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LOOKING FORWARD

Galileo helped kick off JPL's new year last week with a close flyby of icy Europa before moving on to observe several other Jupiter moons.

Next up for the Lab is the launch of the Shuttle Radar Topography Mission (SRTM), set for liftoff onboard Space Shuttle Endeavour no earlier than Jan. 30.

Other key JPL milestones this year: Mars Global Surveyor's continued observations at Mars; the first phase of Stardust's interstellar dust collection March through May; the Space Research Technology Vehicle-2's launch in April; Jason-1's launch in October; Cassini's flyby of Jupiter and the launch of the Atmospheric Infrared Sounder (AIRS) on the Aqua spacecraft in December.

This issue of Universe features brief highlights of some of the Laboratory's other near-term and future projects on pages 1 and 2, as well as a chronological look back at 1999 on page 3.

Asteroid, comet observations coming up

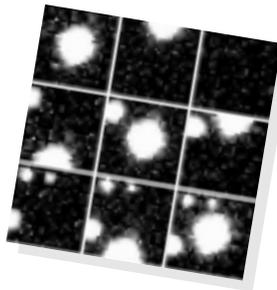
Dramatic advances in near-Earth asteroid discovery are envisioned for the Near-Earth Asteroid Tracking (NEAT)

program in 2000. The NEAT team will play a key role in helping NASA's Near-Earth Asteroid Program's fulfill its goal of discovering more than 90 percent of the near-Earth asteroids larger than 1 kilometer in the next 10 years.

— ELEANOR HELIN, NEAT principal investigator

I'm looking forward to Valentine's Day 2000, when the NEAR spacecraft goes into a year-long orbit about asteroid Eros. This detailed and close look at an asteroid is the first of four encounters with asteroids—and seven encounters with comets—in the next 11 years (NEAR, Stardust, DS1, Contour, Deep Impact, MUSES-C, and Rosetta). The year 2000 will truly usher in the golden age of asteroid and comet exploration.

— DR. DONALD YEOMANS, supervisor, Solar System Dynamics Group



Asteroid Kytheria was imaged by JPL astronomers last June following computerized electronic upgrades to the 1.2-meter-diameter (48-inch) Oschin telescope atop Palomar Mountain near San Diego.

Technology efforts to reach new levels

Looking forward to 2000, I see the JPL technology community engaged in more competitive NASA Research Announcement activities and increased interaction with various Department of Defense agencies. The community is beautifully placed to leverage both NASA and other agency technology efforts.

There will be ever-increasing efforts to tie the technologists and the mission development communities together. The technologies associated with how we do our missions will also be receiving more attention. It's a very exciting time.

— MIKE SANDER, Technology and Applications Programs director



The new In-Situ Instrument Laboratory, now under construction just east of Building 303 (below right), is due for completion later this year. The new Laboratory for In-Situ Microbiology (below left) will be built to its east.

The miniaturization of electronic tools down to submicron dimensions is now permitting the analysis and manipulation of objects at the molecular level, initiating an unprecedented opportunity to combine the efficiency

and versatility of biological systems with the power of electronics. The quantum atomic, nanolithographic and biomolecular capabilities developed and planned for the Frequency Standards Lab, the Microdevices Lab, and the new In-Situ Instrument Laboratory and Laboratory for In-Situ Microbiology facilities, coupled with our strengths in information technology, place JPL in a position to lead NASA into this exciting new era.

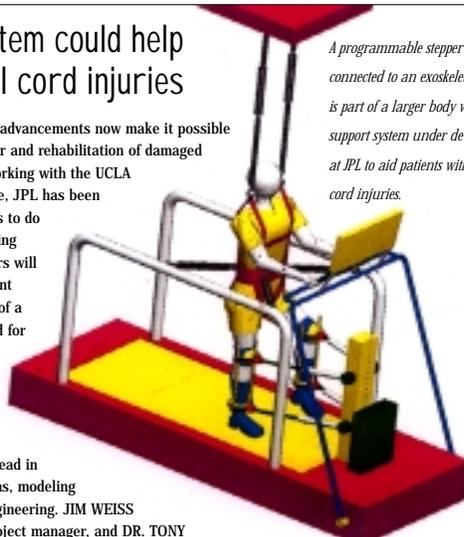
— DR. BARBARA WILSON, JPL chief technologist and program manager for the Center for Space Microelectronics Technology

Robotic system could help rehab spinal cord injuries

Recent technological advancements now make it possible to think about the repair and rehabilitation of damaged human spinal cords. Working with the UCLA Brain Research Institute, JPL has been actively pursuing efforts to do just that. FY 2000 funding from NASA Headquarters will assist in the development and commercialization of a robotic-system designed for locomotion rehabilitation of patients with spinal cord injuries and stroke-related paralysis.

JPL will provide the lead in robotics, control systems, modeling and overall systems engineering. JIM WEISS of Division 32 is the project manager, and DR. TONY BEJZCY of Section 345 is chief roboticist.

"We will design and develop the prototype system and they will test it on their patients in the Neural Rehabilitation Research Laboratory at the UCLA Medical School," Weiss said. "We will work very closely with them during the human testing to ensure compliance and effectiveness."



A programmable stepper device connected to an exoskeleton leg is part of a larger body weight support system under development at JPL to aid patients with spinal cord injuries.

Future Quest

Lab looks beyond 2000

In the next decade, JPL will be leading the way in establishing permanent robotic presence on Mars and across the solar system, interconnecting all our spacecraft via a planetary Internet accessible to all humankind, bringing samples from across the solar system, surveying our stellar neighborhood for planetary systems and possible life, and reaching a better understanding of our planet.

We will be bringing the heavens to Earth, literally and figuratively. Our challenge is how to make this affordable and engage the whole nation in this quest of the next century.

—DR. CHARLES ELACHI,
Space and Earth Science
Programs director

Over the next decade, if all goes according to plan, JPL will launch up to five missions to Mars culminating in attempts to return samples to Earth. Samples from other worlds will also be collected for return to Earth with Genesis (solar wind) and Stardust (comet). Other solar system goals include the Muses-CN rover's encounter with an asteroid in 2003. The next year, Cassini's mission at Saturn will begin, Deep Impact's flyby and impact with a comet will take place, and The Pluto-Kuiper Express will launch for a visit to Pluto near the end of the decade. Origins Program missions include the Space Infrared Telescope Facility (SIRTF), launching in December 2001, and Space Technology 3, to be launched in 2005 to demonstrate interferometry in space.

New Earth missions during the decade include the Gravity Recovery and Climate Experiment (GRACE), set to launch in June 2001; Light-SAR, a radar satellite launching in November 2002 to provide all-weather, day-night measurements of most locations on Earth about once each day; and CloudSat, which will study the role that thick clouds play in affecting climate changes, scheduled to launch in 2003. Described below are a few examples of other long-term projects coming up for JPL in the years to come.

A 'feeling' for remote surgery

Medical professionals may soon have a "feeling" for performing virtual or remote surgical procedures thanks to research performed in Section 354.

DR. YOSEPH BAR-COHEN, group leader, Nondestructive Evaluation and Advanced Actuators, heads JPL's team developing haptic interfacing—operating virtual or real robots via interface that mimics remote conditions. The "CyberGlove" is expected to benefit medical training and therapy, enabling effective minimally invasive virtual or remote surgical procedures for both planetary (space shuttle, international space station, and human exploration of Mars and other planets) at various gravity levels and terrestrially.

The interface technology, called Remote MEchanical Mirroring using Controlled stiffness and Actuators (MEMICA), is being explored jointly with Rutgers University and UCLA.

The system will establish an effective medical education tool, support in-space sharpening of professional skill, allow practicing existing and downloaded new procedures in space, and enable remote urgent care. The developed CyberGlove will be designed to have a high dexterity, rapid response, and large workspace to allow intuitive mirroring of conditions at a virtual representation of a remotely controlled robot, making it a human surrogate.



Simulation shows a surgeon (top) using virtual-reality goggles and "CyberGloves" (middle) to "feel" surgery on a remotely controlled robot, (bottom) a human surrogate.

Planetary protection to be a key

As JPL missions venture into and onto planetary atmospheres and surfaces, the Planetary Protection Technologies Group will be called on to support projects in all mission phases from design to close-out.

Planetary protection refers to the biological safeguards we use to maintain extraterrestrial bodies as biological preserves for scientific investigations, and protects the Earth and Moon from possible contamination by extraterrestrial material collected and returned by our projects.



Technicians perform biological sampling of the Deep Space 2 airbody. Faster, more sensitive methods are under development to detect viable microbes that are not found by culture techniques.

Our challenge will be to develop or find the technologies and processes that will make compliance with planetary protection policy routine and affordable for flight projects.

What's so exciting now is that NASA's search for life in the solar system is not a plan for the distant future—it is our plan for the decade we are entering!

—DR. KAREN BUXBAUM,
supervisor, Planetary Protection
Technologies Group

Correction: The Dec. 15 issue of Universe included an error regarding the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) onboard the Terra Earth-orbiting spacecraft launched last month. ASTER is a Japanese instrument; JPL's role on the experiment is to provide the leadership for the U.S. science team and the associated science data processing and analysis. Dr. Anne Kahle of JPL is the U.S. ASTER science team leader, and JPL's Moshe Priel is the ASTER science project manager.

Special Events Calendar

Ongoing

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

Codependents Anonymous—Meeting at noon every Wednesday. 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. Call employee assistance counselor Cynthia Cooper at ext. 4-3680 or Randy Herrera at ext. 3-0664.

Parent Support Group—Meets the fourth Tuesday of the month at noon. For location, call Jayne Dutra at ext. 4-6948.

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. Call (626) 397-3110.

Saturday, January 8

Folk Music—Bluegrass Etc. will appear at 8 p.m. in Caltech's Dabney Lounge. Tickets are \$12. Call (626) 395-4652.

Sunday, January 9

Chamber Music—South American harpist Alfredo Rolando Ortiz will perform at 3:30 p.m. in Caltech's Dabney Lounge. Admission is free. Call (626) 395-4652.

Monday, January 10

Caltech Ballroom Dance Club—Beginning American Tango will be taught at 7:30 p.m. in Winnett Lounge. Cost: \$30. Call (626) 791-3103.

Tuesday, January 11

ICIS Talk—DJ Byrne of Section 366 will discuss the growth of information technology and will include examples of some of the challenging ways JPL makes it work. At noon in von Kármán Auditorium.

Wednesday, January 12

Caltech Ballroom Dance Club—Intermediate international Cha Cha will

be taught at 7:30 p.m. in Winnett Lounge. Cost: \$1 per lesson. Call (626) 791-3103.

"What Happened in Aeronautics After the Wright Brothers?"—This Caltech lecture will be held at 8 p.m. in Beckman Auditorium. Free admission. Call (626) 395-4652.

Saturday, January 15

Modern Jazz at Caltech—The Gerald Wilson Orchestra will appear at 8 p.m. in Beckman Auditorium. Tickets are \$25, \$21 and \$17. Call (626) 395-4652.

Monday, January 17

Caltech Ballroom Dance Club—Beginning American Tango will be taught at 7:30 p.m. in Winnett Lounge. Cost: \$30. Call (626) 791-3103.

Tuesday, January 18

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

Wednesday, January 19

Caltech Ballroom Dance Club—Intermediate international Cha Cha will be taught at 7:30 p.m. in Winnett Lounge. Cost: \$1 per lesson. Call (626) 791-3103.

Wed., Jan. 19–Thu., Jan. 20

Investment Advice—A TIAA-CREF representative will be available for individual investment and retirement counseling. For an appointment, call (800) 842-2007, ext. 1045.

Thursday, January 20

JPL Astronomy Club—Meeting at noon in Building 306-109.

Von Kármán Lecture Series—Dr. Don Yeomans, supervisor of the Solar System Dynamics Group and manager of the Near Earth Objects Program Office, will speak at 7 p.m. in von Kármán Auditorium. Open to the public.

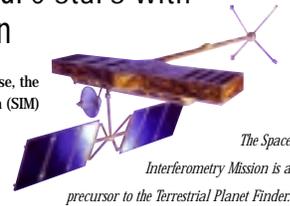
Friday, January 21

Von Kármán Lecture Series—Dr. Don Yeomans, supervisor of the Solar System Dynamics Group and manager of the Near Earth Objects Program Office, will speak at 7 p.m. in The Forum at Pasadena City College, 1570 E. Colorado Blvd. Open to the public.

SIM will measure stars with peak precision

Now in its formulation phase, the Space Interferometry Mission (SIM) will perform precision stellar mapping following its launch in summer 2006. It will measure the position of stars to an accuracy of 4 micro-arcseconds on the sky (an arcsecond is 1/3,600th of a degree; a micro-arcsecond is one millionth of an arcsecond). This requires the ability to measure positions of optical elements within the SIM spacecraft's 10-meter-long interferometer (using lasers) to accuracies of 1/10 the diameter of a hydrogen atom.

In addition to being a stand-alone astrophysics mission, said



The Space Interferometry Mission is a precursor to the Terrestrial Planet Finder.

Deputy Project Manager DR. JIM MARR, SIM will also serve as one of the two technology precursors to the Terrestrial Planet Finder mission, which will launch in the second decade of the new millennium with the goal of directly detecting Earth-like planets and spectroscopically testing them for signatures of life.

JANUARY

Mars Polar Lander launched Jan. 3 from Kennedy Space Center ... Images gathered by the JPL-built Airborne Visible/Infrared Imaging Spectrometer (AVIRIS) onboard a National Oceanic and Atmospheric Administration airplane helped scientists studying the aftermath of Hurricane Georges on coastal areas in Louisiana understand where sand moved and how vegetation was impacted by salt water on two coastal barrier islands.

FEBRUARY

Stardust, which will gather particles from the nucleus of comet Wild-2 in early 2004, was launched Feb. 7 from Kennedy Space Center. The first U.S. mission to a comet, Stardust will also attempt to gather samples from a stream of interstellar dust. ... Mars Global Surveyor successfully completed aerobraking to raise its orbit completely out of the Martian atmosphere, preparing it to begin its primary mapping mission in March. ... Galileo detected a thin carbon dioxide atmosphere on Jupiter's moon Callisto. ... Astronomers using the Near Earth Asteroid Tracking (NEAT) system to search for asteroids headed toward Earth stumbled upon a fascinating discovery—an exploding star, also known as a supernova—located in a galaxy about 650 million light-years away. The star was unknown to astronomers until it was captured by the NEAT camera.



(1)

MARCH

Mars Global Surveyor began its prime mapping mission. ... JPL's TOPEX/Poseidon ocean topography satellite, which has produced the accurate prediction of the globally destructive El Niño phenomenon, switched to a backup altimeter that could extend its mission for months or years to come. The satellite, launched in 1992, was originally designed to last three to five years. ... JPL and NASA began investigations to determine the causes leading to the loss of the Wide-Field Infrared Explorer (WIRE), which launched March 4 from Vandenberg Air Force Base on a quest to explore the history of star formation. Shortly after launch, the spacecraft's supply of frozen hydrogen—needed to cool its cryogenically cooled infrared telescope—was released into space, ending the scientific mission. A NASA board later found that the mission failed because an incorrectly designed electronics box prematurely fired explosive devices, causing early ejection of the telescope cover. ... Galileo scientists announced the discovery of hydrogen peroxide on the icy surface of Jupiter's moon Europa.



(2)

APRIL

JPL was selected to manage CloudSat, an Earth-orbiting radar that will focus on understanding the role that thick clouds play in affecting climate changes. JPL will provide mission management and payload development for the satellite, scheduled to launch in 2003. It is funded under NASA's Earth System Science Pathfinder Program. ... JPL received recommendations from auditors for ISO 9001 certification, culminating a two-year effort of preparation to adhere to the process-documentation standard. ... Utilizing dry lake beds in the Mojave Desert to field-test future Mars rovers, scientists demonstrated the Field Integrated Design and Operations (FIDO) rover, which contains a mini-corer to drill rock samples, a microscopic camera and other advanced technologies.

MAY

A newly installed software patch helped Galileo complete its May 5 flyby of Callisto. ... Scientists using Mars Global Surveyor's magnetometer discovered banded patterns of magnetic fields on Mars, providing further evidence of past movement of the Martian crust. ... Deep Space 1's Remote Agent, the software operating the spacecraft and its ion engine, completed five days of successful testing, accomplishing all of its planned objectives.

JUNE

The QuikScat ocean-observing satellite, carrying JPL's SeaWinds scatterometer, was launched June 19 from Vandenberg Air Force Base. QuikScat will

be NASA's next "El Niño watcher," providing daily, detailed snapshots of ocean winds worldwide and greatly improving weather forecasting. ... A record 55,000 people attended JPL's annual open house June 5 and 6. ... Cassini successfully completed its second flyby of Venus June 24.

JULY

JPL was selected to lead the Deep Impact mission, which would crash a 500-kilogram projectile into a comet, as part of NASA's Discovery Program. ... NASA canceled the Space Technology-4/Champion Project, a mission to flight-validate advanced technologies that included landing on the nucleus of a comet. ... JPL's Dr. Lonnie Lane and Lloyd French tested a deep-sea probe in the Monterey Bay Aquarium, a precursor to later tests of a prototype probe designed to withstand the crushing pressures and extreme temperatures of a deep-space environment. ... Deep Space 1 successfully flew 26 kilometers (16 miles) above asteroid Braille using



(3)

NOVEMBER

NASA's mission failure investigation board revealed its findings on the loss of Mars Climate Orbiter. In response, JPL pledged to make corrective actions in areas such



(4)

as navigation, systems engineering, peer review and mission safety. ... Galileo observed a fiery lava fountain shooting more than a mile above the surface of Jupiter's moon Io during a close flyby on Thanksgiving night, Nov. 25. The erupting lava was so hot and



(5)

its AutoNav autopilot system.

It was by far the closest flyby of an asteroid ever attempted. ... JPL announced the formation of a commercial advisory council that will advise the Laboratory on ways that its research and technology development can be of maximum value to U.S. business and industry.

AUGUST

The SeaWinds radar instrument onboard QuikScat imaged Hurricane Dora and its wind speeds of up to 90 mph, as well as Typhoon Olga as it unleashed torrential rains in Asia. The instrument also tracked the path of a large iceberg near Antarctica that obstructed South American shipping lanes. ... Cassini flew within 1,171 kilometers (727 miles) of Earth to give it a boost of 5.5 kilometers per second (12,000 mph) on its way to Saturn. The spacecraft's imaging science subsystem also took new images and brief movies of Earth's moon during the swingby.

... The largest near-Earth asteroid ever studied in detail, 1999 JM8, was observed by astronomers using the Goldstone Solar System Radar in California and Aricebo Observatory in Puerto Rico.

SEPTEMBER

Mars Climate Orbiter was lost Sept. 23 when no radio signal was detected from the spacecraft following its engine burn to enter orbit around the planet. Analysis showed that the orbiter apparently passed much closer to Mars than planned—within 57 kilometers (35 miles) instead of about 140 kilometers (87 miles). ... The Lab dedicated its new Educator Resource Center and Applied Technology Classroom in Pomona.

OCTOBER

Faced with the intense radiation near Io, Galileo team members corrected a computer memory error discovered just as the spacecraft was to execute the

closest-ever flyby of the volcanic moon Oct. 10. Images taken during that flyby revealed a lava field near the center of an erupting volcano, as well as a volcanic crater several times larger than one found at Hawaii's Kilauea volcano. ... Galileo scientists announced the discovery of sulfuric acid on the frozen surface of the icy moon Europa. ... Lower-than-normal sea surface heights in the Pacific Ocean were observed by TOPEX/Poseidon, indicating a likely repeat of the mild La Niña conditions experienced last winter.

bright, it over-exposed part of the camera picture and left a bright blur in the middle.

DECEMBER

No signal was received from Mars Polar Lander following its expected landing Dec. 3, and repeated efforts to communicate with the spacecraft and the Deep Space 2 microprobes were met with silence. ... JPL appointed a review board to determine the possible root causes of the apparent loss of Polar Lander and Deep Space 2 and identify actions needed to assure success in future Mars landings. The board's findings will be presented in a written report due by March 3, 2000. ... The Earth-observing Terra satellite was launched Dec. 18 from Vandenberg Air Force Base, carrying JPL's Multi-angle Imaging Spectro-Radiometer (MISR), which will study how changes in the amounts, types, and distribution of clouds, airborne particulates, and surface covers can affect our climate; and the

Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER), a Japanese

experiment that will produce detailed global, regional and local image

maps of land surface temperature, reflectance and elevation and other characteristics. ... The Active Cavity Radiometer Irradiance Monitor (AcrimSat)—a satellite designed to measure the total amount of sunlight falling on Earth's atmosphere, oceans and land, and improve predictions of long-term climate change—lifted off Dec. 20 from Vandenberg. Its five-year science mission is to monitor incoming solar radiation and help scientists determine whether an increase in sunlight is contributing to a rise in global temperatures.

- (1) Mars Global Surveyor's camera imaged the "Happy Face Crater" on the first day of its mapping mission, March 8.
 (2) The CloudSat spacecraft. JPL will manage the mission, set to launch in 2003.
 (3) FIDO team members test the experimental rover in the Mojave Desert in April.
 (4) QuikScat, with JPL's SeaWinds scatterometer onboard, launched June 19. It would soon track a U.S. hurricane, an Asian typhoon and a huge iceberg in the South Pacific.
 (5) Lava is shown spewing above the surface of Jupiter's moon Io in this Galileo image taken on Thanksgiving Day. The active lava was hot enough to cause "bleeding" in Galileo's camera. This shows up as a white blur in the image.

1999 in REVIEW



NOVA Awards

The following employees were awarded JPL's Notable Organizational Value-Added awards (NOVAs) in November:

Section 221: Weston Hall, Deanna Sherry, Pat Wielekew.

Section 311: Juan Ayon, Robert Barrett, Tom Clymer, Don Ebbeler, Janis Graham, Cate Heneghan, Allen Kanner, Tom Pastorius, Tamara Roust, Kevin Roust, Brian Rush, George Sprague, Paul Vandamme, Mark Vincent, Richard Wallace.

Section 312: Carl Sauer.

Section 354: Stephen Brown, Ben Dolgin.

Section 368: Stephen Hillbrand, Herlen Reed Jr., Robert Springfield, John Tullius.

Section 369: Angela Esser.

Section 389: Jayne Dutra.

Section 660: Patricia Reed.

Section 950: Valerie Pickett.

The following contractors also were awarded NOVAs as members of JPL teams: Valerie Danah Anderson, James Brison III, Nancy Edwards.

The following employees received NOVAs in December:

Section 312: Gene Bonfiglio, Dennis Byrnes, Louis D'Amario, Paul Fin-

layson, Steve Flanagan, Joe Guinn, Jennie Johamessen.

Section 336: Ferne Griffin, William Hatch.

Section 349: Kathleen Sowles.

Section 336: Joyce Donato, Mark Zawadzki.

Section 388: David Hodges, Thomas

Huang, Paul Johnston, Elizabeth Kay-Im, Michael Mueller, Thuy Nguyen, Stephen Noland, Rajesh Patel, Costin Radulesc, Allan Runkle Carol Stanley.

The following contractors also were awarded NOVAs as members of JPL teams:

Andrew Heaton, James Longuski, Nathan Strange.

Award for Excellence nominations sought

Nominations from business/administrative organizations (IX, 19X, 2X, and 6X) are sought for the Award for Excellence, which gives employees at any level of the organization a chance to nominate other JPL employees whose accomplishments are outstanding. Accomplishments must have oc-

curred between Dec. 1, 1998 and Dec. 10, 1999. Nominations will be accepted Jan. 3-21 and are due to mail stop 291-208 by Friday, Jan. 21.

For program requirements and the nomination form, visit the Award for Excellence home page at <http://eis/Sec614/reward/excel.htm>.

Retirees

The following employees retired in December: Michiko Iwamoto, 36 years, Section 222; Steven Zawacki, 28 years, Section 314.

Letters

We would like to thank the ERC for the beautiful flowers and all our JPL friends for their kind support during the difficult period following the death of our son Kris.

Paul and Sandy Swanson

It was deeply comforting to receive the thoughtful expressions of sympathy extended by my JPL co-workers and friends during my father's recent hospitalization and after his passing. I would like to express my appreciation and gratitude for the support and understanding you gave so freely during this difficult time. Thank you also for the beautiful plant from the ERC.

Ellie Trevarthen

I would like to express my heartfelt thanks for the going-away lunch and gift given for me by the various people I supported in Section 335. It was a warm, generous gesture given by warm, generous people. An extra-special thanks to Katrina Melendez for arranging this gathering. It was beautifully organized and a splendid time was had by all. I miss you all already.

Stephanie Cowans

I want to thank all those at JPL for their continued support over the past year since Barry's death. With all my family on the East Coast, you have been an important part in our mental and emotional health as we have rebuilt our lives. With our deepest gratitude we wish all our friends a wonderful holiday season.

Tonja (Harris), Rachael, Kevin and Samuel Cooper

Passings

JIMMIE ALLBAUGH, 74, a retired member of the technical staff in Section 374, died of heart failure Nov. 20.

Allbaugh worked at JPL from 1985-90. He is survived by his wife, Elizabeth; son Jay; daughter Lisa Anderson and five grandchildren. Services were private.

KENTON MACDAVID, a retired senior engineering associate from Section 351, died Dec. 2.

MacDavid worked on Caltech's Eaton Canyon Rocket Weapon Project in the early 1940s, then worked at JPL from 1946-86. He is survived by his wife, Dotty; sons Daniel and Michael; and four grandchildren.

Services were held Dec. 7 at Mountain View Cemetery in Altadena.

Classifieds

For Sale

AIR CONDITIONER, WINDOW, GE, 10,000 BTU, powerful, perf. for rms up to 20x20, purchased new in '97, \$240, 626/796-1681, John. AIRLINE TICKETS, 2 round trip to Seoul, Korea or Tokyo, Japan; trip must be completed

by May 14, 2000. \$1,100/obo. 626/794-3048. CAMERA BODY, Nikon N6060 autofocus, like-new cond., \$250, case \$25, 626/796-5216. CEILING FAN, 3 spd., w/4 spot lights, provides dramatic area lighting, \$45, 626/796-1681, John. CLOTHING, women's: North Face down jacket w/hood, blue, lg.; wool cashmere black coat, sz. 14; wool gray long dress coat, sz. 16, 248-8636.

COMPUTER, Mac Performa 6400, 180 MHz PPC, OS 8.5, 56 MB, 1.5 GB HD, CD-ROM, diskette, 28.8 fax modem, Apple 13-in. color monitor, \$300, 626/797-6121.

COMPUTER, Mac Powerbook 145B laptop w/printer & case, \$200/obo, 790-0264. DINING ROOM SET, table, china cabinet, buffet cabinet, 8 cane-back chairs; all solid walnut in gd. shape, \$1,600/obo, 243-4340 #1.

DODGER TICKETS, 4 season seats behind 3rd base, Loge, Sectn. 143, Row H; sell at face value, \$22/seat; choice of games, pick bet. 4 and 20 games in 2000, 790-5902.

FISH TANK & STAND, 60 gal., 48" x 15" x 17"; includes Tetra full pump, fluorescent light & bulb, heater, gravel siphon, under gravel filter w/airline & air stones, plants, rocks, & shipwreck; algae pads for cleaning, fish net, water cond. for chlorine, extra air pump that needs new diaphragm; \$100 firm, 626/287-4449. FURNITURE: armoire, dark oak, beveled glass mirror, -75 yrs. old; antique oak chest, 2 drawers, 2 doors, 248-8636.

FURNITURE: beautiful set; couch, loveseat, chair, 4 back pillows, 4 seat pillows; highest qual. fabric, predom. gold w/flower pattern, less than a yr. old, like new, \$800, 562/402-4870. MISC.: all new, Belkin 4 to 1 (or 1-4) peripheral sharing device, w/gold IEEE cable (\$49, orig. \$99); Sony remote (for big screen, satellite, DVD, VCR, \$19, orig. \$60); 'All for One' universal remote, \$17, orig. \$46.66 IDE dual cable (\$12, orig. \$22); 33.3 laptop modem card, w/ cable (\$10); Onkyo Delux Pro Logic surround/sound receiver w/5 CD carousel player/speakers (\$399, 366-6134.

MISC.: Olympus Stylus 35mm S50, Singer Seregr (14110) \$200, microwave \$75, answer mach \$10, iron gate \$10, pasta maker \$10, 661/291-4442.

MOUNTAIN BIKE, specialized stunt-jumper, barely used, \$1,200, complete for \$600; beautiful oak glider/rocker w/matching footstool, blue, like new, \$350, 626/359-8840.

SNOW BOOTS, women's size 8, tan color, only used once, \$25, 714/903-8886.

SPEAKERS, Bose Acousticsystem (5), \$300, Bose VCS-10 tr. speaker, \$100, 661/255-5645.

STROLLER, Graco full-size, navy blue, like-new cond., used 2 mo., \$60 (new \$120), 626/791-6107.

SWAG for Christmas, beautiful, 3 ft. long, red ribbons, white flowers w/gold trim, adorned w/golden apples; hand-made, new, \$35, 626/573-6564, Mary, after 6 p.m.

TABLE INSERTS, (coffee & end table), leaded glass, 20"x24" w/14"x18" beveled glass, \$10/ea, 626/303-1927.

TENNIS SHOES, brand new, men's size 10, five styles, \$20/ea, 626/791-3329.

VIDEO GAMES, Nintendo 64 syst. w/2 controllers, \$150; KEYBOARD, Yamaha PSR-79, \$75; both in exc. cond. 909/953-2099.

VIDEOTAPE of orig. Disney Fantasia, unopened, \$40, 626/797-3310.

WASHER/DRYER, GE super capacity washer, used 2 yrs., \$200 (new \$380); GE extra-lg. gas dryer, 1 yr. old, \$200 (new \$350); both like new, 626/791-6107.

WINDOWS, Milgard double pane, 6 x 4 xox, \$175; 4 windows, all bronze, 34 1/2 x 38 1/2, 78 x 36, 31 x 38 1/2, 75 1/2 x 54, \$80, 957-4770.

Vehicles / Accessories

'95 ACURA Legend LS coupe, 2d, black, auto, 104,000 mi., mint cond., leather, sunroof, heated seats, alloy wheels, CD changer, remote keyless entry, \$17,000/obo, 626/584-3204, day, 909/592-0780 eve.

'84 BMW, red, runs very well, looks good, \$3,500/obo, 626/285-3514, Pam.

'94 CHEVY Astro LT mini van, pwr, everything, class 3 hitch, running boards, roof rack, 4 captains seats + 1 bench seat, CD player, super cond. inside and out, 90K miles; \$12,000/obo, 952-3113, Jeff.

'92 CHEVY S10 pickup 2.5L auto, a/c, cass/radio, only 65K orig. mi., 1 owner, vg cond., compl. maintenance records, \$3,000/obo, 626/443-9774.

'89 CHEVROLET 2500 Silverado pickup, 5.7L EFI V8, HD suspension, AC, AM/FM/cass, cruise control, pwr windows/locks, Snugtop bed cover, tow hitch, 78k mi., exc. mech., needs paint, \$6,500, 626/794-3358.

'95 DODGE Ram 1500 longbed, reg. cab, a/c, pwr/ds, tilt whl., c/c towing pkg., very clean, runs great, extended warranty until 800, 58,100 mi., \$12,500/obo, 352-2337.

'81 FIAT Spider 2000, black/tan, fuel injection, body/engine/tires in great shape, smog checked, \$2,800, 323/225-1732.

'98 FORD Expedition XL 12K mi., 2WD, tan cloth int., dk green, exterior, 3rd seat, CD/am/fm/cass., tow pkg., roof rack, full pwr./auto 4.6 eng., 2-yr factory warr., exc. cond. 249-2403.

'93 GEO PRISM LSI, very clean, metallic black, slick shift, sun roof rack, 84,300 mi., orig. owner, \$5,700, 342-7747, Mark.

'86 HONDA Shadow TT 1100 motorcycle, all black, inmod, 25,500 mi., windshield, backrest, saddlebags, alloy wheels, \$3,100, 626/441-2150.

'92 MAZDA Navajo DX sport utility vehicle, 2 dr., 5-sp. man., 6-cyl. 4.0L, a/c, am/fm stereo owner, gd. cond., \$3,995, 790-0335.

'89 MERCEDES 300 SE, 100K miles, new paint, exc. cond., \$15,500, 891-6836, Steve.

'82 MERCEDES 240 D, 10w mileage, burgundy, 45 + mpg, loaded, manual; body, tires, transmission in gd cond., eng. needs work, \$1,200/obo, 909/620-1364.

'71 MERCEDES 250 coupe, white, dual carb, 6 cyl., 2 dr., everything automatic, a/c, low mileage, runs great, needs minor adjustments, \$1,500/obo, 909/620-1364.

'95 PLYMOUTH Acclaim, 4-dr, silver gray, auto, a/c, PS/W/L, cruise, tilt whl, V6, 90K mi., AM/FM/cass., very roomy 6-passng, orig. owner, gd. cond., \$3,995, 790-0335.

'94 TOYOTA Previa LE, 49K mi., 1 owner, capt. chairs, CD changer, roof rack, etc.; grt. cond., all records, 626/355-9651.

'94 TOYOTA Tercel, 2 dr., white w/black int., am/fm stereo, a/c, 4-sp. manual, 88,000 mi., gd. cond., \$5,500, 909/468-5907.

'88 TOYOTA Celica, auto, sunroof, pwr windows, cruise cont., stereo, air, gd. cond., 140,000 mi., \$2,800, 843-6442.

'88 TOYOTA Celica GT coupe, 151K, a/c, ps/lock, cd, sunroof, single owner, repainted in '94, all records, exc. cond., \$4,000/obo, 661/263-2020.

'86 1/2 TOYOTA Supra, white, 5 sp, leather seats, loaded, tint windows, run great, well maintain, max cond., orig. owner, 98 miles, \$4,300/obo, 626/443-9774.

TRAILERS: '95 Carson utility, hvly duty, seldom used, gd. for hauling cars, \$1,995; Miller equip. trailer, tilt, new deck/tires/brakes/electrical, will support 21,000 lbs., \$4,000, travel trailer, sleeps 6, air, heater, stove, refrig/erator, new tires, \$2,000, 626/798-8261.

'86 YAMAHA Venture Royale, 38K miles, radio/cass., cruise cont., driver-to-passenger comm. syst., CB radio, always garaged, \$2,000 worth of accessories, sell \$3,600, 957-2852.

Wanted

CHEVY Nova, '68-'73, V8, auto, 2 door, 626/445-7425.

CHRISTMAS CARDS and calendars, used, for art projects, 548-5656, Teresa.

JUICERS: Vitamix, any model; 'Juiceman II', 891-6836, Steve.

SPACE INFORMATION/memorabilia from U.S. & other countries, past & present, 790-8523, Marc Rayman.

VACUUM TUBES and table model radios, '20s and '30s; also literature on table mfg. activ. in L.A. in early yrs. 242-8961.

Free

DOG, black Lab/chow mix puppies rescued, 14 wks. old, all shots, leash-trained, cat-friendly, 1 male, 1 female, need loving home, 626/414-1012.

DOG, 5-yr-old Dalmatian, loving family pet, 397-7122.

LEMONS & ORANGES, bring your own packing equipment and haul away, 626/796-1681, John.

MONITOR, 14" RGB; KEYBOARD, XT, 790-0264.

REBATE, white, lip-eared, raised indoors, playing loving, litter trained, grt. pet, for apt. dweller; loves people, esp. kids; about 1 yr. old, 310/214-0248.

For Rent

3 bd., 2 ba., luxury, cent. air/heat, \$1,525, 541-7444.

3-1/2 mi. from JPL & Caltech, lg. rm. & ba. over detached garage, refrig & microwave, cable TV, laundry facil., \$480, 626/398-0263.

neighborhood, walk to Lab, \$400, 790-1893. LA CRESCENTA apt. to share w/1 other, room, sunny, fireplace, non-smoking female pref., \$400 + 1/2 util, 249-9739.

LA CRESCENTA home, high above Foothill, priv. setting, 2 bd. w/pool, stove/oven, \$1,400 incl. gardener/pool service, 952-6007.

MONROVIA, pt. furn. condo, 2 bd., 1.5 ba., 2-car gar., nr. old town Monrovia, cent. air/heat, Indry rm, dishwasher, covered patio and garage, water/trash pd., \$823, 626/573-5189.

PALM SPRINGS area, exquisite 2 bd., 2 ba. villa, rent (or sale) for vac. or long term, newly remodeled, w/skylight, patio & 2-car gar.; located across the Living Desert; great private, secure resort w/tennis cts., multiple pools, spa & clubhouse facil.; great locale; close to Palm Desert Marietta, downtown, tourist attract'ns, major golf courses, 909/620-1364.

PASADENA, rm. in 3-bd. apt to share w/2 others, pool, parking, a/c, washer/dryer, \$460 + 1/3 util, 626/564-1078.

Real Estate

BIG BEAR, new cabin 2 blocks from lake, 2 bd., 2 ba., mud/luxury rm., \$129,000, 909/585-9026.

MONROVIA townhome in quiet, friendly 18-unit complex w/shared pool & spa, approx. 1,024 sq. ft., built '80, 2 bd., 1.5 ba., 2-car att. gar., priv. garden patio & sundeck, dent. heat/air, F/P updated tile floor in kitck, & din. rm., newer carpet, exterior freshly painted, convenient loc. off Foothill Blvd., \$155,000, 626/537-7583.

PASADENA, 3 bd./2.5 ba. townhome built '98, nr. Rose Bowl, 3.5 mi./JPL, gated, 1,440 sq. ft. cent. heat/air, 2-car att. garage, prof. organized closets, tiled fireplace, alarm, dbl glass windows, covered balcony off the master, wood floors everywhere, Arabian counters in kitck/baths, lg. enclosed backyd fully landscaped w/airo sprinklers, palm/fruit trees, fountain, community pool/Jaczz/basketball ct., by owner, \$246,000/obo, 626/568-8298.

TEHACHA area, new custom weekend/retirement hideaway, 3 bd., 2 ba., cent. heat/air, fenced, 2-car gar., new Dutch barn (guest house), on 1 1/2 acres, in mtns., many oak trees, OWC, \$155,000, 626/794-5858.

Vacation Rentals

BIG BEAR, 7 mi. from slopes; full kitck, f/p, 2 bd., 1 ba., sleeps 6; reasonable rates; 2 hrs. min.; no smokers/pets; exc. hiking, biking, fishing nearby, 909/585-9026, Pat & Mary Ann Carroll.

BIG BEAR cabin, quiet wooded area near village, 2 bd., sleeps 8, F/P, TV, VCP, completely furn., \$75/nt, 249-8515.

BIG BEAR LAKE cabin, nr. ski area, lake, shops, village, forest, 2-car garage, up to 6, f/p, TV, VCR, phone, microwaves, BBQ & more, JPL disc, from \$65/nt, 909/522-9874.

BIG BEAR LAKEFRONT, lux. townhome, 2 decks, tennis, pool, spa, nr. skiing, beaut. master bd. suite, sleeps 6, 949/768-6548.

HAWAII, Maui condo, NW coast, on beach w/ ocean view, 25 ft. fr. surf, 1 bd. w/lot, compl. furn., phone, color TV, VCR, microwave, dishwasher, pwr. lanai, slips, 4, 4/15-12/14 rate \$95/nt+2, 12/15-4/14 rate \$110/nt+2, \$10/ntite add'l person, 949/348-8047.

MAMMOTH condo, studio + loft, 2 ba., fireplace w/wood, Jacuzzi, sauna, game rm., color TV w/cable & VCR, full kitck, winterwave, terrace, view, amen, 714/870-1872.

MAMMOTH, Charming Condo, at lifts 7, 8, 16, 17; walk to Warmth Hut, 2 bd., 2 full ba., sleeps 6, fully equip. elec. kitck, w/extras, f/p & wood, color TV, VCR, cable, FM stereo, off Jacuzzi's, sauna, game, rec. & laundry rms; convenient to slopes, lifts; special midweek rates, 249-8524.

MAMMOTH, Snowcreek, 2 bd., 2 ba., + loft, sleeps 6-8, fully equip. kitck, incl. microwave, D/W, cable TV, VCR, phone, balcony w/view to mtns., Jacuzzi's, sauna, streams, fishponds, close to Mammoth Creek, JPL discount, 626/798-9222 or 626/794-0455.

OCEANSIDE/on the sand, charming 1-bd. condo, panoramic view, walk to pier & harbor, pool/spa, game rm., sleeps 4, 949/786-6548.

PACIFIC GROVE house, 3 bd., 2 ba, f/p, cable tv/vcr, stereo, CD, well-equip. kitck, w/microwave, beaut. furn. close to golf, beaches, 17 Mile Dr. Aquarius, Camery Row, JPL discount, 626/441-3265.

ROSARITO BEACH condo, 2 bd., 2 ba., ocean view, pool, tennis, short walk to beach on priv. rd., 18-hole golf course 6 mi. away, priv. secure parking, 626/794-3906.

SOUTH LAKE TEHACHA KEYS waterfront, 4 bd., 3 ba., 1 bd. & liv. rm. upstairs, hep, access fair, slips 12, fireplace, decks overlook priv. dock & ski lifts, gourmet kitck, bikes, boats, 4 color TVs, VCR, stereo w/tape & disk, assn. pools, hot tub & beach, tennis, 10 min./skiing, casinos, golf, 1 hr./wine country, 3-day min., \$1,195/wk, high season 1 June to 15 Sept; 22 Nov to 1 April), 5595/week low seas., + \$90 cleaning fee, 949/515-5812.

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No more than two ads of up to 60 words each will be published for each advertiser. Items may be combined within one submission.

Ads must be submitted on ad cards, available at the ERC and the Universe office, Bldg. 186-118, or via e-mail to universe@jpl.nasa.gov.

Ads are due at 2 p.m. on the Monday after publication for the following issue.

All housing and vehicle advertisements require that the qualifying person(s) placing the ad be listed as an owner on the ownership documents.