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2016 IN REVIEW

The Juno spacecraft's successful entry into Jupiter's orbit July 4 and Dawn's continuing exploration of the dwarf planet Ceres led highlights for 2016. Michael Watkins became JPL's director during the summer, and the Laboratory's suite of Earth science missions kept pace in providing key measurements of a changing world. JPL's Mars rovers, Opportunity and Curiosity, explored valleys, craters and mountains, and Cassini readied for its final months of exploration.

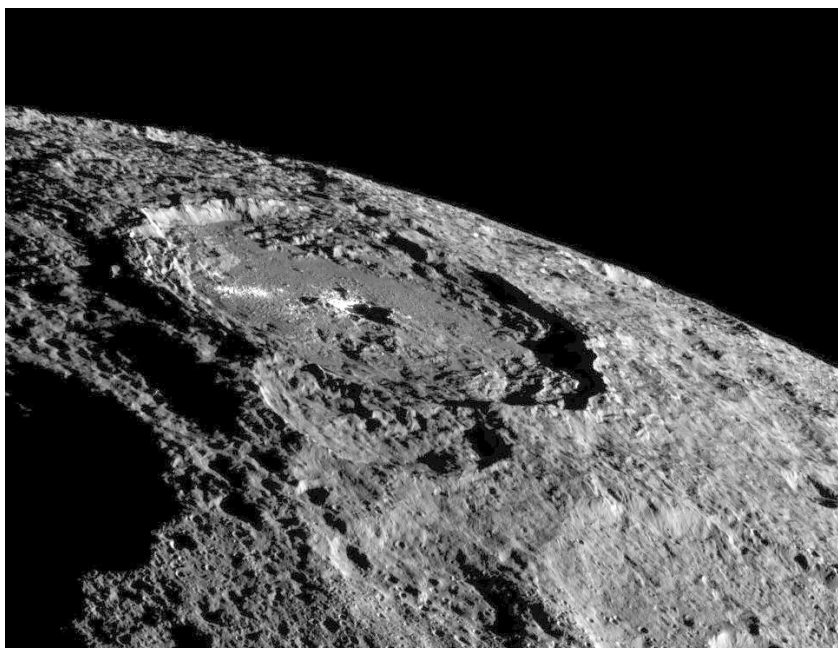


Jovian joy

Leaders of the Juno mission celebrate the spacecraft's July 4 arrival at Jupiter to begin its 32-orbit science mission at the gas giant. Project Manager Rick Nybakken, facing the camera, hugs JPL's acting director for solar system exploration, Richard Cook. Behind Nybakken is JPL Director Michael Watkins.

More Ceres ahead

The Dawn spacecraft completed its primary mission in the main asteroid belt between Mars and Jupiter on June 30 and NASA extended it for an additional year. Since March 2015, it's been exploring dwarf planet Ceres, and is currently measuring cosmic rays in its sixth science orbit. At right is Occator Crater with its intriguing bright regions, composed of reflective salt (principally sodium carbonate) left on the ground when briny water froze before sublimating. Dawn spent 14 months in orbit around the giant asteroid Vesta, departing in 2012.





New leadership

Michael Watkins became director of JPL on July 1, 2016. Watkins, an engineer and scientist, previously was on the staff of JPL for 22 years. In 2015-16 he spent a year at the University of Texas at Austin, where he was director of the university's Center for Space Research.

At JPL, Watkins served as chief scientist for the Engineering and Science Directorate, and managed the Science Division and Navigation and Mission Design Section. He was also mission manager from development through landed operations for Mars Science Laboratory, and led NASA development and review teams for Cassini, Mars Odyssey and Deep Impact.

Watkins served as project scientist for the GRACE, GRAIL and GRACE Follow-On missions.



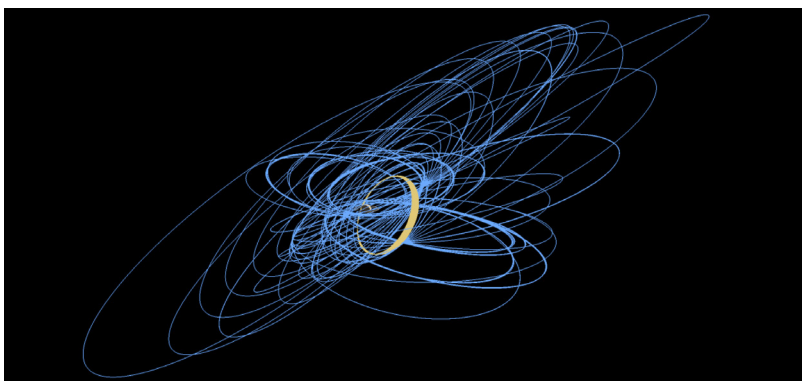
Eyes on the home planet

- Using data from the Atmospheric Infrared Sounder, a study by JPL and partner institutions found that in California's Sierra Nevada, atmospheric river storms are two-and-a-half times more likely than other types of winter storms to result in destructive "rain-on-snow" events, where rain falls on existing snowpack, causing it to melt. Those events increase flood risks in winter and reduce water availability the following summer.

- The Jason 3 satellite, launched in January 2016, extends the timeline of ocean surface topography measurements begun by JPL's Topex/Poseidon and the Jason 1 and 2 satellites. Jason 3 will make highly detailed measurements of Earth's sea levels to gain insight into ocean circulation and climate change.

- JPL's International Space Station Rapid Scatterometer (ISS-RapidScat) Earth science instrument ended operations in November following a successful two-year mission. By using the unique vantage point of the space station to provide near-real-time monitoring of ocean winds—which is critical in determining regional weather patterns—its measurements of wind speed and direction over the ocean surface have been used by agencies worldwide for weather and marine forecasting and tropical cyclone monitoring.

- In a new, space-based view of human-made carbon dioxide, scientists produced the first global maps of human emissions of carbon dioxide ever made solely from satellite observations, using data from JPL's Orbiting Carbon Observatory 2.



Close shave at Saturn

In preparation for its grand finale in September 2017, Cassini began its new Ring-Grazing Orbits mission phase in late November. On each orbit, Cassini will swoop down through the ring plane just outside Saturn's F ring. The orbits will end with the spacecraft's final close Titan flyby in April 2017, at which point Cassini enters a series of even more daring Grand Finale Orbits.

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Rover still exploring

The panoramic camera aboard the Mars Exploration Rover Opportunity imaged “Wharton Ridge” (above), which forms part of the southern wall of “Marathon Valley” on the western rim of Endeavour Crater. Near the right edge of the scene is “Lewis and Clark Gap,” through which Opportunity crossed from “Marathon Valley” to “Bitterroot Valley” in September 2016.



Mt. Sharp beckons

The Curiosity rover is now climbing the layered Mt. Sharp (left) and finding evidence of how ancient lakes and wet underground environments changed, billions of years ago, creating more diverse chemical environments that affected their favorability for microbial life. “There is so much variability in the composition at different elevations, we’ve hit a jackpot,” said team member John Grotzinger. “A sedimentary basin such as this is a chemical reactor. Elements get rearranged. New minerals form and old ones dissolve. Electrons get redistributed. On Earth, these reactions support life.”

Far out astrophysics

- A black hole destroying a star, which astronomers call “stellar tidal disruption” (right), releases an enormous amount of energy, brightening the surroundings in an event called a flare. Astronomers now have new insights into tidal disruption flares, thanks to data from JPL’s Wide-field Infrared Survey Explorer. Two new studies characterize the flares by studying how surrounding dust absorbs and re-emits their light, like echoes. This approach allowed scientists to measure the energy of flares from stellar tidal disruption events more precisely than ever before.

- In a first-of-its-kind collaboration, NASA’s Spitzer and Swift space telescopes joined forces to observe a microlensing event, when a distant star brightens due to the gravitational field of at least one foreground cosmic object. This is useful for finding low-mass bodies orbiting stars, such as planets. In this case, the observations revealed a brown dwarf.



- Heartbeat stars, discovered in large numbers by the JPL-developed Kepler space telescope, can get as close as a few stellar radii to each other, and as far as 10 times that distance during the course of one orbit. “You can think about the stars as bells, and once every orbital revolution, when the stars reach their closest approach, it’s as if they hit each other with a hammer,” said JPLer Avi Shporer, lead author of a recent study. “One or both stars vibrate throughout their orbits, and when they get nearer to each other, it’s as though they are ringing very loudly.”



Peter Theisinger

Career honor to Theisinger

Peter Theisinger, former project manager for the Mars Exploration Rovers and Mars Science Laboratory missions, has been named a recipient of the 2017 National Air and Space Museum Trophy for Lifetime Achievement.

Theisinger, now a special assistant to the director, has been with JPL since 1967. He has also managed JPL's Engineering and Science Directorate, was project engineer

for Mars Global Surveyor spacecraft development, and managed the Spacecraft Systems Engineering Section.

Along with JPL's Richard Cook, in 2013 Theisinger was named as one of Time magazine's 100 most influential people in the world.

Theisinger will receive the lifetime achievement honor next March at a Smithsonian National Air and Space Museum ceremony.

Classifieds

Ads submitted Nov. 12 to Dec. 9.

For Sale

CONCERT TICKETS, 4 for Styx at the Saban Theatre in Beverly Hills on Sunday, Jan. 22, 2017; seats are in the pit, second row (BB), seats 113-114-115-116; asking face value (ticket + fees), \$257 each and includes some VIP merchandise; willing to sell tickets separately if you don't need all four. 626-641-2276 or sierragal@gmail.com.

MISC.: ski wear M/L/SL, mini steam iron, Rollerblades (men's 8), woman's Nordica ski boot, stemless decanter boxed set, ladies holiday dresses (10p, 12) and shoes (8-8.5), board games, Waring Pro Juicerator, fleece-like throw,

insulated/microwaveable soup mugs, pewter motion frame, scarf/glove set, Bloody Mary boxed set, Movietickets.com gift cards (2) and push mower. 818-272-3262.

OLYMPIC WEIGHTS (about 300 lbs.), Marcy pulley weight machine, Baldwin upright piano and bench. 818-353-5156, l.loveo@ca.rr.com.

VIDEO GAME, original PS4 with upgraded 1 TB HDD, includes original box and all cables, controller, \$200. dlamoris@gmail.com.

Lost & Found

LOST: Large gold cuff bracelet, lost Wednesday, 12/14, between Building 180 and the HR Trailer. Please call ext. 4-7510.

Vehicles / Accessories

'05 HONDA Civic LX, 2-door, 135K mi., new tires; \$3,300. 213-514-1032.

Wanted

PIANO TEACHER for kids age 10 and 8; they are 2 years into serious piano lessons, but our teacher is joining the military and will not be able to continue with us. salvo_systems@yahoo.com.

REFRIGERATOR, will to pay up to \$200 for a gently used fridge, preferably white but will consider other colors. 424-744-7998.

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

For Rent

ALTADENA (91001), furn. 2-bedrm., 2-bath home remodeled in 2012; ideal layout for roommates, bedrooms/baths at opposite ends of the house; refrigerator + microwave, plates, pots/pans, utensils, etc.; washer and dryer; gated parking in driveway and carport; nearest cross-st. is Fair Oaks/Calaveras; long- or short-term lease available; renter pays utilities excl. trash, \$2,000/mo., small pet acceptable for additional monthly fee. mpauken@gmx.com, 818-237-0645.

ALTADENA, furn. rm. w/awesome view for lease; non-smoker to share a 4-bedrm, 3-bath house across from community garden; close to local colleges + Pasadena schools, walk to JPL; utilities included, central air/heat, internet access, near bus stop, shopping, banking, entertainment and restaurants; \$800/month. 818-370-0601.

ALTADENA (91001), furnished loft w/awesome view for lease; non-smoker to share a beautiful

4-bedrm., 3-bath house across from community garden; walk to JPL; utilities incl., central air/heat, internet access; close to bus, shopping, entertainment, restaurants; \$740/mo. 818-370-0601.

PASADENA, gorgeous 1911 Craftsman, fully furn. (inc. dishes/linens); 3 bedrooms, 2 baths, 1/2-acre yard w/play structure; 3.5 miles, easy bike ride from JPL; all utilities, internet and streaming TV, gardener included; \$4,000/month, \$1,100/week, \$165/day; can negotiate for longer periods. Text Patty at 626-688-5861.

PASADENA, furnished studio w/private entrance + priv. patio, hardwood floors, full bathrm w/separate shower & bathtub, kitchenette w/microwave, gas stove; driveway parking, paid utilities (lights, gas, water, heat, & Wi-Fi), ~2 miles from JPL, close to public transportation; short- or long-term lease available, \$1,200 + \$1,200 deposit. 626-497-4084.

PASADENA, furn. rm. in a lovely 4-bd./2-bath house, big backyd, hardwd. floor, big closet, shared bathrm., kitchen/laundry privileges; 2 miles to JPL, close to public transpo; short- or long-term lease avail.; must like dogs and be very clean; \$900 + \$900 deposit. 818-960-8654.

Vacation Rentals

JACKSON HOLE, WY: Luxurious bed & breakfast on 3 acres of solitude on Snake River near Jackson Hole Mountain Resort and Grand Teton Park; see <http://www.bentwoodinn.com/>; JPL discount. 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, 626-840-3749 or valeriee@caltech.edu.

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

MAMMOTH, remodeled 2 bed/2 bath + loft, short walk to Canyon Lodge; Courchevel 6 features full kitchen, cable/Internet TV, DVD, Blu-Ray, wireless hi-speed Internet, 2-car garage, Jacuzzi, grill, pool; no pets. <http://Courchevel6.com>.

MEXICO (1 bedroom): Mayan Palace: Acapulco, Nuevo Vallarta, Riviera Maya, Puerto Vallarta; Sea Garden: Acapulco, Nuevo Vallarta, Mazatlan; Kauai, Hawaii (1 bedroom), Pacific Fantasy, Kapaa, HI; trades also available with II and RCI, based upon availability. 818-272-3262.



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