

Dawn of the solar system

Spacecraft enters orbit of dwarf planet Ceres | **By Mark Whalen**

JPL has reached another new world. This time, it's one most people have never heard of.

The anonymity won't last long. The Dawn spacecraft has entered orbit around Ceres, the largest object in the main asteroid belt between Mars and Jupiter. This marks the first time

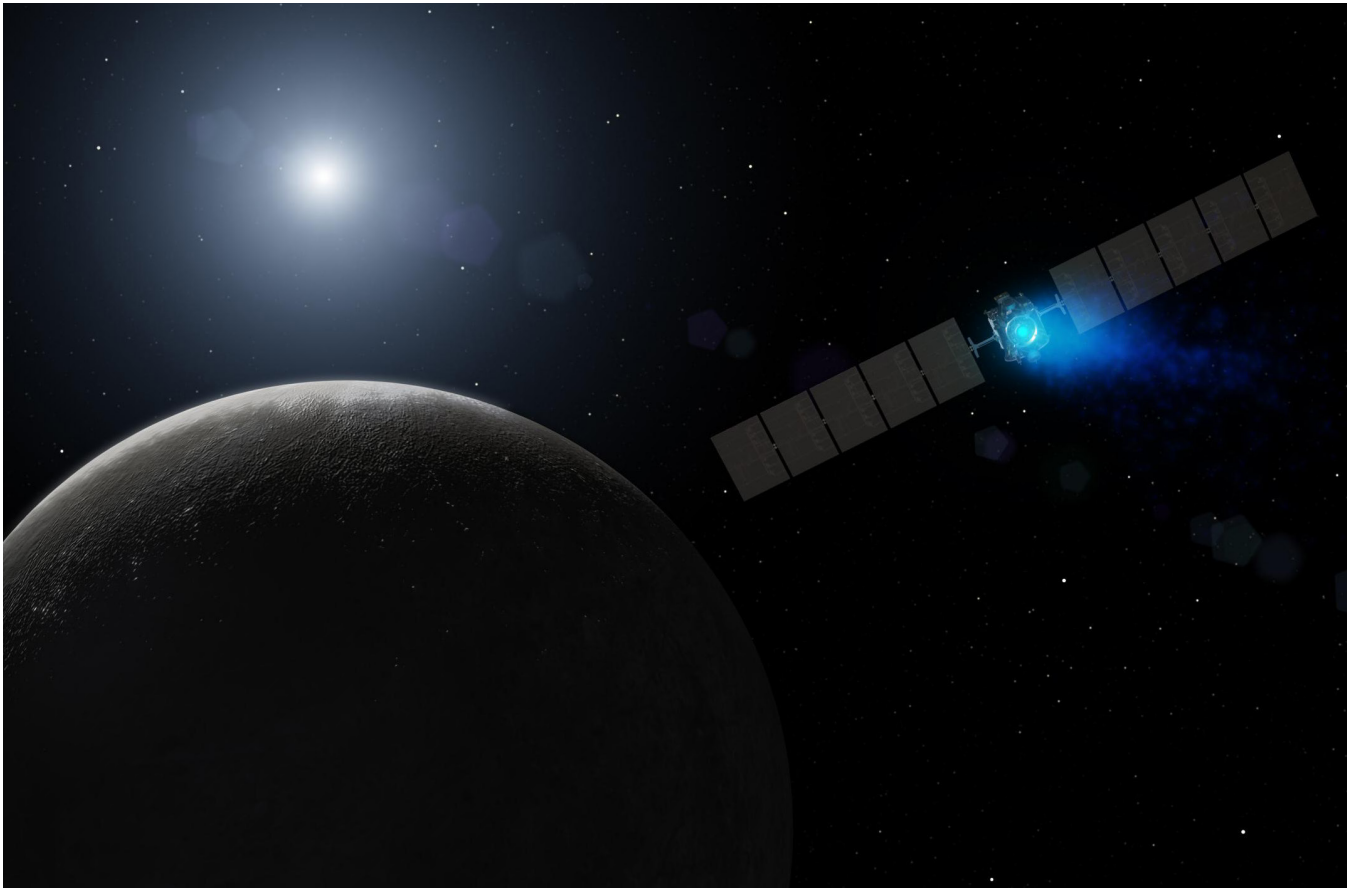
a spacecraft has encountered a dwarf planet.

"Ceres has beckoned us for more than two centuries. Since its discovery in 1801, it has been known as a planet, then an asteroid and later as a dwarf planet," said Dawn Mission Manager Marc Rayman. "And now, after a jour-

ney of 7½ years and more than 3 billion miles, Dawn is about to call it 'home'."

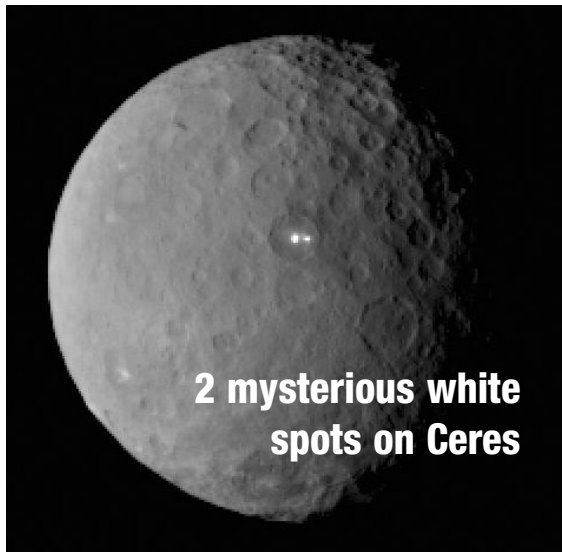
Dawn, which entered Ceres' orbit March 6, will reveal the nature of this water-rich, planetary building block that shares characteristics with the icy moons of the outer solar system.

Continued on page 2



DAWN *Continued from page 1*

Ceres is very different from its sibling, protoplanet Vesta, which Dawn visited from mid-2011 to late 2012. The detailed examination of these two very



different protoplanets will help inform models of how planets formed and the role of wet objects in bringing water to the inner solar system.

Scientists are particularly anxious to solve the mystery of two bright spots on Ceres, shiny beacons that have illuminated the dark gray surface of the planet upon approach. But better views will have to wait until April 23's first intensive science observations, as Dawn's orbit began on the dark side of Ceres.

"Starting then, we'll get much better views of Ceres from several vantage points, details of the surface and how the body rotates," said deputy principal investigator Carol Raymond. She added that there will be an opportunity to follow up on the detection of water vapor made by the Herschel Space Observatory last year.

"The Herschel observations indicate that there is outgassing, which could result from the release of water vapor

from sublimation of the ice, but there could be some active processes going on as well," said Raymond.

One hypothesis on the bright spots posits water vapor emissions that have left deposits on the surface. "It would be surprising if it were ice," said Raymond. "It could be a salt deposit that was left behind after the ice sublimated. It's likely related to some ice in the subsurface."

Some scientists think there's an ice layer on the order of 50 kilometers thick near the surface, she added. "Beneath that could be a thin layer of water, likely only in the equatorial region. Ceres' near-surface temperature is largely regulated by its solar insulation; the poles are always colder."

At an altitude of about 8,400 miles, Dawn's first observation orbit in late April and early May will provide images of the bright spots that are more than three times sharper than the best they now have, said Rayman. Dawn will spiral to progressively lower orbits throughout the year. "By the end of the year, in our lowest orbit, the pictures will be well over 100 times better than what we have now," he said.

About 45 people comprise Dawn's flight operations team, almost all JPLers. There are a few staffed at UCLA (home of Dawn's principal investigator, Chris Russell), with support from industrial partner Orbital ATK.

"The approach has gone exceptionally smoothly," said Rayman. "I'm very proud of the flight team for the superb

plan they devised for this unique approach and for the expertise and diligence everyone continues to bring to its execution."

Raymond said the science team includes about 80 co-investigators or participating scientists from across the United States as well as Germany, Italy and France.

JPL's Alex Konopliv, Ryan Park and Sami Asmar will conduct a gravity investigation using Deep Space Network Doppler, range-tracking data and landmark tracking from camera images to measure Ceres' gravity field and other parameters such as the body's spin pole, rotation rate and ephemeris. Gravity field data, together with the shape determined from camera images, are used to constrain models of Ceres' interior, said Konopliv.

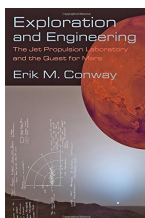
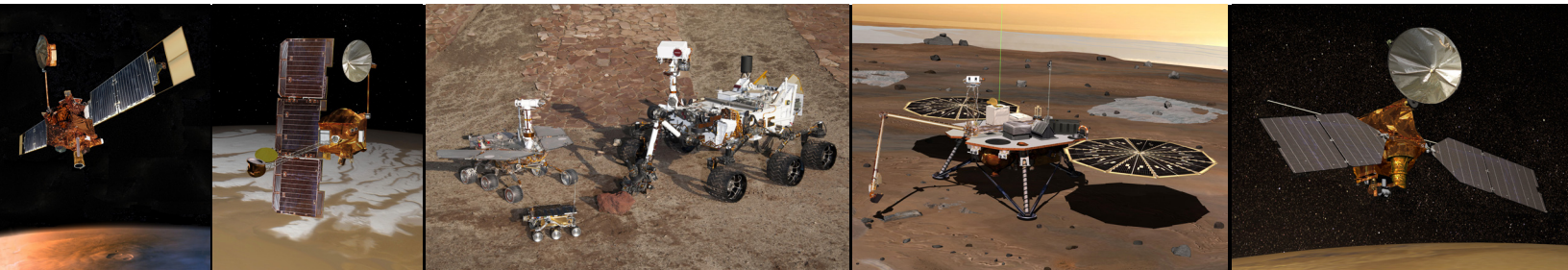
Dawn's spectrometers will provide a global map of the composition of Ceres' surface. After that, the spacecraft will spiral down to an orbit that allows scientists to get very detailed shape information to build a topographic map of the surface and start mapping geologic features in keen detail.

In its final orbit, just 230 miles above the surface, the team will map Ceres' elemental composition and its gravity field, and look at surface features as small as 40 meters across.

"By the time we finish in mid-2016 we're going to know Ceres in exquisite detail," said Raymond. "It's such a cool journey to be on. We're going to understand why it has very bright spots that are unique to any body in the solar system that's been explored thus far. And we're going to understand what Ceres means in terms of a building block for planets in our solar system." ■

Two decades at Mars

Book probes an era when JPL sent 10 spacecraft to the Red Planet | **By Franklin O'Donnell**



*In two decades between the 1990s and early 2000s, JPL sent 10 spacecraft to Mars—an era when NASA was working to implement rapid, low-cost missions under the “faster-better-cheaper” philosophy. During that time, JPL safely delivered the first three rovers to the Red Planet, along with three orbiters and a lander, but also lost three missions. JPL Historian Erik Conway examines that era in a new book, *Exploration and Engineering*. Here he discusses his findings and what he learned along the way.*

Why did you decide to write about this particular era?

The main story arc of this time period was the philosophy of “faster-better-cheaper” that Dan Goldin brought to NASA when he served as administrator in the 1990s. I wanted to look at how all of the missions connected to each other—or, in some ways, how they didn’t. The NASA history program is really focused on books about individual missions, but I wanted to look at the Mars Program, to examine the relationships between projects.

So you begin with Mars Observer, the orbiter that launched in 1992?

Yes. Mars Observer was conceived in the 1980s, when NASA was trying to figure out what to do on Mars after the Viking orbiters and landers. It was to be a fairly complex orbiter with a substantial payload of science instruments, but there was also a desire to make it as low-cost as possible. So it was built using the design for a commercial Earth satellite.

And just as it was arriving at Mars in 1993, it was lost.

Yes. The official conclusion in the failure report was that the loss was caused by a leak in the propulsion system. But other people have different views; there are some at JPL who believe that other factors caused the failure. We will never know the answer, however.

And after that?

NASA Headquarters was very keen to re-fly the instruments lost on Mars Observer, and this led to Mars Global Surveyor, which launched in 1996. However, NASA wanted to do it for a lot less money, so it was constrained to a smaller launch vehicle, which in turn meant that you couldn’t fit on as many science instruments. Global Surveyor orbited Mars very productively for nine years. I attribute its success, both in terms of mission return and low cost, to the fact that it was able to take advantage of a lot of work done for Mars Observer.

And then there was Mars Pathfinder, the lander launched in 1996 that carried the first rover to the planet, Sojourner.

Yes, this was one of the first two missions under NASA’s Discovery Program of low-cost missions. Both of these two missions were assigned, not competed like the later Discovery missions, because NASA felt it needed to do so to get the program going. Originally NASA wanted Pathfinder to be done by the Ames Research Center—the idea was to give JPL competition in low-cost missions—but Ames couldn’t commit to doing it while they were involved in a high-priority astronomy mission. So it came to JPL.

Continued on page 4

What do you think made Pathfinder so successful?

More than anything else it was their insistence on testing. At the same time the cost was constrained; the people running the mission were experienced and knew what corners could be cut safely and which couldn't. Of course it ended up being a great success.

But then came Mars '98, and the back-to-back failures of the Mars Climate Orbiter and the Mars Polar Lander.

Yes, that was really the nadir of the "faster-better-cheaper" era.

Have the theories about what caused each spacecraft to fail stood the test of time?

In the case of Mars Climate Orbiter, yes—it involved lines of code that were removed from the propulsion software that converted between imperial and metric units.

Essentially it braked too hard, and burned up in the upper atmosphere. As for Mars Polar Lander, the official loss report said the most likely cause was that its retrorockets cut off too early during its final descent, causing it to crash.**Does that still hold together?**

That isn't what the Mars Phoenix project found a few years later when they redid the mission, using hardware built for a 2001 Mars lander. They found a number of other problems—for example, the parachute was the wrong size, and the structure that attached the parachute to the lander deck was too weak.

After that, the Mars Program had to work hard to recover.

Yes. There was another orbiter-lander pair in the pipeline for the 2001 launch opportunity. The orbiter, named 2001 Mars Odyssey after launch, went ahead and continues to function in Mars orbit today. It flew some of the instruments from Mars Observer that could not fit on Mars Global Surveyor.

The 2001 lander, however, was cancelled. Originally it was going to carry a rover called Athena, but that had gotten too big and was removed even before Mars Polar Lander failed. But with the Polar Lander failure, the '01 lander was shelved.

And then?

There was a short-term competition to decide what to launch in 2003. That was a fairly chaotic period, with a lot of different ideas. When it settled down, the Mars Exploration Rover project was approved in the summer of 2000. Originally it was going to

be a single rover, but Dan Goldin thought it would be a good idea to have a backup—so it ended up as two rovers, Spirit and Opportunity.

It was a short-fuse project, planned in only eight months. Like Pathfinder it involved a lot of testing, but on steroids—whereas Pathfinder did 16 full-scale airbag tests, MER did 80.

The next U.S. Mars mission was another orbiter—Mars Reconnaissance Orbiter—launched in 2005.

Yes. At that time, NASA Headquarters and JPL were still intent on doing a Mars sample return mission in the early 2010s. To do that, they had to figure out a way to better certify landing sites for safety. That was the engineering reason for the big HiRISE camera on MRO.

Otherwise, MRO was generally similar to the previous orbiter, Odyssey, except that it had more redundancy built in. It was designed to be less prone to single-point failures.

The final mission you deal with is Mars Phoenix—which, as you note, was a redo of Mars Polar Lander.

It turned out that when the Mars '01 lander was cancelled, more than 70 percent of the spacecraft had been completed, and it ended up in storage. So Phoenix made use of a lot of that hardware. By the time of Phoenix, the faster-better-cheaper story cycle was over, and the testing culture at JPL was firmly reestablished.

Overall, was "faster-better-cheaper" a failure for JPL?

I wouldn't say so. Mars Pathfinder and Mars Global Surveyor were great successes of faster-better-cheaper. Pathfinder worked because the science complexity was reduced—it was really a meteorology station with a little bitty rover. The Stardust mission to a comet was another example of a success.

But faster-better-cheaper in general doesn't work well for Mars because too much attention is paid to missions in the media. The Defense Department can lose a billion-dollar satellite without public outcry, but when NASA loses a Mars mission of any size, it's a big deal. More risk or less science are the two paths to low-cost missions, but the public relations risk of Mars mission failures seems to be beyond what NASA can bear. ■

Retirees

The following employees retired in February:

Donald Yeomans, 39 years, Section 3920; **William Imbriale**, 35 years, Section 3330; **Patricia Liggett**, 31 years, Section 393F; **Fabrizio Pol-lara**, 31 years, Section 3320; **Janet Zadeh**, 31 years, Section 1700; **Brenda Jackson**, 30 years, Section 2150; **Charles Weisbin**, 26 years, Section 1011; **Keith E. Wilson**, 26 years, Section 337E; **Donald Plagge**, 23 years, Section 2820; **Alison Weisbin**, 23 years, Section 5330; **Alan Stepak-off**, 22 years, Section 1780; **Calvin Chambers**, 21 years, Section 2500; **Margareth Olm**, 17 years, Section 8010; **Terrance Huntsberger**, 16 years, Section 347J; **Jean Smith**, 14 years, Section 1000.

Passings

Fred Bond, a retired communications operations manager with the Deep Space Network, died Nov. 11.

Bond joined JPL in 1964 and retired in 1977. He was responsible for operations and control of communications between tracking stations in Africa, Spain, Australia, Goldstone, Calif. and JPL's Space Flight Operations Center. He contributed to the Ranger, Pioneer, Surveyor, Mariner, Lunar Orbiter, Viking and Voyager missions.

Bond is survived by his wife, Maya.

Edgar Blizzard, 81, a retired computer programmer, died Jan. 26.

A U.S. Air Force Korean War veteran, Blizzard joined JPL in 1970. He contributed to the Pioneer, Viking, Voyager and Galileo missions. His 1985 deep-space communications work with Voyager 2 (during the Uranus closest approach) created a last-minute patch that enabled photo transmissions. He retired in 1995.

Blizzard is survived by his wife, Jillene; sons Devin and Darin; daughter Danica Money; grandchildren Magenta, Jacob, Alex and Jack; and siblings Margie Kaufman, Jean Vendel, Walt Blizzard and Patty Burkett.

The Blizzard family requests consideration of donations to the Alzheimer's Foundation.



Jon Inskeep

Jon Inskeep, 81, a retired instrumentation engineer, died Feb. 15.

Inskeep worked at a JPL facility at Edwards Air Force Base before transferring to Oak Grove in 1968. His work at JPL included rocket testing and part design for spacecraft, as well as mili-

tary and civilian projects.

He is survived by his wife, Susan; children Mike, Wendy, Jon and Dan; grandchildren Helena, Caleb, Patrick, Alicia, Jon, Reid and Erin; stepmother Prissila and half-sisters Eppie and Meg.

Inskeep's family requests consideration of donations to the Villa Gardens Employee Fund.



Fred Gooden

Retired JPL fire chief Fred Gooden, 73, died Feb. 27.

Gooden joined JPL in 1989. He retired as an employee in 2000 and continued to serve JPL through fire department contractor Wackenhut through 2007.

Gooden is survived by his wife, Linda; sons Russel Berry and Frederick

Gooden; daughter Kathy Gooden-Tyree and sister Barbara Brewton.

A memorial service will be held Friday, March 20 at 11 a.m. at the Veterans National Cemetery, 950 S. Sepulveda Blvd., Los Angeles.

Letters

Thank you to my JPL friends and colleagues for your kindness and words of sympathy during the passing of my grandmother in January. My family and I truly appreciate your support. Thank you also to JPL for the beautiful plant and card sent to my house.

Karen Lum

To our friends and colleagues at JPL, we would like to thank you all for the condolences that we received on the sudden passing of our son, Enrique. Our JPL family has been overwhelmingly supportive so please accept our sincere thanks for your thoughts, prayers and for the beautiful plant.

Enrique and Martha Aviña

A heartfelt thank you to my friends and co-workers for your condolences and support on the passing of my brother, Gary. He always loved to talk about JPL and what we were doing in the space programs. The cards and plants were appreciated by the entire family.

Lloyd Keith

Thank you to JPL friends and colleagues for condolences and support following my mother's death. A special thanks to my teammates on the Mars Odyssey project for the thoughtful gift.

Jeffrey Plaut

Thank you to my co-workers and other JPL friends for your condolences and support after the recent passing of both my stepfather and father-in-law within a few weeks of each other. We also appreciate the beautiful plants from JPL. It's a wonderful reminder how JPL cares for us all.

Kevin Clark

My family and I wish to thank all of my JPL colleagues and friends for the notes and messages of condolence on the recent passing of my father. He and my mom were together for over 58 years, and although his illness with cancer was a difficult time for all of us, we (his wife, children, grandchildren, and great-grandchildren) have many, many happy and wonderful memories of our life with Huelo-Honey. Thank you also for the wonderful plant delivered to my home. It's a daily reminder that life is beautiful.

Randy Herrera

Classifieds

Ads submitted Feb. 28–March 9. To submit an ad, e-mail universe@jpl.nasa.gov.

For Sale

ARMCHAIRS (2), lovely leatherette, in vg condition, pictures available; \$99/each; take the sofa and all three for \$250; pictures available; in Burbank. 818-736-1169.

BOOKSHELVES: 138-plus linear feet in 10 contemporary style bookcases, various in white and wood-grain vinyl, good condition, pick up in Pasadena; e-mail for list. memorgan99@earthlink.net.

DESK, a beautiful example of Art-Deco Venetian style, vg condition, measurements 44 x 27 x height 40; see <http://losangeles.craigslist.org/sfv/fuo/4864752642.html>; original price \$2,250, sell for \$650/obo. 818-736-1169.

SCUBA TANK, steel 72 cu. ft., just passed hydro and visual inspection; tech said it looks "absolutely beautiful" inside; the 1/2" J-valve makes it easy to carry and is in excellent condition; \$75. dgumpertz@live.com.

VACUUM CLEANER, Hoover bagless upright, model U5262900, new HEPA filter and belt, all attachments included; see <http://losangeles.craigslist.org/sgv/app/4914620116.html>; \$45. Peter: 310-850-7845, pmkroger@verizon.net.

Vehicles/Accessories

'08 CHEVY Corvette, black coupe, low mileage (37K), in vg condition, 6-speed manual, heads-up display, variable suspension, performance exhaust, run-flats, 435 HP, GPS, automatic seat positioning, one piece removable roof, \$31,800. 626-794-7498, barneswilma@att.net.

'00 JEEP Wrangler Sahara, tan/green int., 4x4, ~76,000; interior and exterior are in good condition, custom ARB front bumper with integrated WARN 9000 winch and custom bulletproof rear bumper and cargo basket with dual lockable Jerry Can mounts make this vehicle unique; top is clean with no rips or tears, a/c works well; \$13,500. jnarva@cobaltsphere.com or 407-252-8728.

Wanted

SPACE INFO/memorabilia, U.S./other countries, past/present, for personal use (<http://www.youtube.com/watch?v=S7PvjGp7mCU>). mrayman@alumni.princeton.edu, 818-790-8523, Marc Rayman.

Free

GARDEN TOOLS: manual lawn mower, manual lawn edger, to good home. Pcstek@sbcglobal.net.

Lost & Found

LOST: activity notes, April 2006–March 2007. SOSNotez@riseup.net.

For Rent

ALTADENA, one room in a lovely 3-bd./2-bath house, big backyard, hardwood floor, big closet, furnished or unfurnished, shared bathroom, kitch-

en and laundry privileges; 5-minute drive to JPL, close to public transportation; short- or long-term lease available; must like dogs and be very clean; \$750 furnished, \$700 not furnished, including utilities + \$650 deposit. 626-712-3451.

ALTADENA, furnished room with view for lease; non-smoker to share a 4-bedroom, 3-bath house; close to local colleges and Pasadena schools, walking distance to JPL, utilities are included, central air/heat, Internet access; near 210/134/110, bus stop, shopping, banking, entertainment and restaurants; must see; \$710. 818-370-0601.

ALTADENA apt., ground floor, appliances optional, freshly painted, 2 bedrooms, 1 bath, fireplace, good size closets & bedrooms, carpeting, tile in kitchen & bath, miniblinds throughout, carport parking, storage, laundry room on site; very close to Odyssey Charter School, JPL, bus stop, grocery stores, shops, pharmacy, 24 hour fitness and bank, clean; \$750. 818-370-0601.

Vacation Rentals

BIG BEAR lakefront, luxury townhome, 2 decks, tennis, pool/spa, beautiful master bdrm. suite, sleeps 6. 949-786-6548.

BIG BEAR LAKE, newer cabin, 3 bedrms., 3 baths, sleeps 9, knotty pine on quiet cul-de-sac, 50" HDTV w/HBO, spa tub in master, central heat/AC, BBQ, WiFi, 2-car garage, no pets. 818-952-2045.

BIG BEAR LAKE, huge mountain chalet, 8 bedrms., 7.5 baths (2 spa tubs), sleeps 18, cable TV in each room, pool table, deluxe kitchen w/prof appliances, <1 mi. to slopes, no pets. 818-952-2045.

JACKSON HOLE, WY: Luxurious bed and breakfast nestled on 3 acres of solitude on the Snake River and down the road from the Jackson Hole Mountain Resort and the south entrance to Grand Teton National Park; see <http://www.bentwoodinn.com/>; mention JPL for employee discount. <<mailto:info@bentwoodinn.com>>, 307-739-1411.

MAMMOTH, Snowcreek, 2 bd., 2 ba. + loft, sleeps 6-8, fully equip'd kitchen incl. microwave, D/W, cable TV, VCR, phone, balcony w/mtn. vw., Jacz., sauna, streams, fishponds, close to Mammoth Creek, JPL discount, no pets. 626-798-9222, 626-794-0455 or valerie@caltech.edu.

MAMMOTH, Snowcrk, beautiful updated condo, 2 bd., 2 ba. + loft (slps. 6-8), great loc. by pond & meadow, new appliances, TVs, DVD players, free wireless Internet access + washer/dryer, no pets. 818-952-2696 or BigMtnPrettySky@gmail.com.

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

OCEANSIDE white-water view beach condo; new virtual tour: <http://www.previewfirst.com/mls/33034>; 2 bd., 2 ba., sleeps 6; well decorated and equipped: boogie boards, wet suits, full kitchen, all linens, beach towels; Wi-Fi ready, new flat-screen TVs, daily paper, grocery stores nearby; 2-min. walk to the sand, no roads; JPL and Caltech rates: winter \$1,195/week, summer \$2,150/week; monthly/nightly rates avail., reserve with \$500 deposit; see <http://www.warmfocus.com/video/k/1402-999npacificstc213/video.php>. 760-433-4459, Grace; 831-425-5114, Ginger.



READ AND SUBMIT
CLASSIFIED ADS AT JPL'S
ONLINE NEWS SOURCE
<http://jplspspace>

E-MAIL US AT
universe@jpl.nasa.gov

Universe

Editor

Mark Whalen

Photography

JPL Photo Lab

*Universe is published by
the Communications and
Education Directorate of the
Jet Propulsion Laboratory,
4800 Oak Grove Drive,
Pasadena, CA 91109.*