Universe

Jet Propulsion Laboratory

2000 In Review

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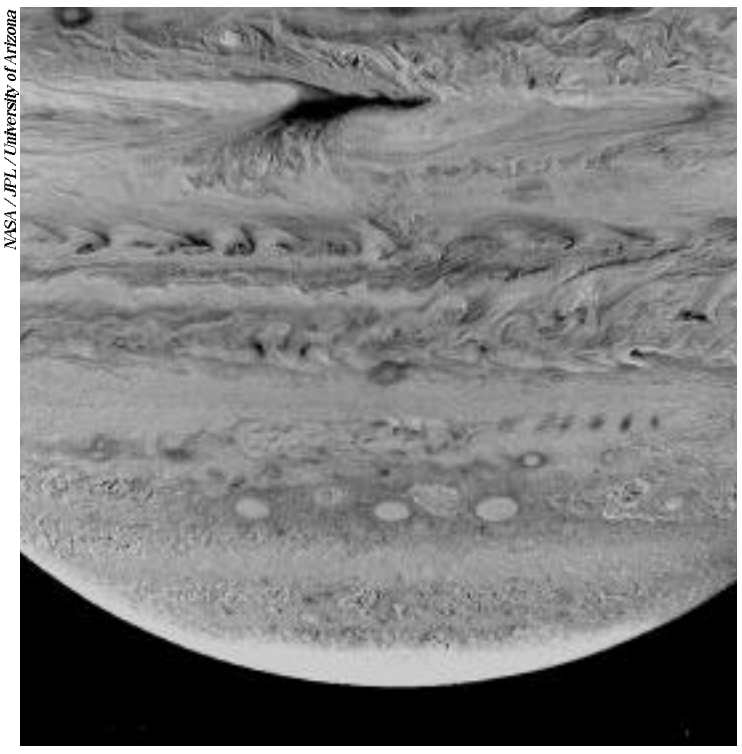
Inside



NASA / JPL / University of Arizona

Cloud structures and movements at different depths in the atmosphere around Jupiter's south pole are shown as imaged through one of three filters on Cassini's camera during its recent approach to the giant planet. This is the first high-resolution image in all three methane bands. See http://photojournal.jpl.nasa.gov.

Galileo, Cassini double-team Jupiter

Joint JPL missions highlight solar system studies

By Martha Heil and Guy Webster

Cassini has capped the year 2000 with a dramatic Dec. 30 flyby of Jupiter, joining Galileo in studying the solar system's largest planet.

Well on its way to Saturn, Cassini teamed with Galileo to take advantage of the unprecedented opportunity to examine an outer planet and its surroundings from two different nearby vantage points simultaneously. Cassini began investigating Jupiter in October, returning thousands of images and measurements before the end of the year. The closest approach on Dec. 30 allowed Cassini to gain the last gravity assist needed for reaching Saturn on July 1, 2004.

Cassini's observations at Jupiter include imaging of thunderstorms and sound recordings based on natural radio emissions created by the energy of the area where the solar wind hit's Jupiter's magnetosphere.

Scientists' analysis of the joint Cassini-Galileo studies of Jupiter will continue for three months.

Cassini passed through the asteroid belt in the first quarter of 2000, and took an image of Asteroid Masursky during that passage. When Cassini was launched in 1997, no one anticipated that Galileo would still be operational in late 2000, three years after the end of its original two-year mission. The plan for Cassini at that time did not include doing science at Jupiter; however, with Galileo still active, NASA approved Jupiter studies by Cassini.

Galileo started 2000 with a Jan. 3 flyby of Jupiter's moon Europa, during which the spacecraft's magnetometer detected the strongest evidence yet for a liquid ocean of salty water under Europa's icy crust. On Feb. 22, Galileo made its closest-ever approach to Io, capturing images and information about that moon's intense volcanic activity and rapid surface changes. Galileo flew close encounters with Ganymede on May 20 and Dec. 28, with the intervening months spent in Galileo's longest loop away from Jupiter since it began orbiting the planet in 1995. The first flyby picked up magnetic evidence that Ganymede, too, may have a hidden ocean under its ice. The Dec. 28 flyby occurred while Ganymede was in eclipse, allowing studies of faint auroral glows that would be washed out in sunlight.

Deep Space 1 has successfully completed its

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Odyssey to continue at Mars in 2001

Orbiter to launch in April, while MGS goes on an extended mission

Right: Sediments that created these layers in Mars' western Arabia suggest they were deposited from above—perhaps by settling out of the Martian atmosphere, or perhaps by settling out of water that might have occupied this crater as a lake. JPL's Mars Global Surveyor imaged the site last year.

Mars Global Surveyor continued to return stunning images in the year 2000, including recently observed features that suggest there may be current sources of liquid water at or near the surface of the red planet. Scientists saw gullies in cliffs, usually in crater or valley walls. Relative to the rest of the Martian surface, the gullies appear to be extremely young, meaning they may have formed in the recent past. Another Global Surveyor finding, though one that is causing more scientific debate, is the idea that in its early history, Mars was covered by lakes or small seas. This suggestion is based upon pictures of sedimentary rocks and layers that look surprisingly like many places on Earth.

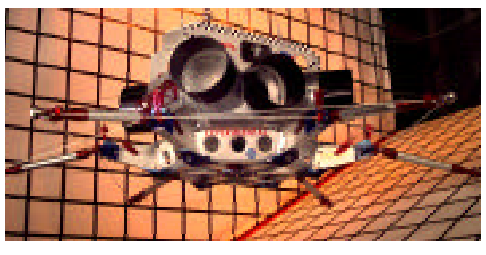
In response to the loss of Mars Climate Orbiter and Mars Polar Lander in 1999, JPL Director Dr. Edward Stone announced the creation of new offices responsible for the management of future Mars missions and the implementation of space science flight projects, and named Dr. Firouz Naderi to head the Mars Exploration Program at the Lab. Stone said the changes were being made to provide strengthened institutional support for implementing JPL's space science missions, and to bring added focus to the Laboratory's management of exploratory missions to Mars planned for coming years.

In addition, NASA Headquarters announced a new Mars Exploration Program for the next two decades. Next April will see the launch of the 2001 Mars Odyssey orbiter mission and then in 2003, the twin Mars Exploration Rovers will set out for the Martian surface. NASA plans to launch the Mars Reconnaissance orbiter in 2005 to analyze the surface at new scales and bridge the gap between surface observations and measurements from orbit. NASA is also proposing to develop and send a mobile science laboratory to Mars as early as 2007 that could employ "smart lander" technology. In the same year, a small "Scout" mission is proposed for launch. Into the next decade, the first Martian sample return missions could possibly take place as early as 2011, or in 2014 and 2016.

PIA 02842

In the new year, Global Surveyor will complete its prime mission on Jan. 31 and begin a new extended mission of exploration the next day. The next mission to Mars will launch on April 7, 2001 when Mars Odyssey lifts off from Cape Canaveral. The spacecraft will carry an array of instruments designed to tell us more about what Mars is made of and what types of minerals and chemicals are on its surface. If launched on schedule, Odyssey will arrive at Mars on Oct. 20, 2001.

Technology leads the way



Bob Brown / JPL photo

A pallet landing system invented by NASA/JPL is one of two different landing systems being tested for the 2007 Mars mission opportunity.

By Carolina Martinez

At the dawn of the 21st century, JPL scientists and engineers are creating the technologies of the future now.

Lighting-speed computer chips, robotic arms, small sensors to monitor the environment, hopping robots for planetary space exploration and shoebox sized, lightweight inflatables that, once in space, can unfurl to the size of a tennis court. These developments will bring about new discoveries and lead in the search for life on other planets. Back home, they hold the promise of breakthrough advances in the communications, medical and commercial industries.

Early in the year 2000, the war against breast cancer had a new weapon, thanks to an advanced sensor developed at JPL. The Quantum Well Infrared Photodetector camera uses extremely sensitive infrared sensors for non-invasive mammography. Commercial applications for the sensor include locating hot spots during fires and observing volcanoes.

Another invention with cross-industry applications is a drill that may end up in the hands of craftsmen and surgeons alike. The ultra-lightweight drill is miniaturized to fit in the palm of a hand and can core hard rocks and potentially be used to extract pacemaker leads.

Earth's environment will also benefit from space technology. A robotic device that safely strips paint from the hulls of ships without polluting the environment, based on NASA robotics technology, can have a positive environmental impact while providing a benefit to the shipyard industry.

JPL engineers continue to miniaturize an electronic nose with the ability to monitor recycled air. The E-Nose may someday monitor the air for toxins in closed environments such as the space shuttle, International Space Station and any future space outpost that features a closed human habitat. Potential commercial uses include sniffing for a fire before the blaze erupts, unexploded land mines, spills in chemical plants that could contaminate workers, plant ripeness to

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Technology

Bob Brown / JPL photo

Scientists demonstrate an ultrasonic driller/corer, shown operating from a small rover. The drill also has potential medical applications. From left are Dr. Stewart Sherrit, Caltech post-doctoral scholar; Dr. Yoseph Bar-Cohen, who leads JPL's Non-Destructive Evaluation and Advanced Actuator Technologies unit; and Dr. Benjamin Dolgin, task manager for robotic drilling.

Continued from page 1

harvest at the desired point in the agricultural cycle, and possible diagnosis of disease based on odors from human perspiration and breath.

It was back to the garden for JPL engineers who "planted" wireless webs of small sensors in gardens here on Earth in preparation for missions to help monitor biological activity on other planets. Sensor webs the size of a small sandwich box may help establish a virtual presence for exploration throughout the solar system.

Breakthroughs in ultralight, inflatable materials are helping to lead development of technologies that will show the way to researchers in their quest to explore the farthest reaches of the universe. Very light, powerful telescopes will someday peer far into deep space, looking for Earth-like planets around stars much like our own Sun. Solar-, laser- and microwave-powered sails weighing less than a paperback book will propel spacecraft through the stars. Robotic rovers with inflatable wheels will explore planets and asteroids—and reveal their secrets.

On Earth, these same low-cost materials offer potential uses such as portable clean rooms that can be used by one person, perhaps to develop pure drugs; small ultralight devices that can make today's cellular phones seem like rocks; flexible devices for dispensing drugs such as insulin; and lightweight, easily launched weather and communication satellites.

Defying traditional laws of physics, researchers may have found a way to blast through imminent roadblocks on the highway to faster and smaller computers. Using modern quantum physics, researchers discovered that entangled pairs of light particles, called photons, can act as a single unit, but perform with twice the efficiency. This research could potentially enable us to continue upgrading computers even after traditional manufacturing procedures have been exhausted.

JPL engineers and neurophysiologists teamed up to create a prototype, robot-like device that, when complete, will be used as part of rehabilitation that can potentially help the wheelchair-bound take their first steps. The device, still in the development phase, could be part of clinical trials in about three years. This device could also someday be useful to astronauts and help them walk safely after prolonged periods in space, such as extended missions on the International Space Station.

On the local front, the city of Monrovia, Calif., is scheduled to pilot test a technology developed at JPL that will alert motorists of rapidly approaching emergency vehicles. The Emergency Vehicle Early Warning Safety System, developed with the assistance of the Technology Affiliates Program, equips emergency vehicles with transponders that communicate via microwave with receivers on large visual displays at major intersections. As an emergency vehicle approaches the intersections, emergency personnel activate the transponder, which automatically turns the traffic light to yellow, then red, for cross traffic.

New technology developments hold promise for the coming year. A hopping robot on wheels, an artificial ear made of nano tubes, ultrasonic motors to drill rocks on Mars, machines with human-like vision, and sensors for monitoring humidity in the space station are just a few. Many of the technologies currently under research and development have non-space related benefits. A hand-held device to measure a patient's eye for a blood glucose reading; a laser to perform a spinal tap; and a nicotine patch that measures calcium loss for the prevention and mitigation of osteoporosis; are all possible in the years to come.

Special Events Calendar

Ongoing Support Groups

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.

End of Life Issues and Bereavement—Meets the second Monday of the month at noon in Building 111-117. Call the JPL Employee Assistance Program at 4-3680.

Gay, Lesbian and Bisexual Support Group—Meets the first and third Fridays of the month at noon in Building 111-117. Call the Employee Assistance Program at ext. 4-3680 or Randy Herrera at ext. 3-0664.

Parent Support Group—Meets the third Thursday of the month at noon in Building 167-111. Call Greg Hickey at ext. 4-0776.

Senior Caregivers Support Group—Meets the the first Tuesday of the month in Building 167-111. For information, call the Employee Assistance Program at ext. 4-3680.

Tuesday, January 9

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

Knowledge Capture—Process owner Lynne Cooper of Section 346 will speak at noon in von Kármán Auditorium on one of JPL's four Knowledge Management processes (Organize, Develop and Distribute Knowledge are the others).

Wednesday, January 10

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

JPL Toastmasters Club—Meeting at 5:30 p.m. in the Building 167 conference room. Guests welcome. Call Jim Raney at ext. 4-6301.

Thursday, January 11

"MLK 2001: Equality, Equity, and Excellence…Mission to Action"—JPL's Advisory Committee on Minority Affairs sponsors a tribute to Dr. MartinLuther King Jr. in the mall from 11:30 a.m. to 1:30 p.m. Guest speaker will be Dr. Clyde Oden Jr., president and chief executive officer of Watts Health Systems Inc. Entertainment will be provided by JPL's Big Band and John Muir High School.

Friday, January 12

JPL 2000 Lecture Series—Galaxy Evolution Explorer (GALEX) Project Manager Dr. James Fanson will speak at 11 a.m. in von Kármán Auditorium.

Songs and Stories—Singer/storyteller Rosalie Sorrels will appear at 8 p.m. in Caltech's DabneyLounge. Tickets are $15 for adults, $4 for children under 12. Call (626) 395-4652.

Saturday, January 13

Jubilant Sykes, Baritone—This vocalist draws on gospel and jazz influences to blur the line between art song and pop. He will perform at 8 p.m. in Caltech's Beckman Auditorium. Tickets are $22, $18 and $14. Call (626) 395-4652.

Sunday, January 14

Contact—The 1997 Jodie Foster film will play at 2 p.m. in Caltech's Beck-man Auditorium as part of *The Future of the Universe* science fiction film festival. A panel discussion that will include JPL astronomer Dr. Don Yeomans will follow the screening. Admission is free, but tickets are required. Call (626) 395-4652.

"Madman of Magic"—The Skeptics Society will present Bob Friedhoffer, the "Scientist's Magician," at 2 p.m. in Caltech's Baxter Lecture Hall. Donations are $5 for members, $8 for nonmembers. Call (626) 395-4652.

Tuesday, January 16

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

Wednesday, January 17

"The Physics of Snow Crystals"—Caltech physics professor Dr. Ken Libbrecht will speak at 8 p.m. in Beckman Auditorium. Admission is free. Call (626) 395-4652.

Thursday, January 18

JPL Stories—Former JPL Director Dr. William Pickering will discuss the Lab's early days from 4 to 5 p.m. in the Library, Building 111-104. For questions or to participate, call Teresa Bailey at ext. 4-9233.

Solar system

PIA 02573

This view of the Nicholson Regio/Arbela Sulcus region on Jupiter's moon Ganymede, taken by JPL's Galileo spacecraft, shows the stark contrast between the smooth bright terrain and the surrounding highly fractured dark terrain.

Continued from page 1

primary mission to test 12 new technologies, and will now observe Comet Borrelly in September 2001. DS1 has become the longest running ion propulsion system in space, operating for two years and two months or 150 percent of its expected lifetime. DS1 began the year 2000 in a crisis: it had lost its navigation system. In a spectacular rescue, mission engineers radioed software to re-format other cameras to replace the lost star tracker.

Stardust began its retrieval of interstellar dust particles for study on Earth. In February 2000 it successfully collected interstellar dust particles in its aerogel collectors. The spacecraft will make its closest approach to Earth on Jan. 15, 2001.

Genesis readies for launch in the summer of 2001. In 2000, its sample return canister was integrated into the main body of the spacecraft. One of the instruments that will help Genesis collect samples of the solar wind is a formulation of bulk metallic glass that was created especially for this project.

Deep Impact, one of the most recent suite of Discovery missions, is in the planning stages, completing its preliminary design review this year. It will launch in January 2004 to impact and examine the nucleus of Comet Tempel 1.

The **Near Earth Asteroid Tracker** (NEAT), a program to search for near-Earth asteroids larger than 1 kilometer (0.6 miles) in diameter, has resumed its five-year-old project. In January 2000 the NEAT camera was mounted on the Maui Space Surveillance Site's 1.2-meter (47-inch) telescope, and in February it began taking sky data on the Maui telescope. The observing cycle has been increased from six to 18 days a month.

Ulysses' most significant event in 2000 was its surprising encounter with Comet Hyakutake. Flying through the comet's unexpectedly long tail, Ulysses, studying fields and particles emanating from the Sun, saw wild variations in the solar wind measurements hundreds of millions of kilometers away from the comet. This led to change in ideas about comet tail structure. Solar wind findings from Ulysses were published in the Journal of Geophysical Research in January. In October, the team celebrated Ulysses' 10-year anniversary.

Voyager, now in its 23rd year, is expected to leave the Sun's sphere of magnetic influence in the next few years. Data is still returning from Voyager, particularly data dealing with the solar wind.

MIRO, JPL's microwave instrument on the European Space Agency's Rosetta Orbiter to Comet Wirtanen, is in the final stages of development. The team will complete environmental testing in early 2001, and deliver the gas- and temperature-measuring instrument to ESA in the summer.

The **Europa Orbiter** and **Solar Probe** missions continued in development throughout 2000. JPL is developing advanced avionics for the missions to study Jupiter's moon Europa and the Sun. Science goals for the Europa Orbiter include determining whether it has an ocean under its ice, and mapping the thickness of the ice and ocean layers. This information will be used in selecting a site for a proposed lander. Target launch dates are planned in the second half of the 2001-2010 decade.

JPL's **Deep Space Network** provides communications between Earth and spacecraft through large antennas in California, Spain and Australia. The network will supported a wide assortment of missions in 2001, such as Earth-orbiting QuikSCAT, Mars-orbiting Mars Global Surveyor, Jupiter-orbiting Galileo, and the most distant of all human-made objects, Voyager 2, at about twice the distance to Pluto. DSN planners and engineers are working on expanding the capabilities of the system for handling strong demand expected for communications-link time in 2003 and 2004, due in part to landers planned for exploring Mars.

The network has partnered with the Lewis Center for Educational Research, Apple Valley, Calif., to make one 34-meter (112-foot) antenna available for students around the country to use by remote control from their classrooms. In November and December, hundreds of students at 25 middle schools and high schools in 13 states used the Goldstone-Apple Valley Radio Telescope to help with interpretation of radio measurements near Jupiter by the Cassini spacecraft.

What on Earth is going on?

JPL satellites, instruments keep track of the home planet

By Nancy Lovato and Rosemary Sullivant

Early last year, new imagery from the JPL-managed U.S.-French TOPEX/Poseidon satellite confirmed that a giant horseshoe pattern of higher than normal sea-surface heights that developed in 1999 was beginning to dominate the entire western Pacific and Asiatic oceans.

Scientists believe that abnormally warm ocean temperatures, which contrast with the present cool La Niña, may be part of a decade-long pattern known as the Pacific Decadal Oscillation. El Niño and La Niña are smaller and shorter-duration events.

In further developments in 2000, JPL scientists found evidence of another temperature shift that appears to take place on a much longer time scale, about 70 years. This indicates that the oscillation has a two-part structure. This study was based on a study of the past 92-year record of sea-surface temperatures in the North and South Pacific.

On Feb. 11, the **Shuttle Radar Topography Mission**, which used an advanced radar technique to obtain data to produce the most precise Earth map ever, was launched from the Space Shuttle Endeavour. SRTM mapped nearly 80 percent of the world's landmass, which contains about 95 percent of the population. Processing the enormous amount of data collected is now underway. SRTM images of various parts of the world continue to engage researchers and the public with their precision.

Scientists, weather forecasters and the public can now take advantage of daily wind data and animations from the ocean-wind tracker **SeaWinds**, a radar instrument on the QuikScat satellite. SeaWinds data show developing weather systems with unprecedented detail information that can improve weather forecasting around the world in addition to details about waves, currents, polar ice features and other phenomena.

Meanwhile, investigations into the Arctic stratosphere showed increased ozone loss during the 1999-2000 winter, which was one the coldest winters on record. Measurements showed ozone in the Arctic decreasing by 60 percent. Scientists noted that more polar stratospheric clouds than anticipated formed high above the North Pole, due to the Arctic becoming colder and more humid. These clouds provide surfaces that convert benign forms of chlorine into reactive, ozone-destroying forms, and they remove nitrogen compounds that act to moderate the destructive impact of chlorine. Researchers note that the Arctic may become more like the colder Antarctic, which could lead to more dramatic ozone loss in the future over the Northern Hemisphere.

A JPL geophysicist was able to solve the century-old mystery of the Earth's "Chandler wobble." The principal cause is fluctuating pressure on the bottom of the ocean, caused by temperature and salinity changes and wind-driven changes in the circulation of the oceans. The Chandler wobble, named for its 1891 discoverer, is one of several wobbling motions exhibited by Earth as it rotates on its axis. The wobble amounts to about 6 meters (20 feet) at the North Pole and takes about 433 days to complete.

Residents of Northern California got some good news as a result of technology developed by NASA. A UC Berkeley geophysicist assessed movement along the northern Hayward fault and found less chance of a major quake originating on that segment than previously thought. The study used new techniques for monitoring earthquake fault activity with the help of radar interferometry and data from the global positioning system.

Image data from the "zoom lens" of NASA's Terra satellite—the **Advanced Spaceborne Thermal Emission and Reflection Radiometer** (ASTER)—are now available to the public. The general-purpose instrument can map Earth's surface and how it changes with time, and can determine the characteristics of land and water surfaces. It has 14 spectral bands, extremely high spatial resolution and stereo imaging capabilities. A joint U.S.-Japan science team is responsible for ASTER.

Data are also available from the **Multi-Angle Imaging SpectroRadiometer** (MISR), another Terra instrument. MISR acquires images of Earth in four color bands at nine angles simultaneously, using nine separate cameras. The change in reflection at different view angles lets MISR distinguish different types of atmospheric particles, cloud forms and land surfaces. The MISR instrument was built at JPL, and the project is managed here.

Images gathered during an Earth-observing mission conducted using NASA's DC-8 Flying Laboratory during the summer around the Pacific Rim region continue to become available. The primary PacRim 2000 instrument was the **Airborne Synthetic Aperture Radar** (AirSAR), designed and built by JPL. AirSAR is a radar technology testbed and is used to demonstrate technology for spaceborne radar missions, such as SRTM. Also onboard was the **MASTER** instrument, which is the simulator for the Moderate Resolution Imaging Spectroradiometer and the Advanced Spaceborne Thermal Emission and Reflection Radiometer instruments on the Terra

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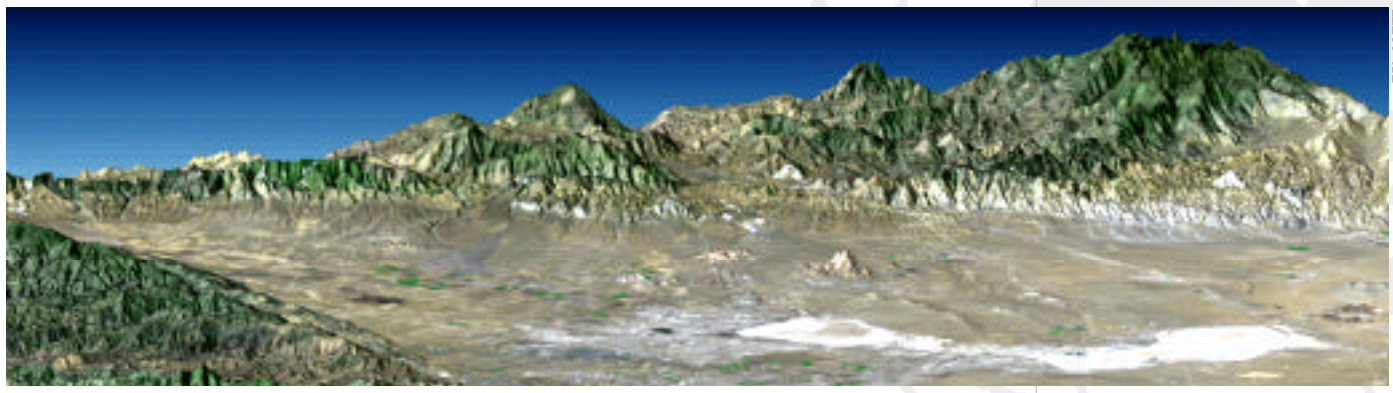


PIA 02775

This view of the Antelope Valley was created by draping a Landsat satellite image over a preliminary topographic map from JPL's Shuttle Radar Topography Mission, which flew onboard Space Shuttle Endeavour last February. Rosamond and Rogers dry lakes appear bright white.

Future missions to pursue universal questions

By Jane Platt

The Laboratory continued progress on missions designed to help us understand our place in the universe, including the quest to answer the age-old questions: Where did we come from? Are we alone?

Science teams were selected for two missions under NASA's Origins Program. The **Space Infrared Telescope Facility,** the first new Origins mission and the last of NASA's Great Observatories, chose six teams of scientists for its Legacy Science Program to study the formation of galaxies, stars and planet-forming dust disks. After the observatory launches in July 2002, the teams will use more than 3,000 hours of observing time, primarily in the first year.

Infrared Processing and Analysis Center/Caltech

Another Origins mission, the **Space Interferometry Mission**, selected a team consisting of 10 principal investigators leading key science teams, and five mission specialists. After launch in 2009, the innovative space system will hunt for Earth-sized planets around other stars and provide new insights into the origin and evolution of our galaxy. It will also precisely measure locations and distances of stars throughout the Milky Way Galaxy.

JPL selected industrial-academic teams to spend two years developing mission concepts for **Terrestrial Planet Finder**, an Origins mission scheduled for launch in 2012. It will hunt for Earth-like planets around other stars that might sustain life. JPL requested proposals that would reflect the most diverse set of feasible and afford able mission architectures. After several months of brainstorming, each team presented its top two design concepts for further study.

The Terrestrial Planet Finder mission will depend on development of the challenging technologies of formation flying, nulling interferometry, and instruments to identify life-sustaining chemicals on a planet up to 50 light years away from Earth.

The Michelson Fellowship Program continues to grow strongly, enabling future scientists and engineers to become familiar with some of the key Origins technologies, such as optical interferometry. Entering its third year, the program currently supports seven graduate students and four postdoctoral fellows at universities throughout the country and has established a series of successful annual summer schools.

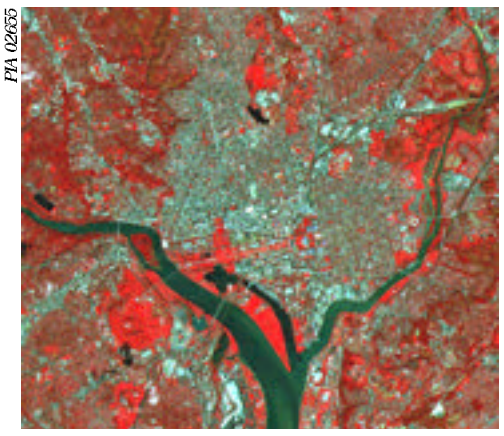
2000 brought progress for the **Galaxy Evolution Explorer**, an ultraviolet mission that will launch in January 2002. The integration of the science instrument and the spacecraft bus was initiated, and the telescope assembly and flight detector tubes were completed and delivered. The mission will study the causes and map the history of star formation in galaxies ranging over 80 percent of the age of the universe.

The **Two Micron All-Sky Survey** continued to dazzle the science community and the public with its enormous output of celestial images. The survey consists of two 1.3-meter (51-inch) ground-based telescopes, one in Arizona and one in Chile. Images from the project, sponsored by NASA and the National Science Foundation, are combined and processed by the JPL/Caltech Infrared Processing and Analysis Center. The survey's Web site drew a large number of hits after the posting of images that included half a million galaxies and 162 million stars—enough data to fill 6,000 CD-ROMs.

Five JPL scientists were among 41 researchers selected by NASA to receive grants to conduct fundamental physics research on Earth and in space. This research will seek knowledge to expand our understanding of space, time and matter.

Left: This image of the portion of the sky known as HII region W48, which is more than 11,000 light-years from Earth, was released by the Two Micron All-Sky Survey at Caltech's Infrared Processing and Analysis Center (http://www.ipac.caltech.edu/2mass).

Earth science



PIA 02655

The Washington, D.C. area as imaged in June by JPL's Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER), one of five Earth-observing instruments on NASA's Terra satellite.

Continued from page 3

satellite. MASTER is used to obtain detailed maps of land surface temperature, emissions and reflectance.

Last year, JPL scientists created the first comprehensive maps of Arctic sea ice thickness using data from Canada's Radarsat satellite. This new mapping technique lets scientists study how Arctic sea ice, a sensitive indicator of climate change, grows and contorts over time.

BlackJack global positioning system receivers, designed and built at JPL, are flying onboard German and Argentinean satellites launched in 2000. In addition to performing navigation functions, the innovative instruments may provide a new way to study Earth's gravity field and atmosphere.

The year 2001 will see more exciting new Earth science missions. **Jason-1**, scheduled for a spring launch, will monitor global ocean circulation, provide information about the link between the oceans and atmosphere, help improve global climate predictions, and monitor events such as El Niño conditions and ocean eddies. The mission is a follow-on to the highly successful TOPEX/Poseidon, and like its predecessor, it is a joint mission of the United States and France. NASA will be responsible for launching the French-built satellite, and JPL will maintain mission operations once it is on orbit.

Also debuting in 2001 is Aqua, part of NASA's Earth Observing System. Flying in an orbit that will cover the globe every 16 days, Aqua, scheduled for a July launch, will provide a six-year chronology of the planet and its processes. Comprehensive measurements taken by its instruments will allow scientists to assess long-term change, identify its human and natural causes and advance the development of models for long-term forecasting. Among Aqua's instruments will be the JPL-managed **Atmospheric Infrared Sounder** (AIRS), designed to make highly accurate measurements of air temperature, humidity, clouds and surface temperature.

The **Gravity Recovery And Climate Experiment** (GRACE), slated for launch this fall, will accurately map variations in the Earth's gravity field over its five-year lifetime. The mission includes two identical spacecraft flying about 220 kilometers (137 miles) apart in a polar orbit 500 kilometers (310 miles) above the Earth. GRACE is a joint partnership between the United States and Germany. JPL is responsible for project management and systems engineering activities.

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Universe

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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.

Letters

On behalf of my husband, Brian, I would like to thank Section 351 and the many supportive friends at JPL for their expressions of sympathy and generous support at the recent passing of my mother-in-law. We would also like to thank the ERC for the lovely plant.

Nancy Chiang and Brian Fung

I would like to thank my friends and colleagues for their expressions of sympathy and support following the passing of my wife Myrna. Please know that she treasured you all. I would also like to thank the ERC and Element 3232 staff for sending beautiful plants to the memorial service.

Randy Friedl

My heartfelt "Thank You" to all of my JPL friends and co-workers who helped to make my retirement party such a huge success. The gifts and good wishes were much appreciated and will not be soon forgotten. I will miss you all; however, you will remain in my thoughts forever.

Stephanie Dangerfield

My family and I would like to thank our friends at JPL for their condolences on the passing of my wife's mother. Judy and I have been bolstered by the support of many of you. We would also like to thank the ERC for the beautiful plant. Your thoughts, plants, cards and prayers have been very much appreciated at this most difficult time.

Lloyd and Judy Keith

My family and I would like to thank our friends at JPL for their many expressions of sympathy following the death of my husband, Roger M. Barnett, on Oct. 21. The beautiful green plant sent by the ERC was appreciated so much.

Katherine Barnett

Passings

GEORGE BAKER, 74, a retired painter, died of cancer Nov. 7.

Baker worked at the Lab from 1973 to 1991. He is survived by his daughter, Judy Sweeney, seven grandchildren and four great grandchildren.

Services were private.

ANTHONY LIU, 73, a retired member of the technical staff, died Nov. 13.

Liu, who joined JPL in 1965 and retired in 1981, determined the lunar gravity field for NASA's Apollo missions and created navigation models for Pioneer 10, the first spacecraft to go to Jupiter. He is survived by his wife, Edith, and son Nye.

Services were held Dec. 17 at Throop Church in Pasadena.

Classifieds

For Sale

BEDROOM FURNITURE: dresser w/mirror and 2 matching nightstands, dresser is 70" W x 30" H w/9 drawers, nightstands are 26" W x 23" high w/2 drawers, all for $225/obo. 626/914-7853.

BIKE, touring, '94 Trek 2120, 54-in. frame, ice violet, Trek carbon/Easton Al stays frame, w/Shimano SPD pedals, Shimano RX100T (triple-21 gear), crankset, Shimano Deore LX, derailleurs w/SIS bar end shifters, 22.8 lbs., exc. cond., 300 miles, $850; CROSSRACK, Blackburn/rear rack, w/Jando pack, $35; BIKE MOUNT SETS, 3 Yakima std. w/security cable and Quik wrench, for use on any Yakima rack, $50. 790-2123.

BOOKCASE, cherry veneer, 76" H x 36" W x 12 1/2" D, 6 shelves, gd. cond., $50; FUTON, wood frame, full-sz. mattr., red cloth cover, gd. cond., $150. 626/398-8702, Tom or Diane.

CAMERA, Leica Z2X, mint condition, comes with Zing foam case, $300. 626/795-8340.

CD BOX SET, Eric Clapton Crossroad, brand new, unopened, $40. 909/861-4860, eves.

CD JEWEL CASES, $10; DIET TAPES, Jenny Craig, set of 14, $50; COMPUTER POWER CONTROL CENTER, 5 power switches + 1 master switch, 5 surge-protected outlets + 2 modem/fax/phone jacks, new, $20; SPRINK-LER VALVE ADAPTERS, Lawn Genie auto. model 756LG 3/4, new, $10 each; ORGAN, Yamaha 415 electronic console w/13 pedals, 3 keyboards, 144 rhythm patterns, pd. $7,500, sacrifice for $3,000. 790-3899.

CLAY POTS, round, large (2-ft and 3-ft diameter), each 2" $50/obo, each 3" $60/obo. 626/398-3480.

COUCH AND LOVE SEAT, matching, exc. cond., taupe, $495. 626/794-3144, Donna.

CRIB, Childcraft, w/mattress, makes into toddler bed, storage drawers under and at side, honey oak, exc. cond., $250/obo. 957-3130.

CRIB, Simmons, dark wood, plus newer mattr. w/15-yr. rating, exc. cond., $600 new, sell both for $150/obo. 626/798-5143 or jfhook@pacbell.net.

DESK, oak exec. style, 6 drawer, gd. cond., $75/obo. 626/798-5143 or jfhook@pacbell.net.

DESK for office, 60" x 30" x 29" H, oak veneer, 4 drawers, 1 file drawer, gd cond., $150; COMPUTER DESK, solid oak, 26" x 48" x 29" H, keyboard drawer, 1 drawer, vg condition, $100. 626/398-8702.

DESK, perfect for home office, new, never used, see www.bushfurniture.com/html/desks_ 29.htm for picture, $175/obo. 626/403-9002.

DOG, male beagle, tri-color, 16 weeks old, current on shots, sire and dame on site, $250/obo. 661/722-6067, Debi.

FENCING, 4 ft., chain link, new, approx. 25 ft., $20; TIRE CHAINS, bought for '94 Ford Ranger, never used, still in box, $20. 626/ 798-7339.

FURNITURE: sofa & loveseat, beige leather, gd. cond., $300; coffee table, oak, + matching end tables w/brass trim, gd. cond., all for $50; ent. unit, oak and glass, houses up to 31" TV, lots of display/storage space, exc. cond., $280; dining rm. table, oak, oval, removable extension, seats 6-8, exc. cond., $280; oak chairs, 6, w/brown/beige tweed upholstered back & seat cushions, gd. cond., each $15; kitch. tbl., oak, & 4 matching chairs, country style, exc. cond., all for $150. 626/793-3019.

FUTON, queen size couch/bed, light Indian/desert design/colors, heavy-duty wood frame, $95/obo; CALIFORNIA KING BED, converted waterbed w/mattr., dark wood, lg. headboard w/7 shelves, 2 cabinets & 2 hideaway compartments, mirror & 12 lg. drawers under mattr., $350/obo; photos avail. by e-mail at Pj1mktg @aol.com. 626/303-5595, Paul.

HOCKEY TICKETS (2), Kings season ticket holder selling individual games, lower level, each $45. 626/331-9998.

KEYBOARD, Yamaha YPP-45, velocity sensitive, 76 keys, MIDI-equipped, free-standing, $500. 626/296-0472.

LUMBER, from dbl. garage door, approx. 130 sq. ft. of 1"x10"x16' shiplap, (8 ea.) 2"x4"x8', (2 ea.) 2"x4"x16', lot $80. 626/797-6644.

NOTEBOOK, Sony VAIO, brand new, SuperSlim Pro Z505JE, Pentium III, 500 MHz CPU, integrated 56K modem and 10/100 Ethernet, 1" thin, 3.75 lbs., retails for $2,500, sell $1,900. 323/256-6642.

OVEN, convection by Décor, self cleaning, electric, white, wall mount, $150/obo. 626/ 584-9632.

POOL TABLE, full sz., wood cover & soft cover, complete w/cue sticks, balls w/rack, $400 firm. 626/284-9664.

SKI BOOTS, Salomon SX-71, men's size 11, worn only a few times, in original box, $25/obo. 236-4869, evenings.

SHELVES, metal, 3 sets, 6 ft. x 3 ft. x 18 in. deep, each $10; wood shelves, 3.5 ft. x 5 ft. x 11.5 in. deep, $20. 626/303-1927, Steve.

TABLE, dinette, sq. glass top 5'x5' w/metal feet & 4 matching chairs, $800/obo; BAR STOOLS, 4 matching, metal frame, all in superb cond., $400/obo. 626/398-3480.

TABLE, dining room, with 6 chairs, seats 10 comfortably, walnut-light colored, entire unit $125. 626/445-6677, after 6 p.m. M-F, and after 9 a.m. Sat./Sun.

TROMBONE, Yamaha, excellent condition, $425. 626/850-4378 day or 909/598-0065.

WASHER & DRYER, Maytag, exc. cond., white, both for $325/obo. 909/598-1232.

Vehicles / Accessories

'65 BUICK Skylark Special Edition, 2 dr., black w/white vinyl top, auto, pwr. windows/seats, factory a/c, orig. white interior, 85,000 orig. miles, orig. owner, runs exc., $6,000/obo. 626/443-9774.

'70 CHEVROLET Chevelle Malibu, 2 dr., hardtop, classic muscle car, 1-year-old paint, Chevy med. green, headliner/some interior, window tinting, new chrome on bumpers and more, Centerline rims, 350 eng., automatic trans., runs great, 159,000 orig. miles, photos avail. by e-mail at Pj1mktg@aol.com, $7,600/obo. 626/303-5595, Paul.

'95 DODGE Neon Highline sedan, 5-speed, a/c, cruise, power locks, CD, white w/gray interior, 68,000 miles, original owner, good condition, $4,950/obo. 626/355-4376, leave message.

'94 FORD Club Wagon XLT, 12-pass. van, 5.8 L, V8, 76K miles, a/c, power everything, ABS, alarm, AM/FM cass. premium sound, tow pkg., recent tires, front brakes, shocks, excellent condition, $13,200/obo. 790-3217.

'78 FORD Fairmont, 4 dr., 1 owner, all orig., low miles, $1,700. 790-7062.

'95 JAMBOREE Searcher, 22C, 21-ft. motorhome, rear ba., new carpet, awning, microwave, generator, roof & dash a/c, 73K original miles, runs great, $18,500/obo. 626/398-1915, Digette.

'92 LEXUS SC400, white with beige leather interior, Lexus factory phone, Nakamichi CD, moonroof, chrome rims, new tires, recent service, always garaged, 104K miles, 2nd owner, tags paid to 5/01, $13K or trade for truck. 952-1538.

'98 PONTIAC, convertible, beautiful, white, loaded, ~13,000 mi., exc. cond., 25 mpg, factory warranted, $13,000/obo. 790-2123.

'92 SATURN SL-2, original owner, 5-speed manual, A/C, cassette, airbag, antilock brakes, oil changed every 3,000 miles, runs great, 140K mi., $1,000/obo. 952-7624.

'98 TOYOTA Sienna LE, loaded, w/captain's chairs, approx. 35K miles, earth tone in color, very clean, well maintained, excellent condition, original owner, $21,000. 626/850-4378 daytime or 909/598-0065 after 7 p.m.

'96 TOYOTA Rav 4, 4 dr., 4 WD, auto, a/c, cruise cont., purple, tow hitch, alloy whls, pwr. windows/doors, CD/cass./am/fm, floor & cargo mats, gd. cond., 128,500 mi. 760/765-3157 or e-mail cnj@abac.com, Richard.

'93 TOYOTA shortbed pickup, 5 sp., gray, always garaged, 90K mi., $4,200/obo. 323/550-8139.

Wanted

BABYSITTER/LIGHT HOUSEKEEPING, Tues.-Wed.-Thur., pick up 2 kids from school + cook, 4-7 p.m., Altadena area, must be reliable w/own transp. 626/791-9758, Debbie.

LIVE-IN HELP for elderly lady in Lancaster. 661/251-3854.

LUXURY CAR, 1999 or 2000, low mileage, Acura 3.5RL, Lexus GS-300 or Lexus LS-400, will pay finder's fee. 236-4869.

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

THIGHMASTER or PROMASTER EXERCIZER. 626/798-7339.

CHRISTMAS CARDS & CALENDERS, used, with images for art projects. 548-5656.

VOLLEYBALL PLAYERS, coed, all levels of play, Tues. nites 8-10 p.m. at Eagle Rock High School, $3/night. 956-1744, Barbara.

Lost & Found

Lost: TWO-WAY RADIO, Motorola Visar, black with green #s and radio 206 on it (on Lab). Call ext. 4-0414 or 626/334-1535.

Free

DOG: German Shepard needs good home, neutered male, approx. 1 yr. old, house-broken, gd w/other dogs, likes people. 352-4102.

DOG: rescued beautiful black lab/chow mix, 3-yr-old male, trained, healthy/shots, needs loving family, great companion. 661/257-5817.

For Rent

ALTADENA, lg. house to split, lg. master bd. & ba., big liv. rm., din. rm., new kitch., den, 3 bd., laundry rm., detached gar., shade trees, big yd., weekly gardener & water pd., 1 mile/JPL, 5 min. from Old Town Pasadena, $650 + util. 626/791-2332, Dave.

ARCADIA condo/townhouse, 2 bd. + den, 1 3/4 ba., pool & spa, 2-car enclosed garage w/storage space, balcony, c/a, quiet, close to all, no pets, includes washer/dryer, stove and refrig., all new, $1,450 + sec. deposit. 626/445-0884.

LA CRESCENTA apt., 1 bd., garage, 10 min./JPL, $650. 626/445-0884.

PASADENA townhouse, near Caltech, 2 bd., 1 1/2 ba., a/c, heat, built-in washer/dryer, refrigerator, $1,200. 626/578-7226, Erik.

SIERRA MADRE townhouse, 2 story, 1 1/2 ba., new kitch., new carpet, pool, laundry facil., gated patio & balcony, 2 parking spaces, cent. air/heat, $1,300. 626/836-0210.

Real Estate

SEQUIM, Wash., solar passive heated dbl.-shell house, 2 bd., 1 1/2 ba., solarium, green- house, 1-car gar. on 3.6 acres w/irrigation & trout pond; multipurpose barn w/ kitch., toilet, shower, wood stove, space for 1 car & 12 guests in loft; vw. of Olympic mtns.; 1/4 mile/hwy. 101; $200,000. 360/683-6068.

Vacation Rentals

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

BIG BEAR LAKEFRONT lux. townhome, 2 decks, tennis, pool/spa, nr. skiing, beaut. master bdrm. suite, sleeps 6. 949/786-6548.

CAMBRIA, ocean front house, sleeps up to 4, excellent view. 248-8853.

HAWAII, Kona, 166 feet of oceanfront, on Keauhou Bay, priv. house + guest house, comfort. slps 6, 3 bd., 2 ba., rustic, relaxing & beautiful, swimming, snorkeling, fishing, spectac. views, near restaur., golf courses, other attractions. 626/584-9632.

HAWAII, Maui condo, NW coast, on beach w/ocean view, 25 ft. fr. surf, 1 bd. w/loft, compl. furn., phone, color TV/VCR, mcrowv., d/w, pool, priv. lanai, slps. 4, 4/15-12/14, $105/nt./ 2, 12/15-4/14, $120/nt./2, $10/nt. add'l. person. 949/348-8047.

LAKE ARROWHEAD house, 4 bd., 2 1/2 ba., sleeps 10, quiet, secluded, relaxing, woodsy area of Cedar Glen, JPLers who book directly w/owner get 2 for 1 + cleaning fee; http://www.highcountryrents.com/cedar_run.html for pictures/rates. 626/403-0446, owner.

MAMMOTH studio condo, qn. size bed, full kitch., great complex w/sauna & Jacuzzi, bus to lifts stops in front of complex, price is sure to please. 626/791-5376.

MAMMOTH, Courchevel, walking distance to Canyon Lodge and lifts, 2 bd., 2 ba., sleeps 6, fully equipped unit. 661/255-7958.

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

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

PACIFIC GROVE hse, 3 bd., 2 ba., f/p, cable TV/VCR, stereo/CD, well-eqpd kit. w/microwv, beaut. furn, close to golf, bches, 17 Mile Dr., aquar., Cannery Row, JPL discnt. 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.