

## Astronomers set to track asteroid's buzz by Earth

By Mark Whalen

On Friday, Feb. 15, asteroid 2012 DA14 will zip past Earth, coming within 18,000 miles of the planet's surface. The roughly 45-meter-wide rock will make the closest approach for an object of its size that astronomers have ever known about in advance.

But Lance Benner isn't worried. In fact, he's rather looking forward to it.

Benner, from the Asteroids, Comets and Satellites Group, along with JPL colleagues and other astronomers who closely observe near-Earth objects, is taking advantage of the flyby to study the small body.

"Every time an asteroid makes a really close flyby, it's an invaluable opportunity to study it," said Benner. "Radar is a powerful tool for doing that—because we can see features on the object's surface that we can spatially resolve at finer detail than we can achieve with any other ground-based telescope, or any space telescope, short of going there."

**Overall, part of what radar observations do is protect the Earth. It's an inexpensive form of planetary insurance.**

Lance Benner



To get a more precise picture, Benner, along with Marina Brozovic of the Solar System Dynamics Group, will conduct an observation campaign Feb. 16–20 using the Goldstone 70-meter Deep Space Network antenna, which features a high-powered radar transmitter that is one of only two such facilities worldwide. The Arecibo Observatory in Puerto Rico is the other.

"2012 DA14 is going to be a very strong radar target and we should see it very quickly," Benner said. "I'm hopeful that on the first day we'll be able to get radar images with Goldstone's finest resolution of 3.75 meters."

Plans call for tracking 2012 DA14 at Goldstone beginning at 7 p.m. Pacific time on Feb. 15 (3 a.m. Greenwich

Mean Time Feb. 16), which will be several hours after the asteroid's closest approach. The asteroid won't be visible from Goldstone during the closest approach because it will be below the horizon.

"Several hours later, we'll take a look at it," Benner said. "At 7 p.m. it will still be well inside the distance of the moon. The time it will take for the radar signal to go up to the asteroid and bounce back to us is going to be only 1.2 seconds. For comparison, the time for a radar signal to go to the moon and back is 2.6 seconds. So the asteroid will already be outward bound when we can start looking at it with the Goldstone radar."

The principal scientific objectives are to investigate the object's size, shape and spin rate, and to improve the asteroid's orbit by measuring its Doppler shift and distance. Once they're measured, the data are entered into software developed by Jon Giorgini from the Solar System Dynamics Group to generate a new set of ephemerides.

"The measurements will enable us to compute the trajectory farther into the future than we could otherwise," Benner noted. "At roughly 45 meters in diameter, the asteroid may be too small to see detailed surface features, but we could be surprised if it turns out to be bigger than expected."

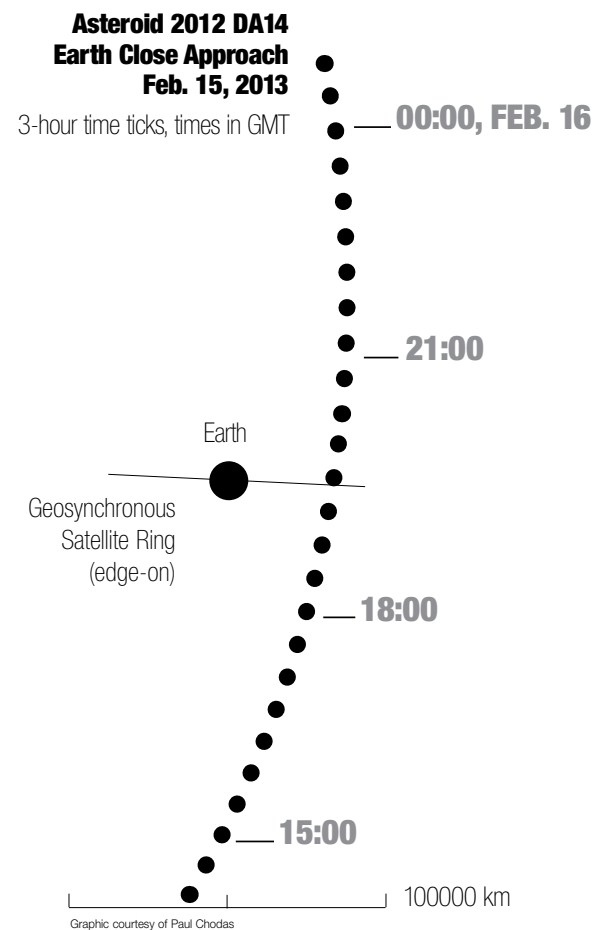
The uncertainties in the asteroid's position in the sky are big enough that Goldstone astronomers would not be able to point the telescope and be guaranteed of actually seeing 2012 DA14 without the help of

professional and amateur astronomers worldwide.

"Other astronomers who use optical telescopes are going to observe it and report their measurements, which will shrink the pointing uncertainties," Benner said. "We've seen dramatic improvements in the last few weeks from astronomers using a telescope in Chile, and others have indicated they will observe 2012 DA14 before the close approach."

The late JPL astronomer Steve Ostro began the program of dedicated radar reconnaissance of near-Earth objects in 1980. The effort has since mushroomed.

"At the time I started working with Steve in 1995, the number of near-Earth asteroids observed with radar was



only 34," said Benner, now one of about 15 people in the radar community who are involved in this kind of work.

"Now we have observed 353."

The impact of the radar observations is particularly notable when considering the potential fate of a small asteroid called Apophis—measuring about 325 meters across, or about seven times larger than 2012 DA14—which Benner said will make an extraordinarily close flyby of Earth on Friday, April 13, 2029. He added, however, that there's no chance it will hit Earth. Apophis will travel to within one-tenth of the distance between the Earth and the moon, about 24,000 miles, and not as close as 2012 DA14 this month.

"We always feel a lot of responsibility to do good work and to be very careful—particularly if there's an object that's a high priority, like Apophis, which we observed at Goldstone in December and January," he said. "There was once a small chance (about 1/250,000) it could hit in 2036 so we checked and checked our recent measurements before we announced anything. The radar data helped determine that Apophis can't hit us in 2036. We will continue to track it at each opportunity to improve our understanding of its future motion."

Asteroid scientists have also become more prominent outside the astronomy community due to the growing awareness of asteroid flybys close to Earth. "The work we do is now much more in the public eye," said Benner. "After the president's speech in 2010 about a human mission



## Curiosity & team land at Obama inauguration

With the U.S. Capitol providing a backdrop, JPLers Jennifer Trosper and Bobak Ferdowski, with NASA's Dave Lavery, walk in the inaugural parade (below). Inset photos: at left, Ferdowski, sporting a JPL logo hairstyle; at right, the procession passes by the president's viewing stand along the parade route. Other JPLers, including Mars Science Laboratory Project Manager Richard Cook and Deputy Project Scientist Ashwin Vasavada, were in Washington, DC for NASA events surrounding the inauguration.

### Asteroid *Continued from page 1*

to an asteroid, there's been much more interest."

Indeed, 2012 DA14 is on NASA's Near-Earth Object Human Spaceflight Accessible Targets Study list of potential mission targets. The information astronomers hope to learn during radar observations of near-Earth asteroids could also have some effect on NASA's decision on which bodies to target for a human mission. For example, one of the key physical properties to understand for any potential mission target is its rotation period. "Five minutes of radar

observations can very quickly tell you whether an asteroid is rotating rapidly or not," Benner said. "If this object has a very rapid rotation period of only a few minutes, then that would rule it out as a human mission target, but if the period is about six hours, as we expect for 2012 DA14 based on results from other astronomers, then that would be attractive for a human or robotic mission."

Benner also noted that the United Nations Committee on the Peaceful Uses of Outer Space has expressed interest in efforts to find and track potentially hazardous objects.

"Overall, part of what radar observations do is protect the Earth. It's an inexpensive form of planetary insurance. By looking at an individual asteroid, making measurements of distances and velocities, and using that information to improve the orbits, we can predict their motion farther into the future than if we didn't have radar measurements—and identify any potential risk much earlier and have more time to do something about it."

For more information on JPL's asteroid radar research, visit <http://echo.jpl.nasa.gov>. ■

# Jackpot find for Curiosity

Yellowknife Bay yields diverse rock and grains, shaped by water

By Mark Whalen

Mars Curiosity's landing site has proven not only to be a safe place for the rover to touch down on the Red Planet, but is surprising team members with the rich science it has to offer.

Even before Curiosity sets off for its ultimate destination at Mount Sharp—about 12 kilometers (7.5 miles) away—the rover has found a high diversity of rock types at Yellowknife Bay, with cracks and veins indicating mineral precipitation. Curiosity has settled for a stay this winter and will perform its first rock-drilling campaign before heading to Mount Sharp.

“The scientists are ecstatic about the kinds of things they’re seeing in this area,” said Project Manager Richard Cook at a Jan. 15 press briefing.

The potential drilling target lies within an outcrop named in memory of the mission's former deputy project manager, John Klein, who died in 2011. “Drilling

**This is at least as complex a history for the involvement of water as we've seen anywhere on Mars so far.**

Project Scientist  
John Grotzinger

is the most difficult aspect of the surface mission, as we're going to interact with unknown Mars surface terrain,” said Cook. “We will probably go slowly.”

“This lowest unit at Yellowknife Bay—the furthest thing we drove to—turned out to be a jackpot unit,” Project Scientist John Grotzinger said. “The rocks are literally shot through

with these fractures. In most cases they're covered with dust, but even when the dust is present, you can still see fractures with veins.”

The veins show, Grotzinger noted, that water percolated through the rocks' fractured networks, then minerals precipitated to form a white material, which Curiosity's ChemCam instrument concluded “is very likely calcium sulfate, probably hydrated in origin.”

“This is the first time in this mission that we have seen something that is not only an aqueous environment but also results in precipitation of minerals, which is very attractive to us,” Grotzinger added. He explained that veins in rocks indicate that they were likely once saturated with water. “It could be several phases of this history of water; we still have that to work out.”

Also of keen interest to the science team are areas of cross-bedding, near-horizontal units consisting of inclined layers. The areas record the passage of sediment in a current that created small dunes, Grotzinger said. As the dunes migrate, they preserve their avalanche



bases and get preserved in the rock record as the cross-bedding.

“In this case, we know the grains that make up this rock are too coarse for the wind to be the current that has pushed the grains along, so we think this was formed in water,” he said. “And the inclination of this cross-bedding is very divergent—another clue we're looking at an aqueous origin here for these deposits.”

R. Aileen Yingst of the Planetary Science Institute, deputy principal investigator for the Mars Hand Lens Imager, noted the “fabulous” images acquired at Yellowknife Bay, including some that approach the camera's best resolution, which is 16 microns per pixel. “We've had an absolute field day at this site,” she said.

Yingst said the wide variety of rock textures ranges from silt—finer than powdered sugar—to pebbles. She said all are sedimentary, indicating other rocks had to be broken down into fragments and transported elsewhere. “This means that Mars, at least in this location, was geologically active enough to have created such rocks,” she said. “This is totally cool.”

The difference in grain sizes truly stands out in the images, Yingst said. “Grain size tells us the strength of the transport mechanism. The stronger the transport mechanism, the larger the grains can be transported. Greater than sand size usually indicates a fluid that is not air that has transported those grains. We see in a lot of these samples that the grain size is larger than that. We also see that they've been kind of knocked around. That starts to indicate to many of us that we're looking at water.”

Grotzinger said plans call for driving to an area of the Klein outcrop where rock veins protrude vertically, breaking up the rocks, and studying them with the Chemistry and Mineralogy Experiment, Alpha Particle

Above: Curiosity's right mast camera provided this contextual view of the vicinity of the location called “John Klein,” selected as the rover's first drilling site.

X-Ray Spectrometer and Mars Hand Lens Imager instruments before starting drilling there. “We're hoping to sample all of the vein-filling material as well as what we call the country rock around it—which has all the likely concretions in it—and get a sense of the mineralogy that makes these up,” he said. “But the main goal is to try and assess this material in a very general way that will give us an appraisal of the habitability of this environment.

“The important thing is—from a relative time scale—the geological data are pointing to this probably being an aqueous environment, with the primary sediments accumulated, then after the sediments get buried, they become fractured,” Grotzinger said. “This is at least as complex a history for the involvement of water as we've seen anywhere on Mars so far.”

Cook said the drilling will go to a depth of about 5 centimeters into the rock target and collect powdered rock material as samples to be analyzed by the rover's Chemistry and Mineralogy instrument and the Sample Analysis at Mars instrument.

Grotzinger appreciates the rover's good fortune in reaching “a really sweet spot” to commence drilling. “This is something that we waited patiently for, and except for the little bit of risk in driving to this destination, this has been really exciting.”

The team, however, hasn't lost sight of the big picture.

“We're all very much committed to making the trek to Mount Sharp,” Grotzinger said. “We've got some really good stuff here to look at, but then we're actively planning to hit the pike when we're done here.” ■

# News Briefs



Jason Rhodes

## JPL science to contribute to Euclid mission to probe 'dark' universe

NASA has officially selected three U.S. science teams to participate in the European Space Agency's planned Euclid mission, one of which is led by JPL.

NASA is a partner in Euclid, a space telescope designed to probe the mysteries of dark energy and dark matter. Euclid is scheduled to launch in 2020.

JPL will provide 16 advanced infrared detectors, as well as four spare detectors, for one of two instruments planned for the mission. JPL will also contribute to science planning and data analysis with the help of its 43-member science team, the largest of the three U.S. teams. This team is led by JPL scientist Jason Rhodes.

The other two U.S. science teams are led by Ranga-Ram Chary of NASA's Infrared Processing and Analysis Center at Caltech and Alexander Kashlinsky of NASA's Goddard Space Flight Center, with seven and three members, respectively.

Rhodes was also appointed by NASA to be a member of ESA's principal 12-member Euclid Science Team and the U.S. representative for the Euclid Consortium's governing body. The Euclid Consortium is an international body of 1,000 members, including the U.S. science team members, and will oversee development of the instruments and analyze the science data jointly.

Of the 43 team members, those based at JPL are Rhodes, Peter Eisenhardt, Alina Kiessling, Leonidas Moustakas, Daniel Stern and Olivier Doré. Mike Seiffert is the U.S. project scientist for Euclid at JPL, and Ulf Israelsson is the U.S. project manager at JPL.

## Mars Science Lab wins Space Foundation award

JPL's Mars Science Laboratory project has been selected as the 2013 recipient of the Space Foundation's John L. "Jack" Swigert, Jr., Award for Space Exploration.

"We are recognizing the mission team for its aggressive and technologically advanced exploration of another planet," said Space Foundation Chief Executive Officer Elliot Pulham. "This incredible mission will yield valuable science about conditions on Mars and enable critical technologies for future missions."

The award is given annually to the person or organization that has made the most significant accomplishment in advancing the exploration of space during the previous year. It will be presented April 8 during the opening ceremony of

the 29th National Space Symposium in Colorado Springs, Colo.

The award honors NASA Apollo astronaut Jack Swigert. Previous recipients include JPL's Phoenix Mars Lander Team, Caltech, JPL, the Mars Exploration Rover team from JPL and, in 2012, the Kepler mission.

## Asmar, Linick take honors

Two JPLers received honors at the recent SpaceOps2012 Conference.

Sami Asmar, a principal scientist and supervisor of the Radio Science Systems Group, received the 2012 International Exceptional Achievement Medal, which recognizes distinguished individuals in the field of space operations and support and whose exceptional contributions were critical to the success of one or more space missions, or who has made significant contributions to the field of space operations. Asmar was recognized for creating a system that has transformed space operations during critical events to acquire information indispensable to the safety and health of costly space exploration missions via radio science systems.

Terry "Dave" Linick, Multimission Ground Systems and Services Program manager, was presented the International Distinguished Service Medal. He was recognized as the initiator of the SpaceOps organization in its current form. His activities date back to 1990 with continuous service in various functions and on SpaceOps committees since then.

For more information, visit <http://www.spaceops.org/content.cfm?pageid=39>.

## Painter starts leadership post

Thomas Painter of JPL's Water and Carbon Cycles Group has begun a term as president of the American Geophysical Union's Cryosphere Focus Group.

A JPL employee since 2010, Painter also serves on the union's Joint Focus Group Fellows Committee, Cryospheric Executive Board and Remote Sensing Technical Committee. He is also an adjunct professor of geography at UCLA, visiting associate researcher in the Joint Institute for Regional Earth System Science and Engineering at UCLA, and adjunct professor of atmospheric sciences at the University of Utah.

His principal research interests are snow hydrology and water resources, energy balance of snow and ice, radiative forcing by light-absorbing impurities in snow and ice, imaging spectroscopy and multispectral remote sensing, and planetary ices.

Memorial services were held Dec. 12 at the Temple of the Universal Spirit in La Crescenta.

**Frank Leppla**, 75, a retired Deep Space Network engineer, died Jan. 4. Leppla worked at JPL from 1962 to 2004. Among his duties was serving as team chief for the Resource Allocation Planning and Project Resource Scheduling teams.

He is survived by his wife, Patti; sons Michael and Joey; and grandchildren Eddie, Vanessa, Sean and Sophie.

A celebration of life was held Jan. 19.



United Way campaign chair Magalene Powell-Meeks and JPL Deputy Director Gene Tattini at an event to thank JPL volunteers.

Thom Wynne / JPL Photo Lab

## JPLers give \$485,000 to United Way

JPLers contributed almost half a million dollars to the 2012 United Way campaign, "Creating Pathways out of Poverty," conducted in November and December.

JPL staff overall raised \$485,595 for the United Way of Greater Los Angeles, which fell just short of its campaign goal of \$500,000. Overall participation of 34 percent was the highest in six years, said campaign chair Magalene Powell-Meeks.

In addition to increasing the overall dollar amount from last year, the 2012 campaign improved 2011 numbers in the number of participants, percentage of participation and the number of leadership givers. The Mars Exploration Directorate showed the highest percentage of participation, at 79 percent. Per capita contributions were \$96—about \$7 higher than in 2011—and the highest in the past 18 years, she said.

Also, JPLers donated 68 boxes of food to help families and seniors during the holidays.

For more information on the campaign, visit [https://gateway.jpl.nasa.gov/sites/EmployeeInvolvement/SitePages/UnitedWay\\_Fund.aspx](https://gateway.jpl.nasa.gov/sites/EmployeeInvolvement/SitePages/UnitedWay_Fund.aspx).

## Activities offered for retirees

JPL retirees are urged to consider joining the Associated Retirees of Caltech/JPL, an organization that since 1984 has provided retirees and pre-retirees with a forum for the exchange of experiences and ideas with colleagues and a place to keep in touch and to participate in social activities.

For 2013 the group has planned

a trip to Viejas Casino and a tour of SpaceX. Recent monthly bus trips have included a tour of LAX, including the flight museum and inside a DC-3; Oktoberfest in Big Bear village; a private tour of Mt. Wilson Observatory; and the Getty Museums.

For more details and application forms, visit <http://www.arcjplcaltech.com> or contact Warren Moore at 818-790-4576.

## Ceremony honors King



Claudia Alexander, project scientist for the U.S. Rosetta Project, addresses a von Kármán audience at "Living the Dream," JPL's tribute to Martin Luther King Jr. Jan. 17.

Thom Wynne / JPL Photo Lab

## Passings

**John F. South**, a retired member of the technical staff, died Sept. 21.

South joined JPL in 1978 and retired in 2001. He was a longtime Division 34 engineer and developer of engineering sensors for spacecraft, including gyros and accelerometers for Cassini and Mars Pathfinder.

In 1995 he received the NASA Exceptional Service Medal.

## Letters

I want to thank my co-workers in Section 347 for the beautiful plant sent to me on the passing of my father, Norton Snyder. Looking at it here at my desk will be a constant reminder of the care and concern shown to me at this rough time and I appreciate this very much. My father was very proud of me working here and loved it every time I sent him a JPL or NASA sweater or coat. Dad once convinced someone he worked on the Apollo program when

he was asked if he worked for NASA. The NASA logo sweater he wore at that time has been bequeathed to my son and now he'll look just as good in it as Dad did.

Stephanie Cowens

## Retirees

The following employees retired in January: **Craig Cheetham**, 37 years, Section 334B; **Shu-chen Lee**, 23 years, Section 5125; **John Martonchik**, 40 years, Section 3285.

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<http://jplspace>

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