

Galileo completes daring Io flyby

By Jane Platt

for the men and women of the Galileo project, Sunday, Oct. 10 began as a real nail-biter, but ended with immense pride and relief as the spacecraft successfully completed its daring flyby of Jupiter's moon Io. An unexpected 3:09 a.m. wakeup call on Sunday sent Galileo team members scrambling into action. Three hours after entering the intense radiation zone near Jupiter and Io, Galileo went into safing when an error popped up in the memory of the onboard computer. The team was faced with a daunting task—to get the spacecraft out of safing and back to normal operations in time for the flyby at 10:06 p.m. (Earth receipt time).

"It was a heroic effort to pull this off," said Galileo Project Manager Jim Erickson. "The team diagnosed and corrected a problem we'd never come across before, and they put things back on track."

"We waited four years for this encounter and we would do everything in our power to make it happen," said Eilene Theilig, spacecraft and sequence team chief. "Each person in this talented, dedicated and professional group knew what he or she had to do."

"Before every encounter, we go through various contingency scenarios, including a possible safing," said Nagin Cox, spacecraft and sequence team deputy team chief. "That preparation paid off and the anomaly resolution team swung into action quickly."

"It was poetry in motion," said Olen Adams, lead

for Galileo's command and data subsystem. "People were traveling around these aisles like it was a relay race. Every single person had to perform perfectly. We could not afford one single 'gotcha.' If one person got sick, or one PC crashed, or one command didn't make it to the spacecraft, it wouldn't have worked."

"I knew that if the radiation had triggered one memory fault, there was a good chance it could trigger another," said Tal Brady, who designed the command and data subsystem flight software. "I was very relieved when we got the spacecraft out of safing and later when the flyby data was recorded successfully."

The team saved the day by first pinpointing the location of the computer memory error. They did this by analyzing telemetry and memory readouts and looking at the timeline of spacecraft activities. They changed the encounter sequence to avoid activities that use the faulty portion of the memory. By late Sunday afternoon, Galileo engineers unplinked a new command sequence to the spacecraft. That posed another risk, since the transmission took place while Galileo was in the deepest portion of the radiation zone near Io. Against all odds, Galileo resumed full operations at 8 p.m., just two hours before the Io flyby.

The spacecraft and sequence team did much of the hands-on work, in conjunction with the science and mission control teams. Erickson pointed out, "We were able to meet this enormous challenge because the other teams did their work and assured us that we were free to focus on the crisis at hand."

During the flyby, Galileo's science instruments studied the surface chemistry, heat, gravity and magnetic properties of Io, the most volcanic body in our solar system, from an altitude of only 611 kilometers (380 miles). This was the closest look at Io by any spacecraft. The data, including close-up images, will be transmitted to Earth in coming weeks.

"We want to learn more about the differences and similarities between volcanoes on Io and volcanoes on Earth," said Dr. Duane Bindschadler, Galileo manager of science operations and planning.

A second, closer flyby of Io by Galileo is planned for Nov. 25 at an altitude of 300 kilometers (186 miles).

Good news for NASA, JPL budgets

By Mark Whalen

Last week's House/Senate conference committee recommendation for a NASA fiscal year 2000 space science budget of \$2.198 billion, representing President Clinton's full request for the agency's funding next year, comes as "excellent news for JPL," according to Dr. Richard O'Toole, manager of the Lab's Legislative and International Affairs Office.

However, he said, the allocation may be reduced somewhat depending on how NASA allocates a general funding reduction of \$30 million for science, aeronautics and technology.

In addition to the modest cut in space science funding, Earth science programs are due to be cut by only about \$4 million next year as part of NASA's overall budget increase of \$75 million above the president's request.

NASA's budget bill is expected to be approved by both houses of Congress this week and Clinton is expected to sign the bill before the current continuing resolution to operate the agency expires on Oct. 21, O'Toole said.

Local congressional representatives David Dreier (R-Glendora) and James Rogan (R-Glendale) "really went to bat for us, helping restore space science funding above what it was in both the House and Senate bills," O'Toole noted. "We faced cuts of \$240 million in the House and \$120 million in the Senate, and it came out at the president's requested level, pending the allocation of the general funding reduction. That's very positive."

California senators Dianne Feinstein and Barbara Boxer also helped NASA's cause, he said, with a joint letter of support to conference committee chair Christopher Bond (R-Mo.) and Barbara Mikulski (D-Md.), the ranking minority senator on the conference committee.

The exact effect on JPL programs will not be known until Dr. Ed Weiler, NASA's associate administrator of space science, decides where to make specific funding adjustments for next year. That could be decided in the next few weeks.

Still, O'Toole said, "I wouldn't expect significant dislocations to our programs."



A plume of gas and particles is ejected some 100 kilometers (about 60 miles) above the surface of Jupiter's volcanic moon Io in image recently taken by Galileo.

Battery acid chemical found on Europa

By Jane Platt

Sulfuric acid—a corrosive chemical found on Earth in car batteries—exists on the frozen surface of Jupiter's icy moon Europa.

"This demonstrates once again that Europa is a really bizarre place," said Dr. Robert Carlson of JPL. "Sulfuric acid occurs in nature, but it isn't plentiful. You're not likely to find sulfuric acid on Earth's beaches, but on Europa, it covers large portions of the surface."

The new Galileo findings were reported in the Oct. 1 issue of the *Journal of Science*. Carlson, principal investigator for the near-infrared mapping spectrometer aboard Galileo, is the lead author of the paper. The instrument works like a prism to break up infrared light. Scientists can study the resulting

light patterns to determine what chemicals are present, since different chemicals absorb infrared light differently.

Pictures and other information gathered by Galileo indicate Europa may have a liquid ocean. Water is one key ingredient essential for life.

At first, Carlson thought the findings of sulfuric acid on Europa would quash any talk that life might exist there. Those thoughts were negated by a colleague, Dr. Kenneth Nealson, head of JPL's astrobiology unit.

"The presence of sulfuric acid on Europa in no way rules out the possibility of life," Nealson said. "In fact, to make energy, which is essential to life, you need fuel and something with which to burn it. Sulfur and sulfuric acid are known oxidants, or energy sources, for living things on Earth. These new findings encourage us to hunt for possible links between the sulfur

oxidants on Europa's surface, and natural fuels produced from Europa's hot interior."

Carlson proposes the theory that the sulfur atoms originate with the volcanoes on Io, with the material being ejected into the magnetic environment around Jupiter and eventually whirled toward Europa. Another idea is that sulfuric acid comes from Europa's interior, beneath the icy crust, ejected by sulfuric acid geysers or oozing up through cracks in the ice. Yet another theory is that sodium and magnesium sulfates may have leached onto Europa's surface from underground oceans and then were altered by the intense radiation field, producing frozen sulfuric acid and other sulfur compounds.

Carlson and one of his co-authors, Mark Anderson, a chemist in JPL's Analytical Chemistry Laboratory, hope to determine whether Jupiter's largest moon, Ganymede, also contains sulfuric acid.



Frozen sulfuric acid on Jupiter's moon Europa is depicted in this image produced from Galileo data.

A visitor center exhibiting spacecraft models, artifacts and JPL space exploration is part of the new Educator Resource Center and Applied Technology Classroom.

New JPL facility will help space educators

By John G. Watson

Southern California educators seeking innovative ways to integrate space exploration into their classrooms now have an exciting, new resource with last month's opening of JPL's Educator Resource Center and Applied Technology Classroom in Pomona.

Developed as a result of a new partnership between JPL and the Pomona Unified School District, the state-of-the-art facilities will provide materials and strategies for teachers at all levels who wish to include the space program in their curricula.

"We are excited about the capabilities of these beautiful facilities and about the new relationship with the district," said site administrator Gene Vosicky of JPL's Communications and Education Office.

The center is a focal point for educators to become acquainted with NASA/JPL educational materials and resources. The classroom is designed to increase students' knowledge of technology and science through scientific investigations, and also serves as a model for educators on how to utilize computers and other technologies in the instructional process.

The facility is located in the district-owned Village at Indian Hill educational mall, 1460 E. Holt Ave., Suite 20. For information, call (909) 397-4420.



Bob Brown/JPL Photo

ABOUT 3,500 PEOPLE attended the Lab's annual Family Day Oct. 2.

Family members of JPL employees and contractors enjoyed music, children's activities, tours of various Lab facilities and a complimentary lunch.

"A big thank you to all those at JPL who volunteered to make the day a success," said NANCY KAPEL of the Reward and Recognition and Employee Services Group.

INFLUENZA VACCINES will be offered to employees and affiliates twice weekly from Oct. 26 to Nov. 18.

The vaccine will be available in a series of clinics on Tuesdays and Thursdays at Occupational Health Services, Building 310-202, on the corner of Surveyor and Explorer roads. On each of those days, 125 vaccinations will be administered. Occupational Health Services will open at 1:30 p.m. and give out tickets for that day. Appointments will not be given, and shots will be administered on a first-come, first-served basis.

Influenza vaccine is strongly recommended for people over 65, residents of nursing homes and other chronic care facilities, adults and children with disorders of the pulmonary or cardiovascular systems, and those with chronic metabolic diseases. This year, the target population includes women in the second and third trimester of pregnancy and women in any trimester of pregnancy with a high-risk condition. The vaccine does not affect the safety of breastfeeding.

Immunization is also recommended for household members of high-risk persons.

Weekly schedules, including exceptions and changes, will be advertised on JPL monitors and posted to JPL forum. For more information, see Occupational Health Services' home page at <http://eis/medical>.

A KICKOFF CELEBRATION for this year's United Way campaign, "Make A Smile Last A While," will be held Oct. 29 at noon in the mall, in conjunction with the ERC's Halloween Fashion show. Displays by various community service agencies supported by United Way will be featured.

A \$5 lunch special will be offered, of which 50 cents per meal will be donated to United Way by Eures Dining Services, JPL's cafeteria contractor.

In addition, JPL's United Way food drive begins Oct. 25 and continues for three weeks. Last year, JPL staff donated enough food to help feed more than 1,000 families.

Through Nov. 12, food donations can be placed into barrels at the following locations: Building 114 (ERC); Building 167 cafeteria; Building 180 lobby; Building 190 cafeteria; Building 230 lobby; Building 264 (repro); Building 301, second floor; Building 302, second floor; Building 303 cafeteria; and Building 601 (Woodbury). Suggested items for food donations include canned stew, pork and beans, soup, chili and dried foods such as cereal, coffee, flour and sugar.

Last year, United Way of Greater Los Angeles raised \$62 million, including \$433,000 from JPL's campaign.

Campaign representatives in each JPL organization will begin contacting employees Oct. 29 for participation. Awards will be given to the top campaigners in each organization.

For more information, go online to <http://hr/unitedway> or contact NANCY KAPEL at ext. 4-9432.

WITH ANNUAL BENEFITS ENROLLMENT under way through Nov. 1, the Benefits Office urges employees to consider several factors before enrolling.

How well did your choices work for you last year? Do you need to add or delete dependents from coverage? Do you need to increase or decrease life insurance for yourself or dependents? Did you defer too much or too little from health care or depending care spending accounts?

To assist employees with coverage options and other questions, representatives from the Benefits Office and each of JPL's medical and dental insurance carriers will be on Lab from 9 a.m. to 3 p.m. on Oct. 21 (167 cafeteria) and Oct. 26 (303 cafeteria).

In addition, training sessions have been scheduled to show employees how to use the Oracle Web Applications system—the same web site used for timekeeping—to make benefit changes. Remaining dates and times are Oct. 20, 3 to 4 p.m., Building 167 conference room, and Oct. 28, 1 to 2 p.m., Building 180-101.

Updates on benefits enrollment will appear in "This Week." For more information, call the Benefits Office at ext. 4-3760. For questions about web application training, call ext. 4-1268.

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.

Friday, October 15

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

JPL Perl Users Group—Meeting at noon in Building 301-127.

Saturday, October 16

SURF Seminar—Registration for the Summer Undergraduate Research Fellowship begins at 9 a.m. at Caltech's San Pasqual Mall. Student presentations will be held from 10 to 11:40 a.m. and 1 to 4 p.m., followed by a poster session and reception. Admission is free; a \$10 lunch will be available between noon and 1 p.m. Call 395-2885 or e-mail to sfp@cco.caltech.edu.

Monday, October 18

Caltech Ballroom Dance Club—Beginning east coast swing will be held from 7:30 to 9 p.m. in Caltech's Winnett Lounge. \$1 per lesson. See www.caltech.edu/~ballroom or call 626/791-3103.

Galileo's 10th Anniversary—A new video celebrating the mission and its science contributions will be shown at 12:30 p.m. in von Kármán Auditorium.

Tuesday, October 19

Virtual Private Network—Bill Vlahos of Section 366 will describe this new remote access service, which supports secure dial-up Internet service providers and other connections. At noon in von Kármán Auditorium.

Wednesday, October 20

AFS Quick Start Session—Jeff Sachs of Section 366 will provide an overview of the benefits of this distributed file system to manage computer files, change passwords and protect data. At noon in von Kármán Auditorium.

Caltech Ballroom Dance Club—Beginning salsa will be held from 7:30 to 9 p.m. in Caltech's Winnett Lounge. Cost: \$30. See www.caltech.edu/~ballroom or call 626/791-3103.

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

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

Thursday, October 21

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

Von Kármán Lecture Series—Mars '98 Project Scientist Dr. Richard Zurek and Deep Space 2 lead scientist Dr. Susan Smrekar will present "Return to Mars" at 7 p.m. in von Kármán Auditorium. Open to the public.

Friday, October 22

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

Von Kármán Lecture Series—Mars '98 Project Scientist Dr. Richard Zurek and Deep Space 2 lead scientist Dr. Susan Smrekar will present "Return to Mars" at 7 p.m. in The Forum at Pasadena City College, 1570 E. Colorado Blvd. Open to the public.

Saturday, October 23

Beakman—The zany scientist from CBS' Beakman's World will present an interactive show on scientific principles at 2 p.m. in Caltech's Beckman Auditorium. Tickets are \$10 for adults, \$5 for children. Prior to the show, Family Day activities featuring scientific demonstrations, face painting and food will be presented beginning at 11:30 a.m. next to the auditorium. Call (626) 395-4652.

Sunday, October 24

Chamber Music—The Emerson String Quartet will appear at 3:30 p.m. in Caltech's Beckman Auditorium. Tickets: \$25, \$21, \$17 and \$13. Call (626) 395-4652.

Monday, October 25

Caltech Ballroom Dance Club—Beginning east coast swing will be held from 7:30 to 9 p.m. in Caltech's Winnett Lounge. \$1 per lesson. See www.caltech.edu/~ballroom or call (626) 791-3103.

Wednesday, October 27

Caltech Ballroom Dance Club—Beginning salsa will be held from 7:30 to 9 p.m. in Caltech's Winnett Lounge. Cost: \$30. See www.caltech.edu/~ballroom or call (626) 791-3103.

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. Call Mary Sue O'Brien at ext. 4-5090.

Thursday, October 28

Caltech Architectural Tour—The Caltech Women's Club presents this free service, which is open to the public. The tour begins at 11 a.m. and lasts about 1 1/2 hours. Meet at the Athenaeum front hall, 551 S. Hill, Pasadena. Call Susan Lee at (626) 395-6327.

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

Y2K Readiness—Kimberly Simpson will moderate a panel comprising members of JPL's Y2K Project and JPL Security and which will discuss the Lab's Y2K compliance efforts and what employees should know about the year 2000 transition. At noon in von Kármán Auditorium.

Friday, October 29

JPL Perl Users Group—Meeting at noon in Building 301-127.

News Briefs



Top photo: astronaut candidates and former JPLers Drs. John Olivas (left) and Stan Love sign autographs at Family Day. Bottom: Roger Gibbs shows visitors the Mars Yard.

Members of the Mars '98 operations team who worked on Mars Climate Orbiter are now gearing up for the upcoming landing of Mars Polar Lander on Dec. 3.

JPL Director Dr. Edward Stone and Mars Surveyor Operations Project Manager

Richard Cook discussed with Universe the preparations under way for the mission.

Q: Dr. Stone, following the loss of Mars Climate Orbiter, what do you believe is the most important thing for employees to keep in mind?

Stone: The primary objective for the Laboratory now is not to look back, but to focus on Dec. 3. That's the key. All of our energies need to be focused on whatever needs to be done to assure a successful landing for Mars Polar Lander.

Q: As landing day approaches, how is the morale of the Mars team?

Cook: Obviously, the team was extremely disappointed by the loss of the orbiter. Yet, in a sense, having Mars Polar Lander coming up in less than two months is really the best thing for them. Everybody is moving on as rapidly as they can and focusing on what needs to be done.

Q: Can the loss of the orbiter in some way help the team ensure success on the lander mission?

Cook: Yes. We're using this opportunity to take a bottoms-up look at the risks we're taking and make sure we're doing all the right things. It allows us to see that everything really does work. Personally, I'm optimistic because I know the caliber of the people working on the flight team. To a person, they are committed to ensuring the success of Mars Polar Lander. I'm also extremely proud of the way they are handling adversity while staying focused on MPL.

Q: Review teams within JPL and from NASA are probing the causes of the loss of Climate Orbiter. How can their findings be used to help Polar Lander?

Cook: These reviews should help us identify process improvements that we can immediately apply to help the lander mission. We had already identified some improvements, but additional recommendations from the boards should be very helpful. One change that we are making is to improve our quality assurance, to make it as sound and as all-encompassing as possible. We are also increasing the fidelity of our operations testing to exercise more contingency paths. We are going back and taking a look at what we call an end-to-end risk tree or failure tree, and see where we might have holes. So we're updating our assessment of risk. We've also brought in other external organizations to help us with our processes and to provide us with another double-check.

Q: How are these external organizations helping you with Polar Lander?

Cook: A particularly good example is a team from Langley Research Center, which is helping us go over all the simulations we've done to validate the lander's entry, descent and landing system. They are uniquely qualified to do this work and will help us to verify all of the atmospheric entry and terminal guidance simulations that are performed.

Q: So the checks that are going on are not in reaction to Climate Orbiter's loss?

Stone: Most of these activities are, in fact, not in reaction to the orbiter. We'll know very shortly what the orbiter's problems were, but we are not limiting what's being done to just addressing those issues.

Cook: I can say right now that the specific problem that led to the loss of Climate Orbiter—one team providing thruster activity information in imperial units with another using the metric system—will not occur with the lander. We're already done assessing that.

Stone: That isn't the main issue, however; the main issue is the process that should have recognized that situation. But rather than just focus on that process, we're taking a second look at all the processes, all of the critical elements and the hard parts of landing on Mars.

Q: Can you address recent concerns about the state of the lander mission, particularly a potential problem with the spacecraft's flight aeroshell?

Cook: This is a good opportunity to put some of those rumors to bed. During final inspections at Kennedy Space Center before launch, a very small pinhole was detected in the substrate, the structural backing behind the aeroshell. At the time, there was no real concern about it. But since the launch in January, some on the project suggested we make sure it's not a problem.

So just last week, we completed a set of tests using what's called an arc jet—like a giant blowtorch—at Ames Research Center, which effectively tests the heating environment we expect for the spacecraft's entry to Mars. The tests were completed with that small pinhole, and everything looked fine—the aeroshell worked exactly as planned.

Q: What is the plan for direct-to-Earth communication with the lander and the use of Mars Global Surveyor as a relay?

Cook: The Deep Space 2 mission, which will last for about about a week, will rely solely on Mars Global Surveyor for Earth communication. So for the first week or so of the lander mission, we will primarily depend on the lander for direct-to-Earth communication. After that, we'll be able to use Mars Global Surveyor for the relay of the lander data.

We will soon do end-to-end validation testing of our engineering unit copy of the Mars relay hardware at Lockheed Martin. We did that before launch, but we think it's useful to repeat those tests.

We've sharpened our pencils about how we might use direct-to-Earth; it would only extend the amount of time it will take to do things at the beginning of the mission. We're probably not going to get color panoramas within the first couple of days, like Pathfinder did; it will probably take three or four days this time. But we will get enough data to do a really successful science mission.

Q: Dr. Stone, do you feel that the reviews and extra attention to detail on Polar Lander will help lead to a successful mission?

Stone: I'm confident that we will have a successful landing, and the processes and additional checks we're going through will help us make sure we've got it exactly right. Our internal activities already in place are looking at all the critical areas, and the JPL review team led by John Casani, as well as the external NASA review team, will make independent assessments of what can be done to assure a safe landing on Mars.

Q: On another subject, Galileo's flyby of Jupiter's moon Io this week has given JPL another shot in the arm, hasn't it?

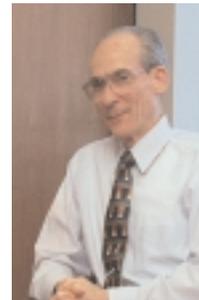
Stone: Yes. The successful Io flyby is a very important milestone. The team did a tremendous job in recovering the spacecraft from "safe mode," identifying the problem with the computer's memory and restoring the sequence, all during the day of encounter. It's a testimony to the skill the Laboratory has in dealing with complicated missions in difficult environments.

Learning from the occasional setback is critical to honing those skills in the new era of going often, landing and bringing samples back.



"Personally, I'm optimistic because I know the caliber of the people working on the flight team. To a person, they are committed to ensuring the success of Mars Polar Lander. I'm also extremely proud of the way they are handling adversity while staying focused on MPL."

Richard Cook
MARS SURVEYOR OPERATIONS
PROJECT MANAGER



Bob Brown/JPL Photo

In December,
JPL's next
Mars adventure
will begin

By Mark Whalen

POLAR LANDER APPROACHES

