pathfinder and Viking landing sites, Cydonia region*

By DIANE AINSWORTH

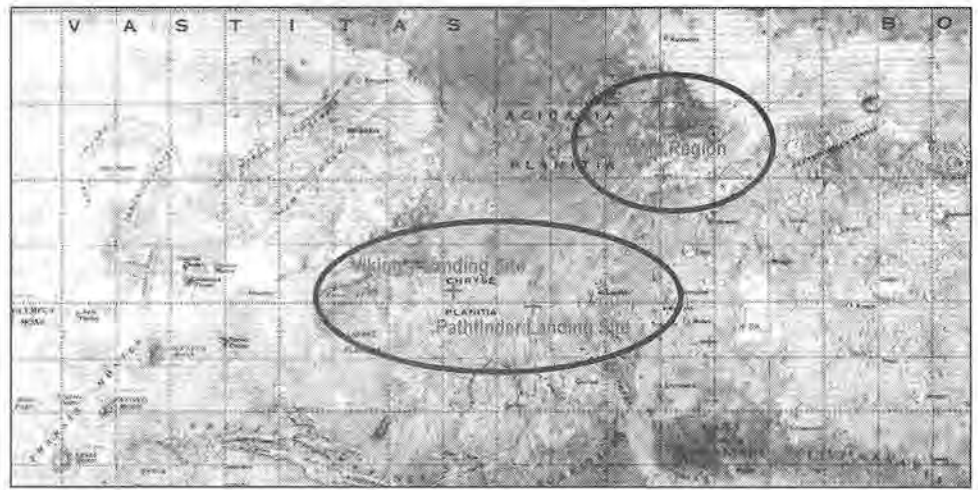
JPL's Mars Global Surveyor project has resumed scientific observations of the surface of Mars and has scheduled opportunities to image four selected sites: the Viking 1 and 2 landing sites, the Mars Pathfinder landing site and the Cydonia region.

Three opportunities to image each of the four sites using the spacecraft's high-resolution camera will take place over the next month, beginning on April 3 at 1:58 a.m. Pacific time, when Global Surveyor passes over the Viking 1 landing site. The spacecraft will next pass over the Viking 2 landing site at 1:37 p.m. Pacific time on April 3. On April 4, Global Surveyor will try to image the now-silent Mars Pathfinder spacecraft at 1:16 a.m. Pacific time. It will then capture a portion of the Cydonia region of Mars, location of the so-called "Face on Mars," on April 5 at 12:33 a.m. Pacific time.

Attempts to rephotograph the sites will occur during two additional opportunities falling about nine days apart. A detailed schedule of the imaging attempts is listed below. Uncertainties in both the spacecraft's pointing and the knowledge of the spacecraft's ground track from its navigation data will provide only a 30- to 50-percent chance of capturing the images of each site.

All of the selected targets are located south of Global Surveyor's periapsis, or point of closest approach to the Martian surface.

Shortly before the spacecraft reaches this point, the Global Surveyor spacecraft will rotate slightly so that when it nears the selected target, the camera's field-of-view will sweep across the target as the spacecraft flies south and rises away.



Target areas for Mars Global Surveyor imaging include the landing sites of Pathfinder (near bottom center of map above), Viking 1 (above Pathfinder) and the Cydonia region (to the right of center, near top). Another target area is the Viking 2 landing site, not shown on this map, which was created from Viking orbiter data.

The spacecraft will begin transmitting to Earth data stored on its onboard solid-state recorders about seven hours after the images are acquired, concluding about three hours later. Currently it takes radio signals from Mars Global Surveyor about 20 minutes to travel from the spacecraft to Earth.

Data will be received at one of NASA's Deep Space Network tracking stations at Goldstone, Calif., near Madrid, Spain or near Canberra, Australia, and then sent by satellite to JPL. There the images, along with all of the rest of Global Surveyor's science and engineering data, are placed in the project database for access by flight controllers. This process takes only seconds for each bit of data. Consequently, the image data will not be available on the ground until about 10.5 hours after they are acquired. Data received overnight will not be retrieved until 9 a.m. Pacific time on the following workday.

When image data are retrieved by camera operators, the information is assembled into "raw" images. Raw images may contain data errors or drop-outs introduced by noise in the telecommunications channel between the

spacecraft and the ground, as well as very slight picture element variations inherent in the camera. This data processing takes about 30 minutes.

Raw images will be posted on three World Wide Web sites: JPL's Mars news site at <http://www.jpl.nasa.gov/marsnews>, the Mars Global Surveyor project home page at <http://mars.jpl.nasa.gov>, and NASA's Planetary Photojournal site at <http://photojournal.jpl.nasa.gov>.

Information identifying the acquisition time, predicted center latitude and longitude of the target location, and the local solar time will accompany these images. Contrast enhancement will be performed by JPL's Multimission Image Processing Laboratory and posted on the World Wide Web a few hours later. The Global Surveyor project home page also contains spacecraft orbital velocity and distance to the planet in real time.

Images of the Viking and Mars Pathfinder landing sites will not be posted until image enhancement and identification of the vehicles have been completed, because the small spacecraft will be at the limits of the camera's resolution. This process will take about 24 hours. □

## Pacific Ocean warm water pool near normal, but El Niño expected to stay

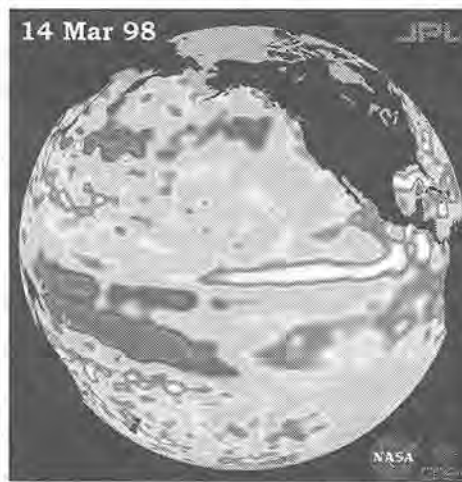
By MARY HARDIN

The most recent image from the JPL-managed TOPEX/Poseidon satellite shows the sea surface height along the central equatorial Pacific has returned to a near normal state and remnants of the warm water pool, commonly referred to as El Niño, are now situated to the north and south of the equator.

The image shows sea surface height relative to normal ocean conditions on March 14. Sea surface height is an indicator of the heat content of the ocean. Oceanographers indicate this is a classic pattern, typical of a mature El Niño condition that they would expect to see during the ocean's gradual transition back to normal sea level. These sea surface height measurements have provided scientists with a detailed view of how the 1997-98 El Niño warm water pool behaves because the TOPEX/Poseidon satellite measures the changing sea surface height with unprecedented precision.

Sea surface temperatures, as measured by the National Oceanic and Atmospheric Administration (NOAA), are still well above normal throughout the tropical Pacific Ocean and are expected to remain that way through April and into May.

Using satellite imagery, buoy and ship data, and a forecasting model of the ocean-atmosphere system, NOAA has extended an advisory



March 14 TOPEX/Poseidon image shows that the sea surface height along the central equatorial Pacific has returned to a near normal state and remnants of the El Niño warm water pool are now situated to the north and south of the equator. Sea surface temperatures, however, are still well above normal and El Niño conditions are expected to continue through the spring.

indicating that the so-called El Niño weather conditions that have impacted much of the United States and the world are expected to continue through the spring. □

## Tech Affiliates success story helps pilots avoid danger

By JOHN WATSON

Two new software packages enabling pilots to use laptops to avoid hazardous terrain and find their place on maps are the latest success stories of a JPL program bringing together entrepreneurs and space engineers.

Pilots of small planes, for whom such tools have been largely unavailable until now due to cost and the sheer size of bulky hardware, may soon be able to carry onboard the personal computer equivalent of collision-avoidance systems now used by the military and commercial airlines.

"TerrAvoid" and "Position Integrity" combine Global Positioning Satellite (GPS) data with high-resolution maps of the Earth's topography. Dubbs & Severino, Inc., based in Irvine, has developed software that allows the system to be run on a battery-powered laptop in the cockpit.

The packages, designed primarily for military sponsors and now positioned to hit the consumer market in coming months, came about as  
See Tech transfer, page 3

## News Briefs

Friends and co-workers are invited to the dedication of a memorial bench in honor of former JPL mechanical engineer **Jordan Kaplan** April 6 at noon in the courtyard of Building 301.

Numerous donors from JPL and elsewhere supported construction of the bench, which was built in Kaplan's home state of Massachusetts under the supervision of his family.

Kaplan, 32, died March 23, 1997, eight days after an airplane he was piloting crashed in Pacoima.

Kaplan's parents and siblings are planning to attend the dedication. Music will be provided by The Patio Players, with whom Kaplan played music at the site of the memorial dedication. □



Jordan Kaplan

JPL's Library, Archives and Records Section will celebrate

National Library Week later this month in the library reference area at the west end of Building 111.

Activities will take place April 21-23 from 11 a.m. to 1 p.m. and will include hands-on demonstrations of the newest Bibliographic and Electronic Access Connection (BEACON) World Wide Web resources (<http://beacon>) and tours of the recently renovated facility. Also, the Online Search Center will demonstrate its mediated search capabilities; attendees will have the opportunity to sign up for a sample search.

Ten drawings will be held each day of the celebration, with prize winners receiving one of two books: *Pioneering Venus: A Planet Unveiled* or *The Face of Venus: The Magellan Radar Mapping Mission*.

For more information contact the Library at ext. 4-4200 or e-mail [Library@jpl.nasa.gov](mailto:Library@jpl.nasa.gov). □

## SIRTF

Continued from page 1

one of astronomy's most advanced telescopes. Its unconventional approach uses new technologies, an innovative mission design and small launch vehicle. It is being developed on a quick schedule that closely integrates the work of the contractor and academic teams responsible for SIRTF development and delivery. Its design promises high sensitivity and observing capability along with efficiency of operations and long lifetime of at least two-and-a-half to as many as five years.

SIRTF is the fourth and final element in NASA's family of spaceborne "Great Observatories" that includes the Hubble Space Telescope, the Compton Gamma Ray Observatory and the Advanced X-Ray Telescope Facility, or AXAF.

SIRTF's findings will complement those of the other Great Observatories.

The project also represents a bridge to NASA's new Origins program—administered by JPL—which seeks to answer fundamental questions about the birth and evolution of the universe. SIRTF will lay the groundwork for many investigations that are fundamental to the Origins program, such as studies of the birth and evolution of galaxies, their stars, and searches for planets that orbit some of those stars. Astronomers around the world are invited to request observing time on SIRTF.

Cold is the key to success in infrared astronomy, and designing and maintaining the liquid helium-based cooling system for infrared telescopes has long been a major challenge because the detectors must be kept to near absolute zero (-273 degrees Centigrade or -479 degrees Fahrenheit). "We have to defend against the heat produced by the instruments and satellite systems themselves," said SIRTF project manager Larry Simmons of JPL.

"Once the cryogen is exhausted, the mission is over, so any steps we take to lower the consumption of the use of liquid helium increases the life span of the telescope."

One new approach is SIRTF's "warm launch architecture."

Previous infrared telescopes in space required large amounts of liquid helium to keep the entire telescope assembly cooled before launch. But SIRTF's telescope

assembly will be launched at ambient temperature and allowed to cool off in space, Simmons said. "This provides a huge savings in the amount of cryogen we need to place onboard, and greatly simplifies the overall handling and assembly of the observatory before it is launched."

Another key innovation is SIRTF's unconventional orbit around the sun, trailing the Earth by up to about 50 million kilometers (30 million miles). "This will prevent the telescope and its detectors from being exposed to heat from Earth, but allows SIRTF's solar panels to remain illuminated while the telescope enjoys an unobstructed view of the heavens," Simmons said.

The detectors that will form the heart of SIRTF's system have been developed under NASA sponsorship by industrial fabricators and university researchers who adapted technology originally developed for military applications. The result is a giant leap in sensitivity matched by a dramatic increase in the size of the arrays of detectors that will form the focal planes.

SIRTF's 85-centimeter diameter (33-inch) primary mirror is significantly larger than mirrors used on previous infrared astronomy missions. The mirror is made of the ultralightweight rare metal beryllium. The entire optical system weighs just 31 kilograms (70 pounds).

Lockheed Martin Missiles & Space of Sunnyvale, Calif. is responsible for the spacecraft and for the SIRTF system integration and testing. Ball Aerospace and Technology Corp., Boulder, Colo., is responsible for the cryogenic telescope assembly. The manufacture and delivery of SIRTF's science instruments is due in April 2000, and the spacecraft and telescope are scheduled to be integrated in February 2001.

NASA's Deep Space Network will provide the telecommunications link between the orbiting telescope facility and a flight operations team at JPL. The SIRTF Science Center at Caltech will receive the data from JPL, process it, and serve as the interface with the astronomy community.

The project scientist at JPL is Dr. Michael Werner.

More information about SIRTF and other infrared astronomy projects can be found online at <http://sirtf.jpl.nasa.gov/sirtf> and <http://www.ipac.caltech.edu>. □

## A marathon effort



PHOTO BY JIM MORAN / JPL PHOTO LAB

JPL Deputy Director Larry Dumas meets with JPL employees who competed in last Sunday's Los Angeles Marathon. Top row, from left, Bob Edelson, Susan Merrill, Paul Herrera, Steve Schlaifer and Dumas. Middle row, from left: Ray Garcia, Debbi Dachinger, Greg Koellner, Michael Taylor and Carol Bruegge. Front row, from left: Padma Varanasi, Jennifer Harris, Rashmi Bansal, Jon Hamkins, Bill Taber, Mike Allen and Tom Hoffman.

Having better things to do than sit around the house last Sunday, 16 JPL employees decided to stretch their legs a bit—for 26.2 miles, to be exact.

They joined more than 19,000 others who ran, jogged, walked and wheeled through the grueling course on the streets of Los Angeles in the city's annual marathon.

In addition to the runners pictured above, a number

of other JPL employees spent their day off by volunteering their time as ham radio operators for the marathon, which helped in medical and other emergencies. This vital communication support was provided by Bob Dengler, Jay Holladay, Allen Hubbard, Rick McKinney, Larry Ruple, Chuck Sarture, John Tallon, Jan Tarsala and Gerry Walsh. □

## Special Events Calendar

### Ongoing

**Alcoholics Anonymous**—Meeting at 11:30 a.m. Mondays, Tuesdays, Thursdays (women only) and Fridays. For more information, call Occupational Health Services at ext. 4-3319.

**Codependents Anonymous**—Meeting at noon every Wednesday. For more information, call Occupational Health Services at ext. 4-3319.

**Gay, Lesbian and Bisexual Support Group**—Meets the first and third Fridays of the month at noon in Building 111-117. For more information, call employee assistance counselor Cynthia Cooper at ext. 4-3680 or Randy Herrera at ext. 3-0664.

**HIV Support Group**—Meets quarterly. Call employee assistance counselor Cynthia Cooper at ext. 4-3680 for more information.

**Parent Support Group**—Meets the fourth Tuesday of the month at noon. For location, call Jayne Dutra at ext. 4-6400.

**Senior Caregivers Support Group**—Meets the second and fourth Wednesdays of the month at 6:30 p.m. at the Senior Care Network, 837 S. Fair Oaks Ave., Pasadena, conference room #1. For more information, call (626) 397-3110.

### Friday, April 3

**ACW Seminar Series**—Caltech and

USC law professor Edward McCaffery will discuss the social and political importance of tax, how tax systems affect women, and how tax reform can provide more options for achieving balance between work and family. At noon in von Kármán Auditorium.

**JPL Dance Club**—Meeting at noon in Building 300-217.

**JPL French Club**—Club member Dr. William Smyth will speak about his working visits to Antarctica, where he has conducted seismology experiments. At noon in Building 183-328. The program will be repeated at 7 p.m. in the San Marino home of another club member.

**"Scotland and the Scottish Isles"**—Joe and Mary Liz Adair will narrate their travel film at 8 p.m. in Caltech's Beckman Auditorium. Tickets are \$9 and \$7. For information, call (626) 395-4652.

### Saturday, April 4

**Chinese Golden Dragon Acrobats**—This People's Republic of China company will present a spectacle of acrobatics, music and dance at 8 p.m. in Caltech's Beckman Auditorium. Tickets are \$26, \$23 and \$20. For information, call (626) 395-4652.

### Sat., Apr. 4–Sun., Apr. 5

**All-Mozart Concert**—The Caltech Glee Clubs will present this free per-

formance at 8 p.m. in Caltech's Dabney Lounge. For information, call (626) 395-4652.

### Tuesday, April 7

**JPL Gamers Club**—Meeting at noon in Building 301-227.

**JPL Genealogy Club**—Meeting at noon in Building 301-169.

### Wednesday, April 8

**"Can We Use Chemistry to Change the Way Our Genes Work?"**—Caltech chemistry professor Dr. Peter Dervan will deliver this free lecture at 8 p.m. in Caltech's Beckman Auditorium. For information, call (626) 395-4652.

**JPL Amateur Radio Club**—Meeting at noon in Building 238-543.

**JPL Drama Club**—Meeting at noon in Building 301-127.

**JPL Toastmasters Club**—Meeting at 5:30 p.m. in the Building 167 conference room.

**SESPD Lecture Series**—Lute Maleki will discuss laser-cooling atomic physics research at noon in von Kármán Auditorium.

### Thursday, April 9

**JPL Dance Club**—Clogging class will be held at noon in Building 300-217.

### Friday, April 10

**JPL Dance Club**—Meeting at noon in Building 300-217.

### Monday, April 13

**Develop New Products Seminar**—Michael Dickerson of Section 344 will present an overview of new rate structures for DNP strategic tools. At noon in von Kármán Auditorium.

### Tuesday, April 14

**JPL Scuba Club**—Meeting at noon in Building 168-427.

**JPL Stamp Club**—Meeting at noon in Building 183-328.

### Wednesday, April 15

**JPL Drama Club**—Meeting at noon in Building 301-127.

**JPL Hiking Club**—Meeting at noon in Building 303-209.

### Thursday, April 16

**JPL Astronomy Club**—Meeting at noon in Building 198-102.

**Von Kármán Lecture Series**—Division 32 outreach specialist Marguerite Syvertson will discuss the Earth Observing System (EOS),

which will provide land, ocean and atmospheric data that will allow scientists to study and eventually model changes in the Earth's environment and climate. At 7 p.m. in von Kármán Auditorium. Open to the public.

### Friday, April 17

**Flamenco Dancing**—La Tania will appear at 8 p.m. in Caltech's Beckman Auditorium. Tickets are \$26, \$23 and \$20. For information, call (626) 395-4652.

**JPL Dance Club**—Meeting at noon in Building 300-217.

**Von Kármán Lecture Series**—Division 32 outreach specialist Marguerite Syvertson will discuss the Earth Observing System (EOS), which will provide land, ocean and atmospheric data that will allow scientists to study and eventually model changes in the Earth's environment and climate. At 7 p.m. in The Forum at Pasadena City College, 1570 E. Colorado Blvd. Open to the public.

### Saturday, April 18

**Lula Washington Dance Theatre**—African American heritage will be explored with the troupe's blend of African, jazz and modern dance. Reserved seats are \$20. For information, call (626) 395-4652.

## Tech transfer

Continued from page 1

the result of JPL's Technology Affiliates Program. Intended to give American industry assistance from Laboratory experts and to facilitate business use of intellectual property developed for the space program, the Technology Affiliates Program introduced the start-up company of Dubbs & Severino to JPL's Dr. Nevin Bryant four years ago.

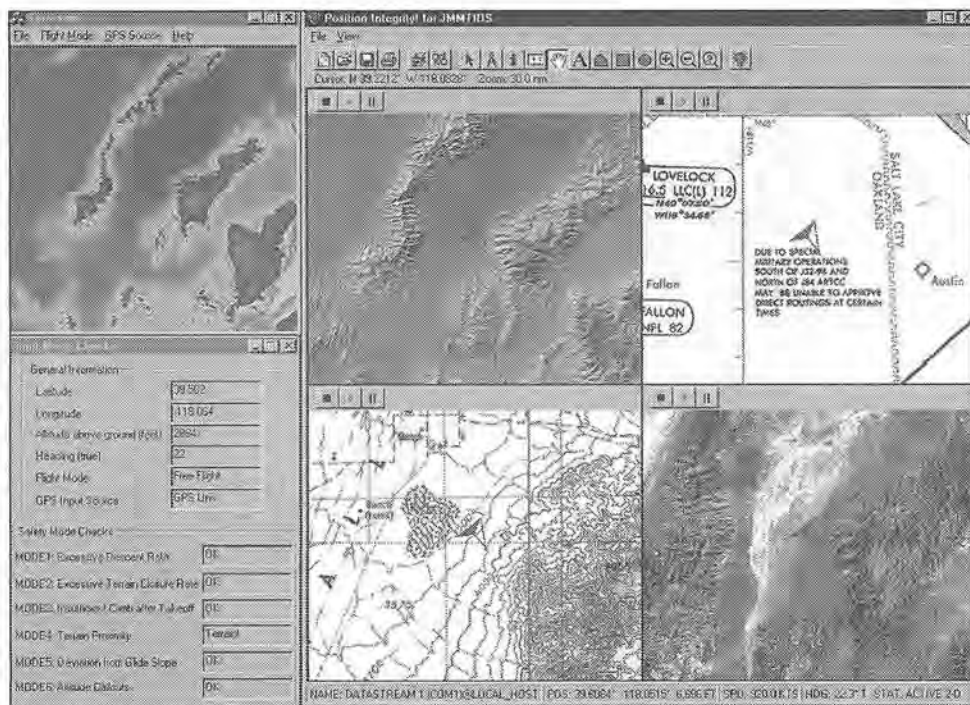
Dubbs & Severino had an idea for mapping software to help private airplane pilots, inspired in part by the fatal crash of a pilot friend of company president Bob Severino. The twist: the package was to be completely software-driven, instead of requiring expensive hardware, as was the norm up to that time.

Bryant's Cartographic Applications Group at JPL had developed GeoTIFF, an architecture standard providing geo-location tools for mapping applications. GeoTIFF proved to be the crucial key that the start-up company needed to bring the idea to fruition, allowing the firm to develop low-cost software packages.

GeoTIFF is now in the public domain, and its use for commercial product development has evolved into an industry standard over the last year. Through the Technology Affiliates Program, Dubbs & Severino obtained JPL's assistance early on and thus gained a jump-start in adapting the architecture for their products' specific needs. "JPL gave us a demonstration and opened up the red carpet. It was a match made in heaven," Severino said.

Merle McKenzie, manager of JPL's Commercial Technology Program, said that Dubbs & Severino's ability to utilize technology originally developed for NASA provides a strong example of the many advantages of technology transfer programs. "This is a win-win partnership through which yet another American business gets a boost from the space program," she said.

"TerrAvoid" is a terrain avoidance system



that graphically shows pilots if they are flying dangerously close to mountains: safe sections can be seen in green, while hazardous sections show up in red, with those proportions changing in real time as the pilot moves through hilly terrain. In a sense, the system "looks" out over a plane's flight path, sweeping 360 degrees, warning the pilot if there are any upcoming hazards. Integrating Global Positioning System (GPS) tracking data with maps on CD-ROM, this software package is approximately 1/20th the cost of its nearest competitor.

"Position Integrity," which also co-registers real-time GPS data with local maps on CD-ROM, is a moving map detailing the exact position of the pilot. Because of the unique features of GeoTIFF, this software can be adapted to operate with any map, chart or photo image in

the world, while comparable versions are limited solely to either military, scientific or commercial maps. GeoTIFF also enables the package to feature four windows at once, a useful and unique option for pilots who need to work simultaneously with maps, charts, photo images and sketches at different scales and zoom levels.

As Severino explains, "GeoTIFF enables terrain avoidance and navigation map packages to manipulate the pixels in each image intelligently, making costly hardware unnecessary. Its clever indexing scheme organizes large numbers of pixels efficiently and inexpensively, compressing and capturing huge amounts of data into a seamless image file. It has paved the way for sophisticated mapping software to be made available not just to major commercial airlines but also to small-plane pilots around the world."

"TerrAvoid" and "Position Integrity" work together to provide pilots with enhanced situational awareness through the use of six mutually supporting graphic windows. In this snapshot, the aircraft is flying through the Dixie Valley near Fallon Naval Air Station, Nevada. The upper left screen shows how the Terrain Avoidance window provides a 60-nautical-mile depiction of the terrain around the aircraft. On-screen colors show various altitude levels of terrain above or below the aircraft.

The lower left window, showing critical navigation information, shows six warning modes to reflect Federal Aviation Administration categories of concern about safe flight. In this example, Mode 4 is alerting the pilot to an impending terrain collision. Voice alerts are simultaneously broadcast into the pilot's intercom headset.

The other four windows show the "Position Integrity" moving map system. Each window is updated in real time using a Global Positioning System feed from the aircraft or from a portable receiver. The top center window shows a JPL-generated, shaded relief of the terrain, with the highest elevations shown to the pilot in the warmest colors.

Dubbs & Severino was formed in 1994 with a flight test contract for the Army, Navy and the Federal Aviation Administration, and today the corporation has eight research and development contracts with various military agencies. Just after start-up, it was awarded a U.S. Army Research Office Small Business Technology Transfer program grant that required it to team with a university or research laboratory, a further incentive for the company to work with JPL. Discussions are ongoing with wholesale software firms to bring "TerrAvoid" and "Position Integrity" to the consumer market by the end of the year.

Further details about JPL's technology transfer activities, including the Technology Affiliates Program, are available online at <http://techtrans.jpl.nasa.gov/tu.html>. □

## Lab-supported childcare available to more JPL families

Waiting lists shorter, more tuition assistance funds available

By ENRICO PIAZZA

Created to accommodate JPL employees' need for quality and conveniently located childcare, the Child Educational Center (CEC) has been serving the Lab community since 1979.

Since that time, close to 1,000 JPL families have been served. The center has expanded three times to meet service demands for its traditional client base of infants, toddlers and preschoolers, and has in recent years added programs for school-age children.

Despite the center's success, however, it has greater capacity to serve

JPL employees than is currently being utilized.

According to CEC executive director Elyssa Nelson, two widespread misconceptions keep some JPL families from exploring enrollment. One has to do with a long waiting list and the other with tuition costs.

While there were times in which waiting lists for some age groups were as long as two years, that's not the case anymore. Openings are updated weekly on the [jpl.forum](http://jpl.forum) newsgroup; enrollment is now underway for the center's summer camps for school-age children; and applica-

tions are available for fall 1998 enrollment for all age groups.

In addition, Nelson said some people don't realize that JPL families have priority enrollment over the general public.

"We were set up to serve JPL employees, and we take that commitment very seriously," Nelson said.

In terms of tuition costs, "The belief that the CEC is too expensive is a problem," Nelson said. Aside from the automatic discount JPL employees receive—ranging from 4 to 10 percent depending on the child's age—Nelson said not too many peo-

ple are aware of the center's tuition assistance program, which can reduce tuition costs up to 70 percent.

"We have reorganized our funding in such a way that we have more tuition assistance money for JPL employees than ever before," she said. "We want to encourage people who might have thought the CEC was too expensive to really check it out."

While CEC tuition is not much higher than that of most private childcare facilities, the quality of the care offered is second to none, according to JPL parents with children at the CEC. The majority of caregivers have college degrees in child education, and the teachers-to-children ratio is

far above—in some age groups more than twice—the guidelines mandated by the state. The CEC is accredited by the National Academy of Early Childhood Education.

"The best part about the CEC is that children get the right kinds of attention," said Dr. Laif Swanson, a technical manager in the Telecommunications and Mission Operations Directorate's Technology Program Office. "There are no rigidly structured activities, like in other places where there is the writing hour, the playing hour and so on."

At the CEC "children can choose the activities they are interested in; See CEC, page 4

## Lew Allen Award winners named

Three JPL scientists have been named recipients of the 1998 Lew Allen Award for Excellence.

The annual awards recognize and encourage significant individual accomplishments or leadership in scientific research or technical innovation by JPL employees during the early years of their professional careers.

The recipients are Dr. Shouleh Nikzad of Section 346, Dr. Bedabrata Pain of Section 385 and Dr. Paul Stolorz of Section 395.

Nikzad was recognized for her outstanding contributions to the fundamental understanding and development of advanced scientific low-energy particle detectors.

Pain was cited for his technical leadership and creative inventiveness in maintaining and expanding JPL's lead role in advanced solid state imagers, particularly the active pixel sensor.

Stolorz received his award in recognition of outstanding research achievement in the areas of data

mining, image analysis and massively parallel computing for the automated analysis of very large scientific data sets, and in the pioneering of concepts for onboard analysis of science data.

The award consists of a plaque and a grant of \$25,000 from the Director's Research and Development Fund, to be used at JPL to enhance the professional efforts of the awardees.

The award was established in 1990 in honor of Allen, who served as JPL's director from 1982-90. □

## Daughters, sons to be welcomed April 23

JPL will again join thousands of employers throughout the nation in recognition of "Take Our Daughters to Work Day" April 23.

The Lab has aligned the name of its program in recognition of the nationwide event; however, both boys and girls continue to be welcome for the activities at JPL.

"The program is designed to celebrate a girl's worth—to value her opinions and ideas, to speak her mind, to never stop asking questions, and to take pride in who she is," noted event coordinator Carmen Nuñez of the Advisory Council for Women (ACW).

"The event was conceived in response to research conducted by Harvard University and the American Association of University Women on the adolescent development of girls, which found that girls tend to like or dislike themselves based on aspects of their physical appearance, and suffer from lower expectations than do their boy counterparts," said ACW chair Jeanette Mills. "Spending a day in the workplace gives girls a glimpse of their own potential and helps them make the crucial connections to their future development."

"Girls and women continue to

struggle—albeit with some improvement—particularly in areas with math, science or technical emphasis," Nuñez added. "We hope to offer a stimulating experience to these young minds, and provide them with options and aspirations for their future."

"At the same time, it's a great bonding experience for parent and child," she said.

The event is also supported by the Human Resources Directorate, Public Affairs, Advisory Committee on Minority Affairs, and Security and Plant Protection.

The event is open to JPL employees only, with approval required from their supervisor. It is limited to one child between the ages of 9 and 17 per participating employee.

An application form was sent to all employees last week. The deadline to apply is April 10. □

## Family

Continued from page 1

Tour sites will include the space simulator, Microdevices Lab, von Kármán visitor center, ERC, Observational Instruments Lab, Spacecraft Assembly Facility, Space Flight Operations Facility and Professional Development Center. An astronaut presentation and children's activities are also planned.

JPL personnel are also encouraged to take their families to their work locations. Lunch and entertainment will be provided in the mall.

For more information, call Kapell at ext. 4-9432. □



Former JPL Director Dr. Lew Allen, left, current Director Dr. Edward Stone, second from right, and Chief Scientist Dr. Moustafa Chahine, right, join Lew Allen Award winners (from left) Dr. Shouleh Nikzad, Dr. Bedabrata Pain and Dr. Paul Stolorz.



## Face it: This is Cydonia

Mars Global Surveyor imaged the Viking 1 and 2 landing sites, the Mars Pathfinder landing site and the so-called "Face on Mars" during two recent passes over those areas of the red planet.

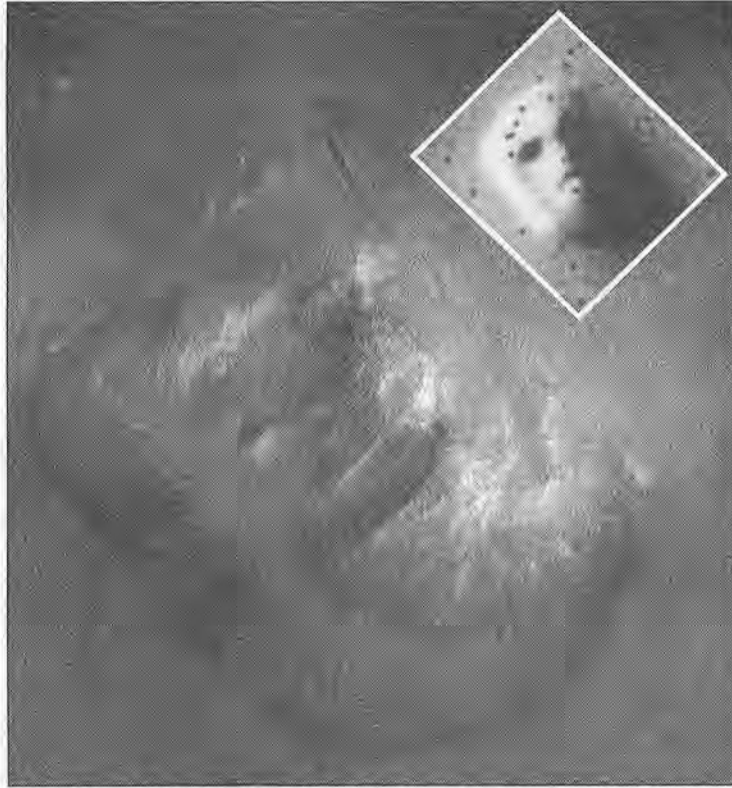
The spacecraft's high-resolution camera captured the "Face," as well as an adjacent set of features known by some as "The City," during imaging passes April 5 and 14 with resolutions 10 and 20 times better than the best images taken by the Viking mission in the 1970s. The images are posted on JPL's Mars news site at <http://www.jpl.nasa.gov/marsnews>, on the Mars Global Surveyor project home page at <http://mars.jpl.nasa.gov>, and on NASA's Planetary Photojournal site at <http://photojournal.jpl.nasa.gov>.

The spacecraft also successfully imaged the site of the Viking 1 lander in Chryse Planitia on April 12, after missing that target by a small margin on its first try April 3. Global Surveyor targeted the location of the Viking 2 lander in Utopia Planitia on April 3 and 13, but during both attempts the site was completely clouded over, with surface visibility reduced by about 70 to 80 percent.

Continuing inaccuracies in navigation data used to target the Mars Pathfinder landing site resulted in Global Surveyor missing that site on both attempts April 4 and 13, the second time by about 40 pixels. The flight team plans to update the navigation data before making a third and final attempt to capture the site next week.

Inaccuracies in the navigation data used to target selected sites and spacecraft performance gave the flight team a 30 to 50 percent chance of capturing each target during any given pass.

The last set of opportunities to image these four regions of Mars will occur Tuesday through Thursday, April 21-23. Meanwhile, all spacecraft operations continue to go well as Global Surveyor carries out a five-month period of data-gathering before aerobraking resumes. □



The high-resolution image of the "Face on Mars" feature in the Cydonia region above—as imaged by Mars Global Surveyor on April 5—contrasts with the same area as imaged by the Viking 1 orbiter in 1976 (inset).

## Decommissioned DSN antenna becomes students' key to the stars

By MARK WHALEN

Thanks to NASA and JPL's commitment to education, an old space communications and tracking antenna has been converted into a radio telescope for the use of students and teachers around the nation.

The telescope at the Deep Space Network's Goldstone complex is remotely controlled from the newly expanded Science and Technology Center in the high desert. The center is a branch of the Lewis Center for Educational Research that was dedicated April 3 in Apple Valley in San Bernardino County.

"The key to the 21st century is education,"

NASA Administrator Daniel Goldin told a gathering of students, teachers, supporters and guests at the dedication ceremony. "(It will take) a commitment by the adults to the children; not just to talk about education, but to really make it happen."

JPL's plans to dismantle a decommissioned 34-meter antenna at Goldstone in 1995 changed when the Apple Valley Unified School District and the Science and Technology Center contacted NASA to request the use of the antenna for radio astronomy. A feasibility study by the DSN Science Office soon followed, and JPL began to implement a plan to convert the telecommunications antenna to a remotely controlled radio telescope. The Goldstone Apple Valley Radio

Telescope (GAVRT) project became a reality when the Science and Technology Center took control of the antenna in the spring of 1997.

The recent dedication marked new classroom and office expansions to the facility, as well as the renaming of the center as the Lewis Center for Educational Research, in honor of U.S. Rep. Jerry Lewis, who was noted as a key supporter to the project's success.

In addition to Goldin and Congressman Lewis, those attending the dedication included JPL Director Dr. Edward Stone; Gayle Wilson, wife of California Gov. Pete Wilson; former astronaut Dick Covey; and Gael Squibb, JPL's director of Telecommunications and Mission Operations.

Dignitaries were given a tour of the center's mission control area, where students in Michigan and Kentucky joined those in Apple Valley to operate the giant radio telescope from their classrooms via the Internet.

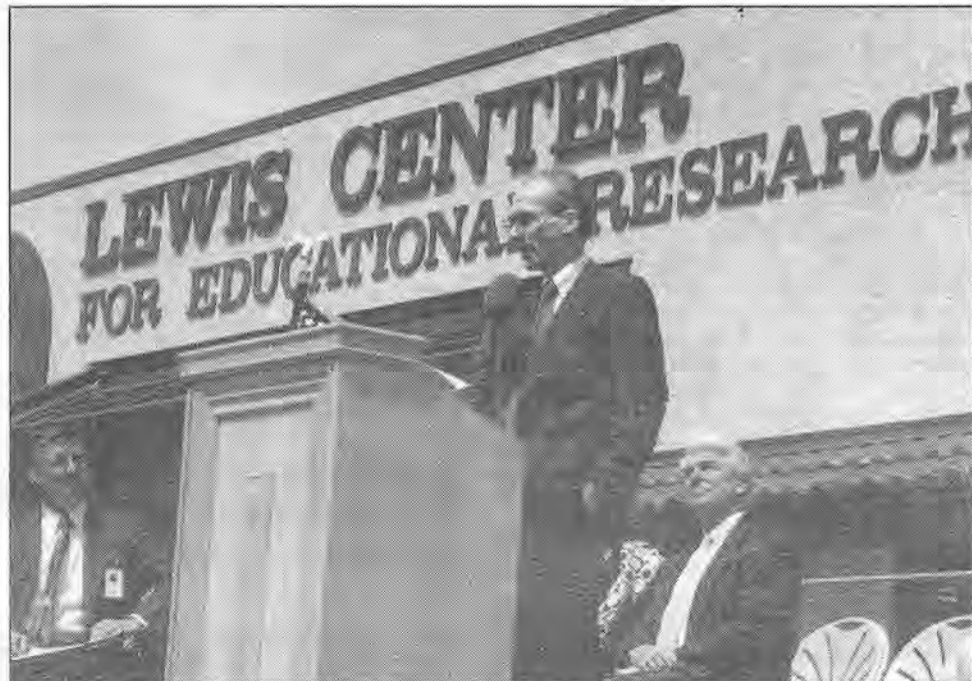
JPL is collaborating with the center to develop fundamental science and technology curricula to support the middle school and high school students who use the radio telescope. The first of these curriculum elements is called "Jupiter Quest," where participants are measuring the planet's temperature, analyzing its atmosphere, and monitoring changes in the high-energy radiation belts around Jupiter.

"I think it's very appropriate that one of the objects being studied by the students is Jupiter," Stone noted, "because this very antenna, during its first 30 years, was a principal point of contact with missions such as Pioneer 10, Pioneer 11, and Voyager 1 and 2—which flew by Jupiter beginning in 1973—and then tracked Voyager well past Neptune in 1989."

Dr. Michael Klein, manager of the DSN Science Office, attributed the success of the program to the fact that students have the opportunity to do real astronomy experiments.

"They compare their measurements with those we do routinely at Goldstone," Klein said. "They're now making measurements nobody else is making and we're merging those into our

See Apple Valley, page 3



JPL Director Dr. Edward Stone addresses the audience at the April 3 dedication of the Lewis Center for Educational Research in Apple Valley. Jerry Lewis, the congressman for whom the facility was named and who represents the high desert area, sits at right. At left is Rick Piercy, Apple Valley Science and Technology Center chief operations officer.

## EOS launch delayed until end of year

AM-1 spacecraft scheduled for June liftoff has Lab's ASTER and MISR onboard

NASA has found software performance problems with ground system software required to control, monitor and schedule science activities on the Earth Observing System (EOS) series of spacecraft.

Officials believe these problems will delay the software, which will impact the launch date for the Earth Observing Spacecraft AM-1. The launch, originally planned for late June from Vandenberg Air Force Base, will be delayed at least until the end of the year.

JPL's contributions to EOS AM-1 are the Advanced Spaceborne Thermal Emission Reflectance Radiometer (ASTER) and Multi-Angle Imaging Spectroradiometer (MISR).

ASTER, a cooperative effort between NASA and Japan's Ministry of International Trade and Industry, has 14 channels in the visible, near infrared, shortwave infrared and thermal infrared, and will allow scientists to study volcanoes, geology, topography, clouds, ice and land changes at spatial resolution of 15 to 90 meters.

MISR comprises nine cameras that observe the Earth at nine different angles, both fore and aft of the spacecraft. Each camera operates at four different wavelengths (red, green, blue and infrared) for a total of 36 different images. The multi-angled images are designed to analyze airborne dust and haze, clouds and the surface.

The ground control software, called the "Flight Operations Segment" (FOS) software, is part of the Earth Observing System Data and Information System (EOSDIS), the ground system responsible for spacecraft control, data acquisition, and science information processing and distribution for NASA's Earth Science enterprise, including the EOS flight missions.

The problem is with the control center system FOS software that supports the command and control of spacecraft and instruments, the monitoring of spacecraft and instrument health and safety, the planning and scheduling of instrument operations, and the analysis of spacecraft trends and anomalies.

Program managers expect it to take several weeks to clearly understand whether correcting the current software or taking other measures is the best approach.

"We're concurrently looking at commercial off-the-shelf technology that was not available when this software system initially was designed," said Arthur "Rick" Obenschain, project manager for EOSDIS at NASA's Goddard Space Flight Center, Greenbelt, Md.

Previous versions of the software successfully demonstrated real-time commanding functions with the AM-1 spacecraft. In the new version, however, a number of problems identified in the previous software deliveries were not corrected as expected, and significant problems were found in the new capabilities. Problems include unacceptable response time in developing spacecraft schedules, poor performance in analyzing spacecraft status and trends from telemetry data, and improper implementation of decision rules in the control language used by the flight team to automate operations.

Government/contractor teams have been formed to evaluate options for correcting these problems to minimize impact on the AM-1 launch. A recovery plan is being developed and will be reviewed during the last week of April. □

## Galileo discovers new dust ring around Jupiter

Scientists have found evidence for a new ring of dust that occupies a backward orbit around Jupiter, based on computer simulations and data from JPL's Galileo spacecraft, it was reported in the journal *Science* this month.

A team led by researchers at the University of Colorado at Boulder reported that a faint, doughnut-shaped ring of interplanetary and interstellar dust some 1,126,000 kilometers in diameter (about 700,000 miles) appears to be orbiting the giant planet. Evidence for the new ring's existence comes from computer simulations that correlate with data collected by a dust

See Galileo, page 4

## News Briefs

NASA astronaut and former Galileo engineer **Stephanie Wilson** will appear at JPL's Employee Family Day on May 16.

Wilson, who was selected as an astronaut candidate two years ago, will give hourly presentations in von Kármán Auditorium on NASA's Space Flight Awareness program.

Tickets are required for Family Day and are available through April 24 at the ERC (Building 114-104), Public Services Office (186-113), Emergency Preparedness Office (180-102), Observational Systems Division (306-416), Compensation and Benefits (291-214), Systems Division (301-230K), Credit Union (218) and Environmental Laboratory (144-121).

Tickets will also be available outside each cafeteria on April 17 and 24 from 11:30 a.m. to 1:30 p.m. □

The winners of JPL's Notable Organizational Value-Added (NOVA) awards for March have been announced:

**Section 190:** Susan Henry.

**Section 194:** Mark Banuelos.

**Section 195:** Paul Gowler.

**Section 346:** Lloyd Doug Bell II, Greg Cardell, Debra Cuda, Edward Fortier III, Winn Hong, James Lamb, Korla Mcfall, Linda Miller, Richard Muller, Barbara Nakamura, Daniel Pinion, Thomas Van Zandt, Roger

Williams, James Wishard.

**Section 354:** Yoseph Bar-Cohen, Patricia Hayes-Rowe, Dean Johnson, Jack Jones, Anthony Lai, Christian Lindensmith.

**Section 391:** Robin O'Brien, Linsey Ray. □

JPL personnel are reminded that all computers capable of being used for external communications must be bannered for security purposes. Unix, Novell and Windows NT computers in particular must be bannered by the end of April 1998.

Computer security measures were outlined in a March 3 memo sent to employees by Deputy Director **Larry Dumas** (available online at [http://icis.jpl.nasa.gov/iis/overview/dumas\\_memo.htm](http://icis.jpl.nasa.gov/iis/overview/dumas_memo.htm)). Instructions for installing the banner on all computer platforms are available online at <http://security.jpl.nasa.gov/banner.html>. □

JPL personnel are invited to submit their best landscape and nature photographs for possible inclusion in a revised version of the "Welcome to Outer Space" multimedia production.

Those interested may submit color 8- by 10-inch photos or color slides to **Sherri-Rowe Lopez** at von Kármán Auditorium (mail stop 186-AUD). □

## A tribute to a colleague



PHOTO BY BOB BROWN / JPL PHOTO LAB

About 100 friends, coworkers and family members of the late JPL mechanical engineer **Jordan Kaplan** gathered earlier this month to dedicate a memorial bench in his honor. Kaplan died in March 1997 as a result of injuries suffered in the crash of an airplane he was piloting. Kaplan's father **Henry**, right, stands aside the new bench in the courtyard area of Building 301 as he addresses the group. From left are Kaplan's sister **Deborah**; his mother, **Phyllis**; sister **Cynthia**; and brother **Josh**. Next to Henry Kaplan is **Jancis Martin** of Section 311, who often performed music with Jordan in the same courtyard as a member of the **Patio Players**. Members of that group performed for the gathering during the memorial dedication.

## Special Events Calendar

### Ongoing

**Alcoholics Anonymous**—Meeting at 11:30 a.m. Mondays, Tuesdays, Thursdays (women only) and Fridays. For more information, call Occupational Health Services at ext. 4-3319.

**Codependents Anonymous**—Meeting at noon every Wednesday. For more information, call Occupational Health Services at ext. 4-3319.

**Gay, Lesbian and Bisexual Support Group**—Meets the first and third Fridays of the month at noon in Building 111-117. For more information, call employee assistance counselor **Cynthia Cooper** at ext. 4-3680 or **Randy Herrera** at ext. 3-0664.

**HIV Support Group**—Meets quarterly. Call employee assistance counselor **Cynthia Cooper** at ext. 4-3680 for more information.

**Parent Support Group**—Meets the fourth Tuesday of the month at noon. For location, call **Jayne Dutra** at ext. 4-6400.

**Senior Caregivers Support Group**—Meets the second and fourth Wednesdays of the month at 6:30 p.m. at the Senior Care Network, 837 S. Fair Oaks Ave., Pasadena, conference room #1. For more information, call (626) 397-3110.

### Friday, April 17

**JPL Dance Club**—Meeting at noon in Building 300-217.

**Flamenco Dancing**—**La Tania** will appear at 8 p.m. in Caltech's Beckman Auditorium. Tickets are \$26, \$23 and \$20. For information, call (626) 395-4652.

**Von Kármán Lecture Series**—Division 32 outreach specialist **Marguerite Syvertson** will discuss the Earth Observing System (EOS), which will provide land, ocean and atmospheric data that will allow scientists to study and eventually model changes in the Earth's environment and climate. At 7 p.m. in The Forum at Pasadena City College, 1570 E. Colorado Blvd. Open to the public.

### Saturday, April 18

**Lula Washington Dance Theatre**—African American heritage will be explored in the troupe's **Muddy Waters**, a blend of African, jazz and modern dance. Reserved seats are \$20. For information, call (626) 395-4652.

### Sunday, April 19

**Chamber Music**—Quartet **Sine Nomine** will

appear at 8 p.m. in Caltech's Beckman Auditorium. Tickets are \$25, \$21, \$17 and \$13. For information, call (626) 395-4652.

**"Jazz and Jokes"**—The Caltech Jazz Bands will appear at the Ice House, 24 N. Mentor Ave., Pasadena, with two shows, starting at 7:30 p.m. Admission is \$8, with a two-drink minimum. The best joke of each set from either audience or band members will win a \$25 gift certificate to a local CD store. Call the Ice House at (626) 577-1894.

### Tuesday, April 21

**Eudora Quick Start Session for Technical Users**—This overview is for cc:Mail PC users who have not yet begun to use Eudora Pro. At noon in the Building 167 conference room. For other Eudora classes, see the ICIS home page at <http://icis.jpl.nasa.gov>.

**National Library Week**—Activities at the JPL Library will take place 11 a.m. to 1 p.m. and will include demonstrations of catalog, online and business-resource requests on Bibliographic and Electronic Access Connection (BEACON) World Wide Web resources (<http://beacon>), as well as tours of the recently renovated facility. For more information, contact the Library at ext. 4-4200 or e-mail [Library@jpl.nasa.gov](mailto:Library@jpl.nasa.gov)

### Wednesday, April 22

**Award for Excellence Ceremony**—To be held at 2 p.m. in von Kármán Auditorium. Seating will be limited, but the ceremony will also be aired live on JPL television monitors. For more information about the award and a list of recipients, visit the Reward and Recognition home page at <http://eis/sec614/reward/tr.htm>.

**Caltech/JPL Flying Club**—Member **Garrett Reisman** will speak on his experiences interviewing to be a NASA astronaut. The club provides airplanes for rent, insurance and club-approved instructors. Prospective members or simply the curious are welcome. A general membership meeting will be held at 7:30 p.m. on the Caltech campus in 269 Lauritsen. Included will be the club's election of its board of directors. For information, call **Peter Gluck** at ext. 4-9425.

**"Increasing Your Value as an Office Professional"**—This live satellite event, sponsored by the Director's Advisory Council for Women, will cover the American Management Association's 11th annual Conference for Secretaries. Topics will include practical ideas and detailed advice on developing communication skills; managing time, work and self; handling demands of multiple managers; and effectively using technology. From 10 a.m. to noon in

Building 180-101.

**JPL Atari Club**—Meeting at noon in Building 238-544.

**JPL Drama Club**—Meeting at noon in Building 301-127.

**JPL Toastmasters Club**—Meeting at 5:30 p.m. in the Building 167 conference room.

**National Library Week**—The JPL Library will dedicate its re-opening with a ribbon-cutting ceremony at 11:30 a.m., followed by speakers **Willis Chapman**, Division 64 manager; Deputy Director **Larry Dumas**; Business Operations Director **Daryal Gant**; and Library, Archives and Records Section Manager **Linda Kosmin**. Refreshments will follow.

### Thursday, April 23

**JPL Dance Club**—Clogging class will be held at noon in Building 300-217.

**The Future of UNIX at JPL**—Dr. **Steve Jenkins**, deputy manager of the Enterprise Information System, Section 175, will speak at noon in von Kármán Auditorium.

**National Library Week**—Activities at the JPL Library will take place 11 a.m. to 1 p.m. and will include demonstrations of catalog and online requests on Bibliographic and Electronic Access Connection (BEACON) World Wide Web resources (<http://beacon>); Cambridge scientific abstracts; and electronic journals, as well as tours of the recently renovated facility. For more information, contact the Library at ext. 4-4200 or e-mail [Library@jpl.nasa.gov](mailto:Library@jpl.nasa.gov)

**Social Security**—Agency representative **Ann Valleroy** will be on hand from 9 to 11 a.m. in the Building 167 cafeteria. Employees may make an appointment to file a Social Security claim; request a personal earnings and benefit estimate statement, information on Social Security benefits, a change of name or replacement of their Social Security card, or ask general questions.

### Friday, April 24

**JPL Dance Club**—Meeting at noon in Building 300-217.

### Fri., Apr. 24—Sat., Apr. 25

**Capitol Steps**—Current and former congressional staffers perform song parodies spoofing politicians and other newsmakers at 8 p.m. in Caltech's Beckman Auditorium. Tickets are \$32, \$29 and \$26. For informa-

tion, call (626) 395-4652.

### Sunday, April 26

**Chamber Music**—Winners of the Coleman Chamber Ensemble competition will perform at 3:30 p.m. in Caltech's Ramo Auditorium. Tickets are \$10. For information, call (626) 395-4652.

### Tuesday, April 28

**Develop New Products Seminar**—**Ted Kopf** of Section 344 will deliver a talk titled "Building Electronic Design Models: The Process and The Tools" at noon in Building 180-101.

**Eudora Quick Start Session for Business Users**—This overview is for cc:Mail PC users who have not yet begun to use Eudora Pro. At noon in the Building 167 conference room. For other Eudora classes, see the ICIS home page at <http://icis.jpl.nasa.gov>.

### Wednesday, April 29

**JPL Drama Club**—Meeting at noon in Building 301-127.

**JPL Golf Club**—Meeting at noon in Building 306-302.

### Thursday, April 30

**Fidelity Workshops**—*Investment Basics I*, which will focus on first-time investors and a refresher of investment choices, will be offered at 10 a.m. in Building 180-101. Those attending *Investment Basics II, Mapping Out a Plan for Your Retirement* will learn about the importance of saving early, and calculating how much to save each year. At 2 p.m. in Building 180-101.

**JPL Dance Club**—Clogging class will be held at noon in Building 300-217.

### Friday, May 1

**JPL Dance Club**—Meeting at noon in Building 300-217.

### Saturday, May 2

**Big Band Music**—The Big Band Alumni Orchestra will perform at 8 p.m. in Caltech's Beckman Auditorium. Tickets are \$32, \$29 and \$26. For information, call (626) 395-4652.

# Engineering, art come together in DS2 'spider'

By SUZANNE D'MELLO  
New Millennium Program  
outreach coordinator

In January 1999, Deep Space 2's twin probes will take off for Mars riding piggyback aboard the Mars Polar Lander spacecraft. The experimental mission is designed to test a number of advanced, miniature instruments and systems inside the probes to see if they can perform experiments beneath Martian soil after surviving crushing impacts on landing and extremely cold temperatures.

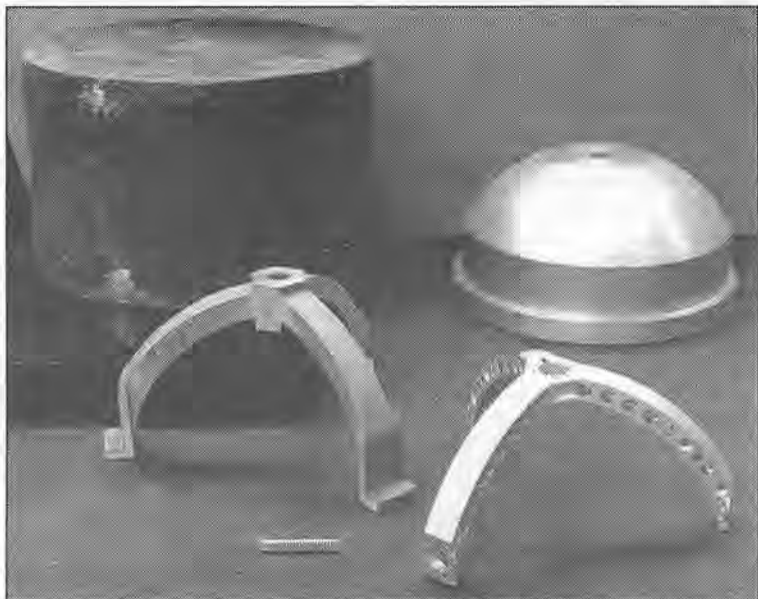
On their journey to the red planet, each probe will be housed in a protective shell that will be attached to the larger spacecraft with a device called a "spider," which is part of an overall attachment structure. The spider is so-called because its curved, three-legged frame resembles the body of that arthropod.

What is striking about this seemingly fragile piece of aluminum is that it's not only functional hardware—needing to withstand the extreme conditions of launch and travel into deep space—but with its spare, elegant, Art Deco-like form, is industrial design at its most beautiful.

Satish Krishnan, 23, who designed the spider, was just a few months out of college when assigned the task by DS2's mechanics lead engineer, Tom Rivellini, in late 1996. Rivellini provided Krishnan with an initial concept, which required that the egg-shaped shell be held on to at three, equidistant points.

With a preliminary design of a three-pronged structure in hand, Krishnan worked closely with Rivellini, structural analysts Darshan Sutharshana and Faz Keyvenfar, manufacturing engineer Bob Moncada, machinist Nelson Leiva, and DS2's graphics designer, Frank Ramirez, during the year it took to complete the part. "This had to be a collaboration from the very start," Krishnan pointed out. "The very nature of this part required it."

Heavily constrained by issues of cost and manufacturability while working concurrently in JPL's "faster, better, cheaper" era, he adapted his design several times on the advice of the others. The single most important question that Krishnan faced in creating the spider was whether to make it one part or three. "We knew that making the



The life cycle of the Deep Space 2 'spider' is shown above. Starting out as a 250-kilogram bar of aluminum, after several stages of development it was eventually shaped into its final shape at lower right. Spider designer Satish Krishnan, below, joins the Deep Space 2 microprobes with the spider onboard the Mars Polar Lander at Lockheed Martin Astronautics in Denver.



spider a single part would be very difficult," he said, "but assembly of three parts would have been a nightmare because of the tolerance mismatches we'd have to contend with—tolerance is the degree of precision required in a dimension. So we decided to bite the bullet and make it a single part."

"This is the toughest part I've ever worked on," admitted Moncada, who added, "The part wouldn't have been as rigid or strong if it had been three pieces, and this was the cleanest, easiest way to mount the shell

inside the spider."

Making the spider a single part was not that much easier a task, either. The finished spider, which weighs a mere 590 grams (1.3 pounds), had to be crafted out of a giant, 250-kilogram (550-pound) billet of aluminum.

Why such a large chunk? Detailed drawings hadn't yet been created when Krishnan decided to make the device a single part instead of three. Ordering a large billet of metal ensured that engineers would have plenty of material to work with once

Krishnan figured out the outer dimensions of the spider.

Leiva machined the spider into its final shape using the process of "undercutting" to hollow out the legs of the spider. Undercutting, a process invented by JPL engineer Don Bickler for the Mars Pathfinder mission, is an innovative way of hollowing out a piece of metal without having to cut it in two. Bickler used the process for the Sojourner rover's "rocker bogie" suspension system, which allowed the rover to negotiate the Martian terrain with its system of joints that rotated and conformed to the contour of the ground.

To drill holes in the precise locations that Krishnan had pinpointed in the legs of the spider, Leiva used a series of fine tools, knowing that if he was off by even an infinitesimal amount the part wouldn't be

functional. At one point he even had to contend with having the material move while he tried to machine it. After consulting with materials engineers the problem was solved, and Leiva completed the spider in October 1997.

The device has since successfully passed all its tests and Krishnan is very pleased with its design. "I think when you look at this part, what makes it interesting is the method we used to hollow it out," he said. "I don't think it would have actually looked as neat if we had used an alternative method."

Though Krishnan may be indebted to Bickler for the aesthetics of his design, he also has Leiva's extraordinary craftsmanship to thank for producing an industrial device that is a perfect blend of functionality and beauty. □

## Science team chosen for DS2 microprobe mission

Nine researchers have been selected to be the science team for the Mars Microprobes, also known as Deep Space 2 (DS2), a technology validation mission that will hitchhike to the red planet aboard JPL's 1998 Mars Polar Lander.

Two identical probes will be carried as a secondary payload on the lander, due for launch in January 1999. Following an 11-month cruise, the microprobes will separate from the lander before it enters the Martian atmosphere, and then hit the ground at approximately 645 kilometers per hour (400 mph).

During the impact, each microprobe will separate into two sections: the forebody and its instruments will penetrate up to six feet (two meters) below the surface, while the aftbody will remain near the surface to communicate with a radio relay on the Mars Global Surveyor orbiter while making meteorological measurements.

The nine selected scientists are David Catling, NASA Ames Research Center, Moffett Field, Calif.; Ralph Lorenz, University of Arizona; Julio Magalhaes, NASA Ames; Jeffrey Moersch, NASA Ames; Paul Morgan, Northern Arizona University, Flagstaff; James Murphy, NASA Ames; Bruce Murray, Caltech; Marsha Presley, Arizona State University; and Aaron Zent, NASA Ames.

The scientific objectives of the Mars Microprobes include searching for the presence of water ice in the soil and characterizing its thermal and physical properties. A small drill will bring a soil sample inside the probe, heat it, and look for the presence of water vapor using a tunable diode laser. An impact accelerometer will measure the rate at which the probes come to rest, giving an indication of the hardness of the soil and any layers present. Temperature sensors will estimate how well the Martian soil conducts heat, a property sensitive to different soil properties such as grain size and water content. A sensor at the sur-

See DS2, page 4

## Apple Valley

Continued from page 1

database. Together, we're watching how Jupiter changes over weeks, months and years, and a new program is designed to search for day-to-day changes."

Eventually, the students' results will be published in scientific journals.

Klein said development of a variety of curriculum elements is planned. The next project will map the sun and compare the radio maps with optical and ultraviolet observatory measurements.

The science center and its curriculum are about far more than astronomy, however.

"The mission to Jupiter idea really opens the door to students' curiosity," Klein noted. "Soon they start talking about scenarios: 'Well, if you're going to send a ship with people in it, you'll have to send food—maybe you'll have hydroponic gardening.' Then they get into issues like radiation protection."

"These young people come up with practical questions that—in their minds—need to get answered. It isn't just an astronomy course. It really does broaden out subject matter to include biology, math, physics and chemistry. They also discover that to do science, you have to write. It isn't just math and numbers; you have to learn how to communicate with others."

Another part of the students' real-world experience involving communication includes learning about proposal writing. In a pilot program last fall, a high school served as a project's "prime contractor," teaming with two middle schools who were "subcontractors." The middle school students came up with problem-solving

ideas that were "peer-reviewed" by the high schoolers.

"If this were just a radio astronomy experiment, it would be rather limiting," Klein said. "The kids get excited as they watch the data come in, take things off the screen and enter them on a spreadsheet; the next day they get the official spreadsheet that comes off our data log. They can look for things like noisy data, bad measurements because of interference—learning the practical aspects of what it's like to get data."

Klein echoed a remark by Goldin that whether the students at the center may become scientists or engineers is not the issue; rather, that understanding the functions and roles of science and technology are essential for all citizens in the future.

"I would be thrilled if every kid in a class will learn that science is a process, not a set of facts to memorize," he said, "and that they have some understanding of what the scientific method is and how we learn about nature."

"We're not trying to clone scientists," he added. "One of the things I've consistently had to make people aware of is this is definitely not a sandbox for the honors kids."

It's possible that hundreds of schools nationwide could participate in running the radio telescope experiments, with telescope time being a limitation. However, thousands more could still be a part of the program by using the curriculum if unable to do the actual observations.

Community colleges and universities may also participate, but must first agree to partner with a high school, Klein said.

Within a couple of years, he added, the curriculum currently developed for middle school and high school students will be adapted to accommodate students from kindergarten to 12th grade.

JPL, with assistance from AlliedSignal person-

nel at Goldstone, will continue to develop the capability of the radio telescope, maintain it and keep it functioning. Because the telescope is remotely operated, all software can be developed at JPL and run through mission control at Apple Valley to operate the radio telescope at Goldstone.

The teachers who have so far participated are considered the program's developers, rather than users. They spend a week at the center, including one day at Goldstone. "They become part of the project and work with us throughout the year," Klein said. "We hope they will stay with the project into the future."

Ten schools—from California (including South Pasadena Middle School), Alabama, Idaho, Kentucky and Michigan—are part of the core group, and more will be added in the fall.

"Eventually we'll have the curriculum robust enough to where we can accommodate users who don't have to go through this training and development process," Klein said.

The original Science and Technology Center, built nearly 10 years ago, has been expanded to



STUDIO WEST PHOTOGRAPHY

Redlands High School students Whitney Price, left, and Nillie Alemozaffar demonstrate mission control operations to guests at the dedication of the Lewis Center for Educational Research. Standing, from left, are NASA Administrator Daniel Goldin; Gayle Wilson, wife of California Gov. Pete Wilson; Rep. Jerry Lewis; and JPL Telecommunications and Mission Operations Director Gael Squibb.

support a charter school (K-12) and to house an observatory, Air Force jet flight simulator, computer center, weather station and related hands-on learning tools for students, which includes mission control for the GAVRT radio telescope. The new center hopes to draw far more than the 80,000 students and teachers from across the nation who have visited since 1989.

It is now staffed by a small professional staff and about 600 volunteers.

Contributions from NASA and corporate sponsors supported the development of a digital TV studio, amateur radio station and control room, which will allow students to produce and broadcast educational programs to more than 35,000 homes. □

