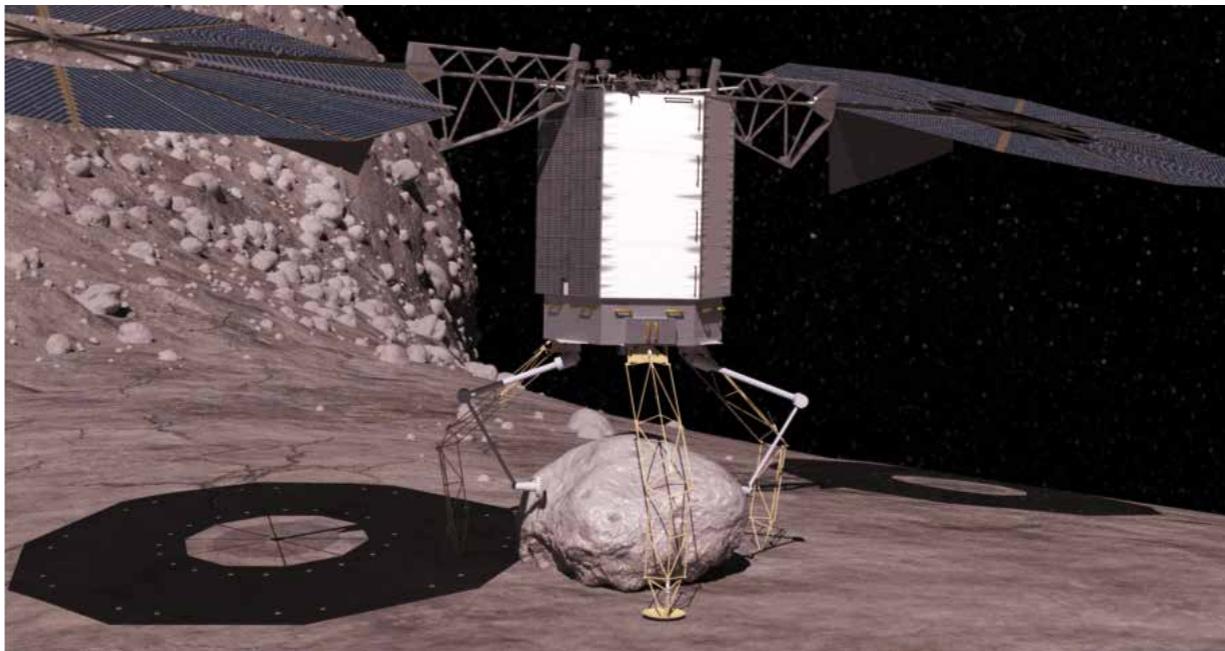


## Space rock lasso

JPL takes on key role for asteroid redirect pre-project | **By Mark Whalen**



Under one option, a robotic vehicle would descend to the surface of a large asteroid to collect a boulder that it can redirect to a distant retrograde lunar orbit.

NASA has designated JPL to be the pre-project lead of the robotic portion of its Asteroid Redirect Mission, a project designed to bring a small asteroid or part of an asteroid into orbit around Earth's moon as a target for astronauts as a stepping-stone to Mars.

The initial segment of the Asteroid Redirect Robotic Mission is targeted for launch in June 2019.

If approved, the robotic spacecraft would capture the asteroid and fly with it as it returns to the Earth-moon system in mid-2020s. The crewed mission taking astronauts to the asteroid for exploration and sampling could launch as early as 2023.

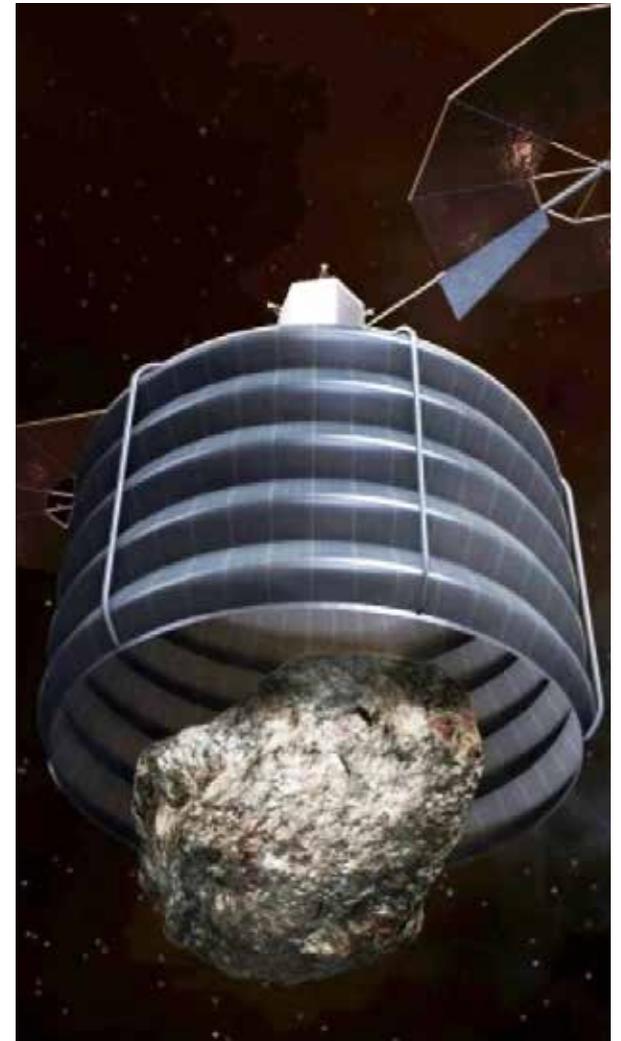
The robotic mission will use an advanced new ion propulsion system, first used on Deep Space 1 and Dawn—but with much more power. “This is a 50-kilowatt system; Dawn is 10,” said JPL Chief Engineer Brian Muirhead, who is leading the effort. “We’re going to have a system that can make use of 10 tons of xenon propellant; Dawn has about half a ton.”

The JPL-led multi-center team is doing pre-formulation work in preparation for a mission concept review next February 2015, said Muirhead. The team is currently defining and developing two different mission options.

Under the first option, the spacecraft would rendezvous with an asteroid with a diameter of 10 meters or less, said Muirhead. “We will capture the body, which may be a loosely held together rubble pile, in a bag. After capture we will nudge it to change its trajectory, so that it will fly by the moon, where lunar gravity will cause the asteroid and spacecraft to enter a very stable retrograde orbit.”

The second option calls for extracting a boulder 2 to 3 meters across from an asteroid about 100 meters in diameter, bringing it to the same lunar orbit. Either option would allow astronauts aboard an Orion spacecraft to visit and study the body and return samples to Earth laboratories.

The asteroid initiative is a unique example of teamwork between NASA centers, Muirhead noted. Glenn Research Center is focusing on the solar electric propulsion module while Goddard Space Flight Center would develop proximity operations sensors for the robotic and crewed missions and provide robotic arms. JPL is also working closely with Johnson Space Center, which leads NASA's human exploration program, in defining the interfaces for the crewed mission to develop a crew safe vehicle.



Under another option, the robotic spacecraft would use an inflatable bag to capture a small asteroid.

NASA's Science Directorate will continue discovering and studying potential candidate targets through the Near Earth Objects Observation Program, managed by Don Yeomans at JPL.

The pre-project team is also evaluating options to demonstrate techniques for “planetary defense” to deflect asteroids that could threaten our planet. “We’re looking at how to demonstrate a couple of basic techniques that we could possibly use as part of a strategy to deflect a potentially hazardous asteroid,” said Muirhead.

Meanwhile, JPL's development team is working risk-reduction tasks including building and testing a new one-fifth-scale testbed of the capture bag system designed to work in Earth gravity as it would in space.

Muirhead, who served as project manager of JPL's Mars Pathfinder and Deep Impact missions, is no stranger to NASA's human spaceflight endeavors. He was chief architect and program systems engineer for the agency's Constellation Program, which created the architecture for a new human exploration spaceflight system to the moon and beyond.

# Surface Water and Ocean Topography mission moves forward

NASA and the French space agency Centre National d'Études Spatiales have agreed to jointly build, launch and operate a spacecraft to conduct the first-ever global survey of Earth's surface water and to map ocean surface height with unprecedented detail.

NASA Administrator Charles Bolden and French space agency President Jean-Yves Le Gall signed an agreement May 2 to move from feasibility studies to implementation of the Surface Water and Ocean Topography mission. JPL will manage the U.S. portion of the project.

The two agencies plan to complete preliminary design activities in 2016, with launch planned in 2020.

Swot is one of the NASA missions recommended in the National Research Council's 2007 decadal survey of Earth science priorities. The satellite will survey 90 percent of the globe, studying Earth's lakes, rivers, reservoirs and ocean to aid in freshwater management around the world and improve ocean circulation models and weather and climate predictions.

This new agreement covers the entire life cycle of the mission, from space-

craft design and construction through launch, science operations and eventual decommissioning. NASA will provide the payload module, the Ka-band Radar Interferometer instrument, the microwave radiometer with its antenna, a laser retroreflector array, a GPS receiver payload, ground support and launch services.

The French space agency will provide the spacecraft bus, the Ka-band Radar Interferometer instrument's radio frequency unit, the dual frequency Ku/C-band nadir altimeter, the Doppler Orbitography and Radiopositioning Integrated by Satellite (DORIS) receiver package, satellite command and control, and data processing infrastructure.

The mission will use wide-swath altimetry technology to produce high-resolution elevation measurements of the ocean surface and the surface of lakes, reservoirs and wetlands. A more complete inventory of Earth's lakes and the changing amount of water they hold will yield improved assessments of how climate-induced changes can impact freshwater resources worldwide. Only



NASA Administrator Charles Bolden, left, and French space agency President Jean-Yves Le Gall sign an agreement to proceed to implementation of the Surface Water and Ocean Topography mission, slated to launch in 2020. JPL will manage the U.S. portion of the project.

15 percent of lakes around the world are currently measured from space.

The mission will be able to measure the ocean's surface with 10 times the resolution of current technologies, which will allow scientists to study small-scale

features that are key components of how heat and carbon are exchanged between the ocean and atmosphere.

For more information on the mission, visit <http://swot.jpl.nasa.gov>.

## Sea level-change web portal on the way

By Mark Whalen

In response to critical needs to increase sea level-change research and provide timely data to scientists and the general public, JPL will develop a web portal that will serve as a "one-stop" source for current information.

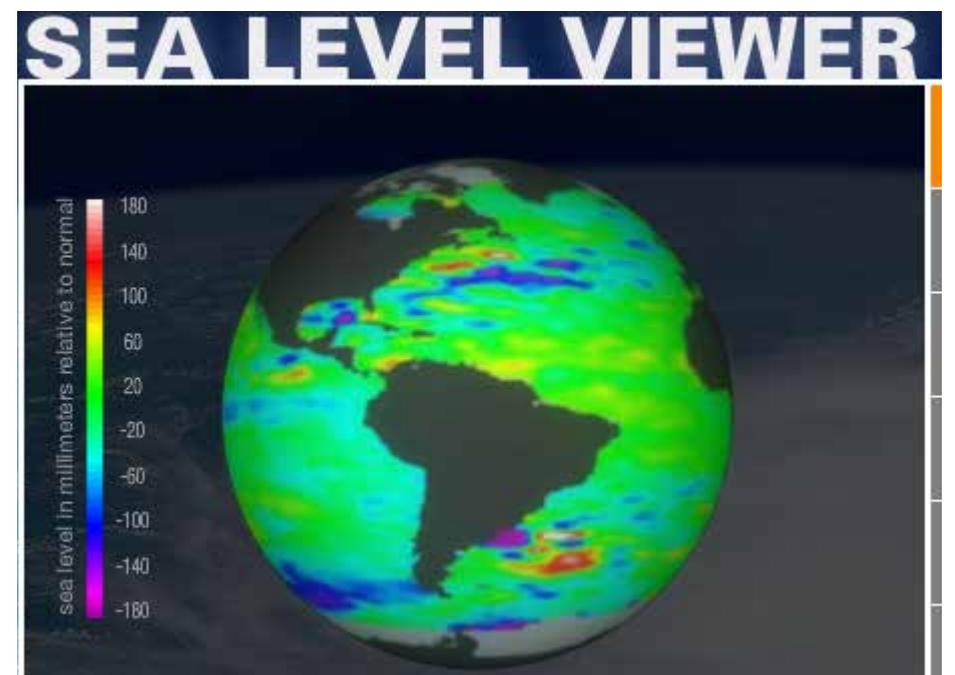
The sea level-change portal was awarded under a recent NASA Research Opportunities in Space and Earth Sciences call. Principal investigator is Carmen Boening. Co-investigators are Andrew Bingham, Michael Greene, Randal Jackson, Amber Jenkins, Bill Patzert, Laura Tenenbaum and Victor Zlotnicki.

"With increasing global temperatures warming the ocean and melting ice sheets and glaciers, there is an immediate need both for accelerating sea level-change research and for making this research accessible to scientists in disparate disciplines, to the general public

to policy makers and businesses, and to other stakeholders," said Boening.

"Our team aims to develop an immersive and innovative web portal for sea level-change research that will address the needs of these diverse audiences, that will also serve as a focal point for research carried out under this opportunity, and that will deliver sea-level data in innovative ways," she added.

The portal will include interactive tools for accessing and viewing regional data, a "virtual dashboard" of sea-level indicators, and ongoing updates through a suite of editorial products that include content articles, graphics, videos and animations. By bridging gaps between various Earth science disciplines, the project aims to encompass the cross-community needs in sea-level research not currently provided by existing web portals, said Boening.



Sea Level Viewer 1.0, a feature of NASA's Global Climate Change website, will be significantly updated and enhanced for the portal.

Portal team members also designed and maintain NASA's Global Climate Change website (<http://climate.nasa.gov>), which enjoys a consistent top-four placing among Google searches, noted Boening. That site is a strong model for the new project, which is shooting for a top-five ranking among Google

searches for sea-level data. The effort will also leverage resources such as the JPL Physical Oceanography Distributed Active Archive Center.

Web design, visualization and programming activities are underway this year for the portal, which is scheduled to begin operations in 2016.

# Caring for a precious resource

Airborne Snow Observatory maps snowpack to aid water managers

By Mark Whalen

As California's current drought conditions persist, water has become an ever more precious resource.

A JPL mission flying over the Sierra Nevada mountain range is giving the state's water resource managers a helping hand by assessing snowpack and the amount of water it holds. About 75 percent of the western United States' freshwater supply comes from snowmelt.

JPL's Airborne Snow Observatory is in its second season of mapping. The current campaign over Yosemite National Park's Tuolumne Basin observed significant changes in snowpack between flights near the Hetch Hetchy reservoir, which supplies water for the San Francisco area.

"There are two things we need to know to understand the magnitude and timing of snowmelt runoff from mountain basins," said Tom Painter, the mission's principal investigator. "The first is how much water there is in the basin, and how it's spatially distributed. The second is the albedo, a reflectivity that's a measurement of the absorption of sunlight, which contributes 90 to 95 percent of the energy that goes into melting snow."

The mission comprises a scanning lidar, which gives provides snow depth, and an imaging spectrometer to measure the albedo. The lower the albedo, the faster the snowmelt rate and runoff.

The mission uses a Twin Otter aircraft based near Mammoth Lakes. For its most recent campaign, JPL researcher Megan Richardson was joined by co-investigator Frank Gehrke of the California Department of Water Resources. As they flew over, each operated one of the two instruments that monitor snowpack.

"Between our first two data collections, Yosemite got a fairly big snowstorm and we actually recorded the spike," said Richardson. "That was the first time we had been recording when we actually saw the snow levels in the area increase."

The mission's end product is a snow water equivalent map, which is provided to the Department of Water Resources. The benefit is in how water resource managers can manage a dam or reservoir. "You could



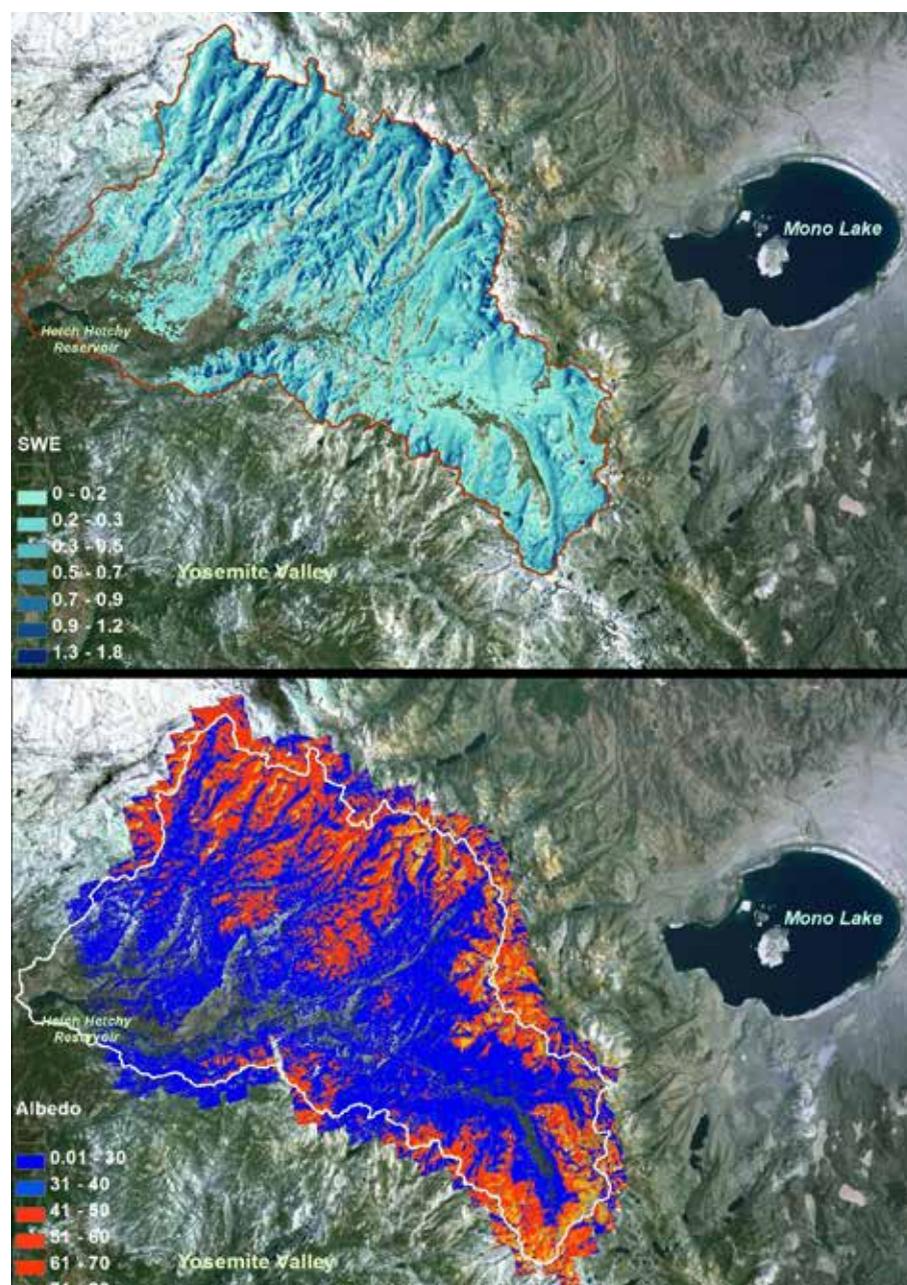
JPL Director Charles Elachi, left, visits with JPL's Megan Richardson and Frank Gehrke of the California Department of Water Resources at the Mammoth Lakes airport.

lose a lot of money if you overfill a dam and water spills over, which could cause flooding," said Richardson.

Before JPL's Airborne Snow Observatory, measurements providing information for snowpack runoff forecasting were relatively sparse, said Painter. The few survey sites were largely located in low to middle elevations, which didn't provide a complete picture of the mountains. This led to significant errors. "Now, our flights can determine how much water is in the whole valley, including the high elevations," said Richardson.

"Airborne Snow Observatory gives us information on every patch of snow, how deep it is and how fast it's melting, providing complete characterization regularly through the snowmelt season," said Painter. "These observations are the future of water management in snow-fed regions."

Airborne Snow Observatory measurements of snow water equivalent (top) and snow albedo (bottom) for the Tuolumne River Basin in the Sierra Nevada in April 2013. The snow water equivalent measured the total water contained as snow in the basin at 375 million cubic meters, or enough to fill the Rose Bowl about 1,180 times.



# News Briefs



Kentaroh Suzuki

## Honors from Japan for JPLer

JPL research scientist Kentaroh Suzuki has received honors from the Japanese Meteorology Society. The Society Award was bestowed to Suzuki during recent ceremonies in Japan, his home country.

Suzuki joined JPL in 2011 after working at Colorado State University's Department of Atmospheric Science, where he was a postdoctoral fellow and research scientist. Previously, he was a postdoctoral fellow at the University of Tokyo's Center for Climate System Research. He earned a Ph.D. at that university in 2004.

Suzuki's work at JPL focuses on aerosol-cloud-precipitation interaction and cloud microphysics.

## Small-business award presented

JPL has named JTC Architects of Arcadia the 2013 NASA Small Business Subcontractor of the Year, one of 10 awards presented by NASA's field centers. The honor recognizes companies that provide "value-added and outstanding support—on schedule and within cost—and innovative solutions to problems/issues that arise in the execution of the contract."

JTC has been providing architectural and engineering design services to JPL since 2005. Among other tasks in 2013, the company designed a new telescope-mounting pier at Table Mountain; designed the data center at the Space Flight Operations Facility; upgraded a stand-by generator for procurement and

communications support; and modified rooms in the Microdevices Lab. The company was recently awarded a subcontract for architectural and engineering design services for the mission-critical data center at the Space Flight Operations Facility (Phase 2).

In addition to the NASA award, JTC Architects was honored with the FY13 JPL Thomas H. May Legacy of Excellence Award for exemplary contract performance by a small business. The award was established in memory of former JPL employee Tom May to honor his dedication to small business utilization.

## Lockheed Martin best large contractor

Lockheed Martin was awarded JPL's 2013 "Large Prime Contractor of the Year" for the NASA Small Business Industry Award in the Center Level category. The award recognizes large businesses that perform well on all NASA contracts, demonstrate sound small-business programs, and use small-business contractors to perform some technical requirements during contract execution.

Headquartered in Bethesda, Md., Lockheed's FY13 work at JPL included the Gravity Recovery and Interior Laboratory, Juno, Desktop and Institutional Computing Environment, InSight spacecraft, Mars 2020, Mars Reconnaissance Orbiter and Mars Odyssey extended mission operations, as well as additional missions and research and development subcontracts.

# Goddard trophy for Kepler



From left: Kepler principal investigator William Borucki of NASA Ames, JPL Engineering and Science Director Leslie Livesay, Kepler Project Manager Roger Hunter of Ames, Jim Fanson of JPL.

The Kepler Space Telescope team recently received the National Space Club's preeminent award, the Dr. Robert H. Goddard Memorial Trophy. The honor was bestowed in recognition of the team's significant contribution to U.S. leadership in the field of rocketry and astronautics.

Kepler has revolutionized exoplanet science and stellar astrophysics by expanding the galactic census of exoplanet candidates and fundamentally altering our understanding of our place in the galaxy. JPL managed Kepler mis-

sion development; Leslie Livesay was project manager from 2006 to 2008 and Jim Fanson served in that role through 2009, when management was transferred from JPL to Ames Research Center.

At the same ceremonies, JPL Fellow Adam Steltzner received the Astronautics Engineer Award for his outstanding leadership in the design and development of the Mars Science Laboratory's entry, descent and landing system that successfully landed the Curiosity rover on Mars in August 2012.

# Passings

**Joseph Bott**, 82, a retired quality assurance engineer, died Sept. 8, 2013.

Bott worked at JPL from 1963 to 1996, earning NASA's Exceptional Service Medal in 1993. He is survived by his wife, Regina, and children Nicole, Ian and Xavier.

**Dora Mata**, 69, an executive staff coordinator in the Engineering and Science Directorate, died March 2.

Mata had worked at JPL since 1997. She supported the Discovery and Kepler program offices as well as the directorate offices for Astronomy, Physics and Space Technology and Engineering and Science. In 2009 she received a NASA Honor Award as a member of the business and administrative team for Kepler.



Dora Mata

Mata is survived by daughters Shelley and Nicole, and grandchildren Jeffrey, Tara, Tracy, Joey and Kailley. A memorial service was held at the Stone Funeral Home in Upland, Calif.

Systems engineer **Kathleen Spellman**, 47, died March 14.

Spellman joined JPL in 1989. On Mars Pathfinder she served as sequence team lead in charge of development,

testing and transmissions of sequences to the spacecraft. After the loss of signal she managed the archiving, distribution and publication of Pathfinder data.



Kathleen Spellman

Her work on the Mars Exploration Rovers involved a telemetry dictionary and developing a process to synch flight software and ground systems weekly, an innovation that has been further developed for other Mars and Earth projects.

A celebration of life event is being planned for later this year. Please contact Trina Ray at JPL for information.

**Thomas Bursch**, 78, a retired electrical engineer, died March 16.

Bursch, who joined JPL in 1978, worked in the Imaging Systems Section. Among the projects he contributed to was the Wide Field and Planetary Camera for the Hubble Space Telescope. He retired in 1994.

He is survived by his wife, Sandra; sons Scott and Sean; and grandchildren Gage, Mason, Bridget, Amber and Sierra. The Bursch family requests consideration of donations in his name to Panorama City Chapter of Grandparents as Parents ([www.GrandparentsAs-Parents.org](http://www.GrandparentsAs-Parents.org)).

**Frank Randolph**, 91, a retired engineer, died March 16.

Randolph worked at JPL from 1978 to 1988, supporting the Test and Mechanical Support Section and later the Reliability Engineering Section. He contributed to Galileo and other missions.

He is survived by his wife, Madonna, three daughters, a son-in-law and two grandchildren. A celebration of his life will be held May 17 at 10 a.m. at Christ Lutheran Church in Valencia, Calif.



Frank Randolph

Astrophysicist **Lucas Kamp**, 68, died March 30. He had been with JPL since 1981.

Kamp from 1972–74 researched model stellar atmospheres, spectroscopy and radiative transfer as a National Research Council affiliate at Goddard

Space Flight Center. He was later an assistant professor of astronomy at Boston University.

At JPL, Kamp earned NASA awards for his work on Voyager, Galileo, Viking orbiter, Epoxi, Rosetta and Juno. He was credited as a major contributor to JPL's near-infrared mapping spectrometer efforts, and in 2003 received the NASA Individual Exceptional Service Medal for contributions to Galileo's near-infrared mapping spectrometer data processing. He was also an author or co-author of 190 scientific publications.

A memorial service was held April 5 in Monrovia.



Lucas Kamp

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# Universe

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# Correction

A story in the print edition of the April issue of Universe on the BICEP2 telescope's observation of ripples from the very early universe included the question, "Did [cosmic] inflation originate from a time when the forces of nature—gravity, electromagnetism and the strong and weak nuclear forces—were originally unified, as scientists believe they must have been?" Gravity should not have been included in the list of forces involved at the grand unification energy scale.

# Retirees

The following employees retired in April: **Robert Chamberlain**, 51 years, Section 393K; **Earl Higa**, 42 years, Section 392A; **Dorothy Crawford**, 40 years, Section 171B; **Edwin Kan**, 36 years, Section 382A; **Richard Fretz**, 31 years, Section 398D; **Kenneth Erickson**, 23 years, Section 5131; **Manfred Richter**, 23 years, Section 333C; **Robert Bonitz**, 18 years, Section 347G; **Thomas Lynch**, 17 years, Section 2661; **Jose Rodriguez Ochoa**, 14 years, Section 2126.