Space News Update

— February 27, 2018 —

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1. On Second Thought, the Moon's Water May Be Widespread and Immobile

If the Moon has enough water, and if it's reasonably convenient to access, future explorers might be able to use it as a resource. Credits: NASA's Goddard Space Flight Center

A new analysis of data from two lunar missions finds evidence that the Moon's water is widely distributed across the surface and is not confined to a particular region or type of terrain. The water appears to be present day and night, though it's not necessarily easily accessible.

The findings could help researchers understand the origin of the Moon's water and how easy it would be to use as a resource. If the Moon has enough water, and if it's reasonably convenient to access, future explorers might be able to use it as drinking water or to convert it into hydrogen and oxygen for rocket fuel or oxygen to breathe.

"We find that it doesn't matter what time of day or which latitude we look at, the signal indicating water always seems to be present," said Joshua Bandfield, a senior research scientist with the **Space Science Institute in Boulder, Colorado**, and lead author of the new study published in Nature Geoscience. "The presence of water doesn't appear to depend on the composition of the surface, and the water sticks around."

The results contradict some earlier studies, which had suggested that more water was detected at the Moon's polar latitudes and that the strength of the water signal waxes and wanes according to the lunar day (29.5 Earth days). Taking these together, some researchers proposed that water molecules can "hop" across the lunar surface until they enter cold traps in the dark reaches of craters near the north and south poles. In planetary science, a cold trap is a region that's so cold, the water vapor and other volatiles which come into contact with the surface will remain stable for an extended period of time, perhaps up to several billion years.

The debates continue because of the subtleties of how the detection has been achieved so far. The main evidence has come from remote-sensing instruments that measured the strength of sunlight reflected off the

lunar surface. When water is present, instruments like these pick up a spectral fingerprint at wavelengths near 3 micrometers, which lies beyond visible light and in the realm of infrared radiation.

But the surface of the Moon also can get hot enough to "glow," or emit its own light, in the infrared region of the spectrum. The challenge is to disentangle this mixture of reflected and emitted light. To tease the two apart, researchers need to have very accurate temperature information.

Bandfield and colleagues came up with a new way to incorporate temperature information, creating a detailed model from measurements made by the Diviner instrument on NASA's Lunar Reconnaissance Orbiter, or LRO. The team applied this temperature model to data gathered earlier by the Moon Mineralogy Mapper, a visible and infrared spectrometer that NASA's Jet Propulsion Laboratory in Pasadena, California, provided for India's Chandrayaan-1 orbiter.

The new finding of widespread and relatively immobile water suggests that it may be present primarily as OH, a more reactive relative of H_2O that is made of one oxygen atom and one hydrogen atom. OH, also called hydroxyl, doesn't stay on its own for long, preferring to attack molecules or attach itself chemically to them. Hydroxyl would therefore have to be extracted from minerals in order to be used.

The research also suggests that any H_2O present on the Moon isn't loosely attached to the surface.

"By putting some limits on how mobile the water or the OH on the surface is, we can help constrain how much water could reach the cold traps in the polar regions," said Michael Poston of the Southwest Research Institute in San Antonio, Texas.

Sorting out what happens on the Moon could also help researchers understand the sources of water and its long-term storage on other rocky bodies throughout the solar system.

The researchers are still discussing what the findings tell them about the source of the Moon's water. The results point toward OH and/or H_2O being created by the solar wind hitting the lunar surface, though the team didn't rule out that OH and/or H_2O could come from the Moon itself, slowly released from deep inside minerals where it has been locked since the Moon was formed.

"The next step is to determine whether it's water, hydroxyl, or a mixture of the two — and where it came from," Poston said. "Is it from external sources, delivered by comet or asteroid impacts? Is it from internal processes on the Moon itself, such as ancient volcanism? Or could it be an ongoing process of the solar wind reacting with lunar materials to create OH or H_2O?"

"Some of these scientific problems are very, very difficult, and it's only by drawing on multiple resources from different missions that are we able to hone in on an answer," said LRO project scientist John Keller of NASA's Goddard Space Flight Center in Greenbelt, Maryland.

LRO is managed by NASA's Goddard Space Flight Center in Greenbelt, Maryland, for the Science Mission Directorate at NASA Headquarters in Washington, D.C. JPL designed, built and manages the Diviner instrument.

Read the paper in Nature Geoscience: http://dx.doi.org/10.1038/s41561-018-0065-0

Source: NASA and Southwest Research Institute Return to Contents

2. Jupiter's Great Red Spot Could Disappear Within 20 Years

An enhanced image of Jupiter's Great Red Spot, as seen by NASA's Voyager 2 probe on July 7, 1979. *Credit: NASA/JPL/Björn Jónsson/Seán Doran/Flickr (CC BY-NC-ND 2.0)*

The iconic Great Red Spot of Jupiter may disappear in the next 20 years, according to a researcher at NASA's Jet Propulsion Laboratory (JPL) in California.

The massive storm — larger than Earth itself — was first spotted in 1830, and observations from the 1600s also revealed a giant spot on Jupiter's surface that may have been the same storm system. This suggests Jupiter's Great Red Spot (GRS) has been raging for centuries.

In a recent story, Business Insider spoke with Glenn Orton, a lead Juno mission team member and planetary scientist at NASA Jet Propulsion Laboratory (JPL), about the giant storm's fate. [Jupiter's Great Red Spot in Photos]

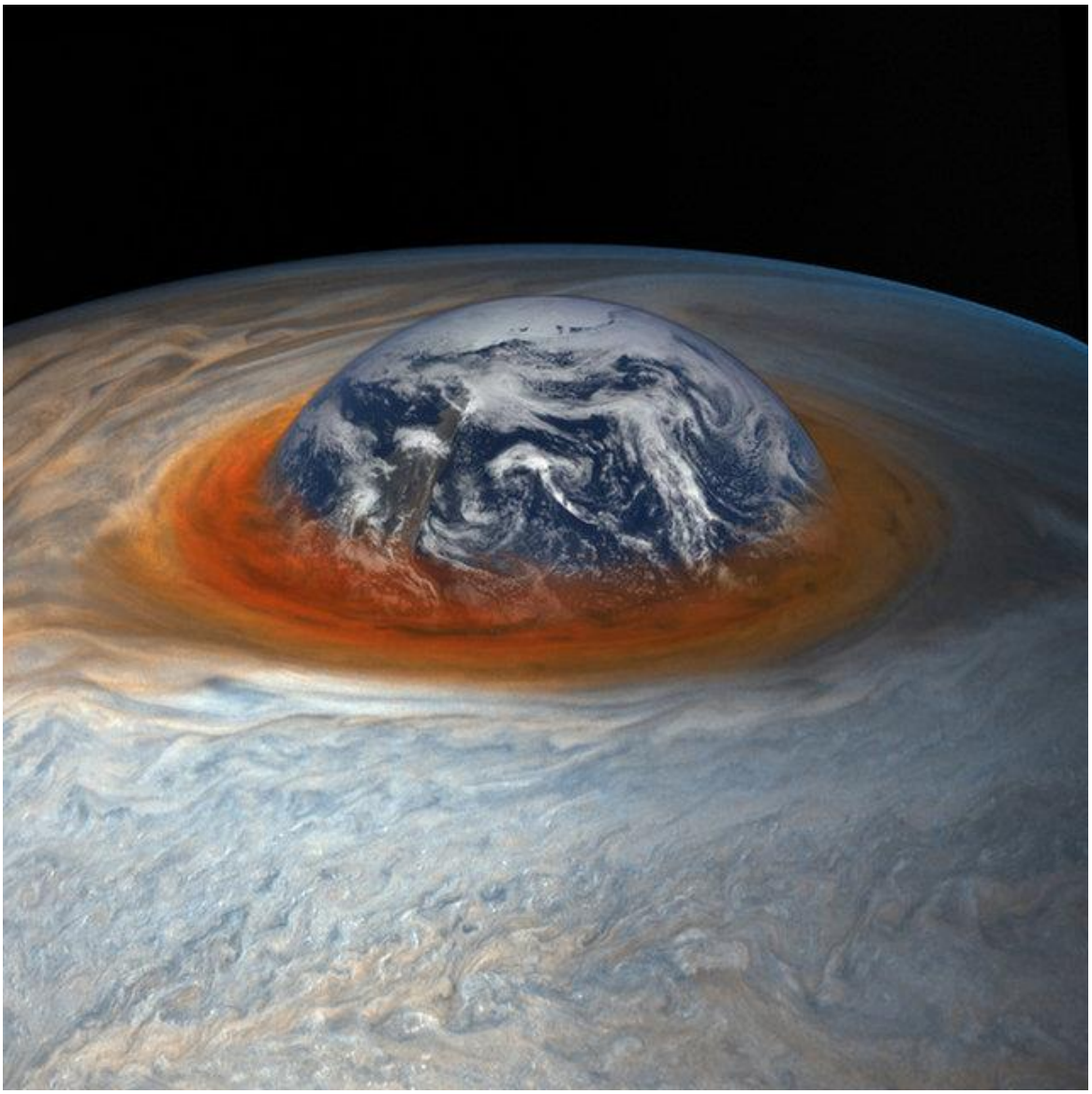
According to Orton, the storm's vortex has maintained strength because of Jupiter's 300-400 mph (483-640 km/h) jet-streams, but like any storm, it won't go on forever. "In truth, the GRS has been shrinking for a long time," Orton told Business Insider.

"The GRS will in a decade or two become the GRC (Great Red Circle)," Orton said. "Maybe sometime after that the GRM," by which he means the "Great Red Memory."

In the late 1800s, the storm was perhaps as wide as 30 degrees longitude, Orton said. That works out to more than 35,000 miles — four times the diameter of Earth. When the nuclear-powered spacecraft Voyager 2 flew by Jupiter in 1979, however, the storm had shrunk to a bit more twice the width of our own planet.

Data on Jupiter's crimson-colored spot reveals that this shrinking is still occurring. As of April 3, 2017, the GRS spanned the width of 10,159 miles (16,350 kilometers), less than 1.3 times Earth's diameter.

The longest storm on Earth lasted 31 days, but Jupiter can sustain longer storms because the gas planet has tens of thousands of miles of atmosphere, and spins much faster than Earth.



An illustration comparing the size of Jupiter's Great Red Spot to that of Earth. While the reddish-hued storm is massive, it was once much larger. According to observations taken in the 1800s, the Great Red Spot was once about four times the diameter of Earth. Credit: NASA/SwRI/MSSS/Gerald Eichstädt/Seán Doran/Flickr (CC BY-NC-ND 2.0)

Source: Space.com

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3. NASA's James Webb Space Telescope to Reveal Secrets of the Red Planet

The planet Mars has fascinated scientists for over a century. Today, it is a frigid desert world with a carbon dioxide atmosphere 100 times thinner than Earth's. But evidence suggests that in the early history of our solar system, Mars had an ocean's worth of water. NASA's James Webb Space Telescope will study Mars to learn more about the planet's transition from wet to dry, and what that means about its past and present habitability.

Hydrogen atoms escape from the Mars upper atmosphere, while water containing heavy hydrogen (deuterium) remains trapped on the planet. The escape of hydrogen helped to turn Mars from a wet planet 4.5 billion years ago into a dry world today.

Mars will be targeted as part of a Guaranteed Time Observation (GTO) project led by Heidi Hammel, a planetary astronomer and executive vice president of the Association of Universities for Research in Astronomy (AURA) in Washington, D.C. The GTO program provides dedicated time to the scientists who have worked with NASA to craft the science capabilities of Webb throughout its development. Hammel was selected by NASA as

a JWST Interdisciplinary Scientist in 2003. Mars will be visible to Webb from May to September 2020 during its first year of operations, known as Cycle 1.

"Webb will return extremely interesting measurements of chemistry in the Martian atmosphere," noted Hammel. "And most importantly, these Mars data will be immediately available to the planetary community to enable them to plan even more detailed Mars observations with Webb in future cycles."

"We are all looking forward to Webb's observations of Mars. I just know they will be fantastic, with the potential for immediate scientific discoveries," said Jim Green, director of NASA's Planetary Science Division, NASA Headquarters, Washington, D.C.

Webb's advantages and challenges

Mars has been visited by more missions than any other planet in our solar system. It is currently orbited by six active spacecraft, while two rovers trundle across its surface. Webb offers several capabilities that complement these up-close missions.

One key asset is Webb's ability to take a snapshot of the entire disk of Mars at once. Orbiters, in contrast, take time to make a full map and therefore can be affected by day-to-day variability, while rovers can only measure one location. Webb also benefits from excellent spectral resolution (the ability to measure small differences in wavelengths of light) and a lack of interfering atmosphere that plagues ground-based measurements from Earth.

That said, observing Mars with Webb will not be easy. "Webb is designed to be able to detect extremely faint and distant targets, but Mars is bright and close," explained Geronimo Villanueva of NASA's Goddard Space Flight Center, Mars lead on the GTO project. As a result, the observations will be carefully designed to avoid swamping Webb's delicate instruments with light.

"Very importantly, observations of Mars will also test Webb's capabilities in tracking moving objects across the sky, which is of key importance when investigating our solar system," said Stefanie Milam at NASA's Goddard Space Flight Center, Greenbelt, Md. who is coordinating the solar system program with Webb.

Water and methane

Much of the water Mars once held was lost over time due to ultraviolet light from the Sun breaking apart water molecules. Researchers can estimate how much water vanished by measuring the abundance of two slightly different forms of water in Mars' atmosphere – normal water (H_2O) and heavy water (HDO), in which one hydrogen atom is replaced by naturally occurring deuterium. The preferential escape of lighter hydrogen over time would then lead to a skewed ratio of H_2O to HDO on Mars, indicative of how much water has escaped into space. Webb will be able to measure this ratio at different times, seasons and locations.

Researchers using ground-based observatories have detected increased concentrations of both methane and water vapor in the Martian atmosphere during the northern hemisphere summer.

"With Webb, we can obtain a real and accurate measurement of the ratio of H_2O to HDO across Mars, permitting us to determine how much water was truly lost. We also can determine how water is exchanged between polar ice, the atmosphere, and the soil," said Villanueva.

Although most of the water on Mars is locked up in ice, the possibility remains that some liquid water could exist in underground aquifers. These potential reservoirs could even host life. This intriguing idea received a boost in 2003, when astronomers detected methane in the Martian atmosphere. Methane could be generated by bacteria, although it could also come from geological processes. Data from Webb could provide new clues to the origin of these methane plumes.

Source: NASA Return to Contents

The Night Sky

Tuesday, February 27

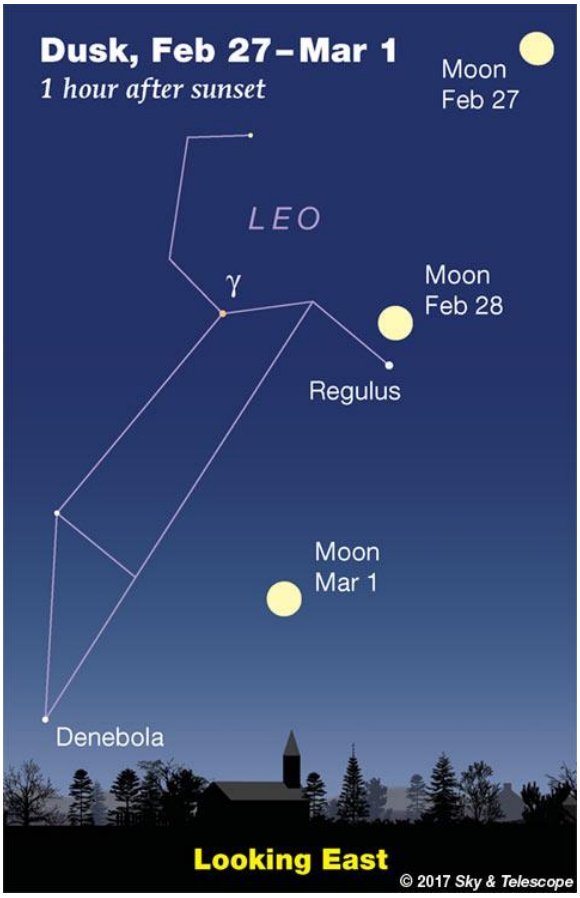
- After dinnertime at this time of year, five carnivore constellations are rising upright in a row from the northeast to south. They're all seen in profile with their noses pointed up and their feet (if any) to the right. These are: (1) Ursa Major the Big Bear in the northeast with the Big Dipper as its brightest part, (2) Leo the Lion in the east (with the bright Moon tonight!), (3) dim Hydra the Sea Serpent in the southeast, (4) Canis Minor the Little Dog higher in the south-southeast, and bright and (5) Canis Major the Big Dog in the south.

Wednesday, February 28

- Follow the almost-full Moon as it begins the night by leading Regulus upward. Watch as the gap between them decreases hour by hour. The Moon's very thin dark limb will then occult Regulus for much of Maine and northeastern Canada.

Thursday, March 1

- Full Moon (exact at 7:51 p.m. EST). The Moon shines under the Sickle of Leo in early evening, as shown here.
- This is the time of year when Orion stands straight upright due south as the stars come out. Later in the night, and later in the month, he begins his long tilt down toward the west.



During the night of the 28th, watch the just-short-of-full Moon creep up on Regulus. As always, the moon symbols here are drawn three times the Moon's actual apparent size. Their centers are plotted exact for latitude 40° N, longitude 90° W, near the population center of North America

Friday, March 2

- If you're in the longitudes of North America, check in on Jupiter's unusually red Great Red Spot with your telescope before dawn tomorrow morning. The GRS should cross Jupiter's central meridian around 6:12 a.m. EST (3:12 a.m. PST) tomorrow morning. Features on Jupiter remain closer to the planet's central meridian than to the limb for nearly an hour before and after they transit.
- You'll also find Ganymede's tiny black shadow crossing Jupiter's face from 4:29 to 6:15 a.m. EST (1:19 to 3:15 a.m. PST) tomorrow morning.
- All of the Great Red Spot's transit times in February and March (they happen about every 10 hours) are listed on page 50 of the February and March *Sky & Telescope*s. Facing those pages are timetables of all the phenomena of Jupiter's moons.

Source: Sky and Telescope

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ISS Sighting Opportunities (from Denver)

Date	Visible	Max Height	Appears	Disappears
Wed Feb 28, 4:24 AM	1 min	17°	17° above SE	14° above ESE
Wed Feb 28, 5:57 AM	6 min	47°	10° above WSW	12° above NE
Thu Mar 1, 5:07 AM	3 min	87°	46° above SW	16° above NE
Fri Mar 2, 4:17 AM	< 1 min	21°	21° above ENE	21° above ENE
Fri Mar 2, 5:50 AM	5 min	24°	13° above WNW	11° above NNE

Sighting information for other cities can be found at NASA's Satellite Sighting Information

NASA-TV Highlights (all times Eastern Time Zone)

Tuesday, February 27

- 1 p.m. - GOES-S Pre-Launch News Briefing from Kennedy Space Center (all channels)
- 2 p.m. - Coverage of the Farewells and Hatch Closure for the Expedition 54 Crew on the ISS (Hatch closure scheduled at 2:50 p.m. ET) (Starts at 2:15 a.m.) (all channels)
- 2:30 p.m. - GOES-S Science Briefing from Kennedy Space Center (NTV-3 (Media))
- 5:30 p.m. - Coverage of the Undocking of the Expedition 54 Crew on Soyuz MS-06 from the ISS (Undocking scheduled at 6:08 p.m. EST) (starts at 5:45 p.m.) (all channels)
- 8 p.m. - Coverage of the Deorbit Burn and Landing of the Expedition 54 Crew on Soyuz MS-06 in Kazakhstan (Deorbit burn scheduled at 8:38 p.m. ET, landing near Dzhezkazgan, Kazakhstan scheduled at 9:31 p.m. ET) (all channels)

Wednesday, February 28

- 10 a.m. - NASA Edge Coverage of the GOES-S Rollout (NTV-1 (Public))
- 1 p.m. - Smithsonian National Air and Space Museum Presents: STEM in 30: Astronaut Training (NTV-1 (Public))
- 4 p.m. - Video File of the Expedition 54 Crew's Post-Landing Activities in Kazakhstan (May include interviews with NASA astronauts Joe Acaba and Mark Vande Hei) (NTV-3 (Media))

Thursday, March 1

- 11 a.m. - Video File of the Return of ISS Expedition 54 Flight Engineers Mark Vande Hei and Joe Acaba of NASA to Ellington Field, Houston (NTV-3 (Media))
- 1 p.m. - ISS Expedition 55 In-Flight Event with Newsweek Magazine and Flight Engineers Scott Tingle of NASA and Norishige Kanai of the Japan Aerospace Exploration Agency (JAXA) (Starts at 1:05 p.m.) (all channels)
- 4:30 p.m. - GOES-S Launch Coverage - Kennedy Space Center (launch window opens at 5:02 p.m.) (all channels)

Watch NASA TV online by going to the NASA website.

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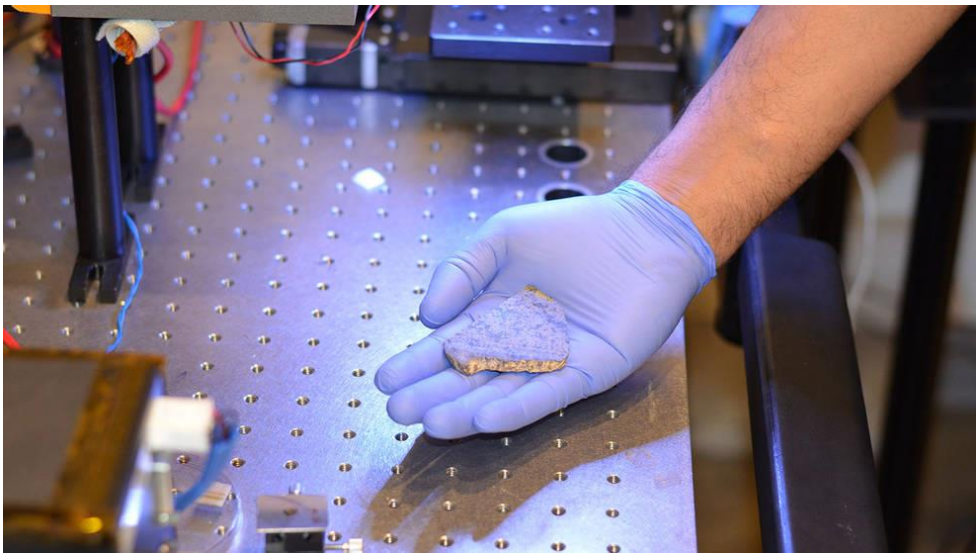
Space Calendar

- **Feb 27 - Soyuz MS-6 Return To Earth (International Space Station)**
- Feb 27 - Comet 321P/SOHO At Opposition (3.810 AU)
- Feb 27 - Comet P/2017 W3 (Gibbs) Perihelion (3.833 AU)
- Feb 27 - Asteroid 4 Vesta Occults TYC 6237-00876-1 (11.2 Magnitude Star)
- Feb 27 - Apollo Asteroid 2018 DT Near-Earth Flyby (0.011 AU)
- Feb 27 - Apollo Asteroid 2018 CU14 Near-Earth Flyby (0.014 AU)
- Feb 27 - Apollo Asteroid 2014 EY24 Near-Earth Flyby (0.038 AU)
- Feb 27 - Asteroid 1831 Nicholson Closest Approach To Earth (1.289 AU)
- Feb 27 - Asteroid 11908 Nicaragua Closest Approach To Earth (1.942 AU)
- Feb 27 - Teleconference: Astronomy and Astrophysics Advisory Committee (AAAC) Meeting
- Feb 27 - Lecture: New Perspective on the Origin of the Moon, Tucson, Arizona
- Feb 27 - Lecture: What's Inside a Black Hole?, Trieste, Italy
- Feb 27 - Colloquium: New Perspective on the Origin of the Moon, Tucson, Arizona
- Feb 27-28 - Workshop: From Mars Express to Exomars, Madrid, Spain
- **Feb 27-Mar 01 - Deep Space Gateway Science Workshop, Denver, Colorado (Westin Denver International Airport Hotel)**
- Feb 27-Mar 01 - 2018 Workshop on Land Product Validation and Evolution (LPVE 2018), Rome, Italy
- Feb 28 - Comet 346P/Catalina Closest Approach To Earth (2.683 AU)
- Feb 28 - Comet C/2017 X1 (PANSTARRS) At Opposition (3.915 AU)
- Feb 28 - Asteroid 451 Patientia Occults HIP 22949 (6.2 Magnitude Star)
- Feb 28 - Apollo Asteroid 2015 BF511 Near-Earth Flyby (0.030 AU)
- Feb 28 - Atira Asteroid 1998 DK36 Closest Approach To Earth (0.824 AU)
- Feb 28 - Asteroid 7434 Osaka Closest Approach To Earth (1.334 AU)
- Feb 28 - Asteroid 21459 Chrisrussell Closest Approach To Earth (1.463 AU)
- Feb 28 - Asteroid 10637 Heimlich Closest Approach To Earth (2.145 AU)
- Feb 28 - Plutino 90482 Orcus At Opposition (47.134 AU)
- Feb 28 - Seminar: Gravitational Waves as Predicted by Einstein - Signals from Black Holes Collisions in the Distant Universe, Trieste, Italy
- Feb 28 - Colloquium: Origin of the Moon, Greenbelt, Maryland
- Feb 28-Mar 01 - Symposium: Mars in the Age of New Space Launchers, London, United Kingdom
- Feb 28-Mar 01 - 2nd International Space Exploration Forum (ISEF2), Tokyo, Japan
- Feb 28-Mar 02 - 1st KMI School: Dark Matter, Nagoya, Japan
- **Mar 01 - GOES-S Atlas 5 Launch**
- **Mar 01 - ANDESITE/ CeREs/ CHOMPTT/ CubeSail 1 & 2/ Da Vinci/ GeoStare/ ISX/ NMTSat/ RSat-P/ Sheilds-1/ STF-1/ TOMSAT R3 Electron Launch**
- Mar 01 - Comet 73P-T/Schwassmann-Wachmann Closest Approach To Earth (1.276 AU)
- Mar 01 - Comet 327P/Van Ness At Opposition (4.117 AU)
- Mar 01 - Comet C/2018 A6 (Gibbs) At Opposition (4.149 AU)

Source: JPL Space Calendar Return to Contents

Food for Thought

A Piece of Mars is Going Home



Rohit Bhartia of NASA's Mars 2020 mission holds a slice of a meteorite scientists have determined came from Mars. One of two slices will be used for testing a laser instrument for NASA's Mars 2020 rover while it's still on Earth; the other slice will go to Mars onboard the rover. Credits: NASA/JPL-Caltech

A chunk of Mars will soon be returning home.

A piece of a meteorite called Sayh al Uhaymir 008 (SaU008) will be carried on board NASA's Mars 2020 rover mission, now being built at the agency's Jet Propulsion Laboratory in Pasadena, California. This chunk will serve as target practice for a high-precision laser on the rover's arm.

Mars 2020's goal is ambitious: collect samples from the Red Planet's surface that a future mission could potentially return to Earth. One of the rover's many tools will be a laser designed to illuminate rock features as fine as a human hair.

That level of precision requires a calibration target to help tweak the laser's settings. Previous NASA rovers have included calibration targets as well. Depending on the instrument, the target material can include things like rock, metal or glass, and can often look like a painter's palette.

But working on this particular instrument sparked an idea among JPL scientists: why not use an actual piece of Mars? Earth has a limited supply of Martian meteorites, which scientists determined were blasted off Mars' surface millions of years ago.

These meteorites aren't as unique as the geologically diverse samples 2020 will collect. But they're still scientifically interesting -- and perfect for target practice.

"We're studying things on such a fine scale that slight misalignments, caused by changes in temperature or even the rover settling into sand, can require us to correct our aim," said Luther Beegle of JPL. Beegle is principal investigator for a laser instrument called SHERLOC (Scanning Habitable Environments with Raman and Luminescence for Organics and Chemicals). "By studying how the instrument sees a fixed target, we can understand how it will see a piece of the Martian surface."

SHERLOC will be the first instrument on Mars to use Raman and fluorescence spectroscopies, scientific techniques familiar to forensics experts. Whenever an ultraviolet light shines over certain carbon-based chemicals, they give off the same characteristic glow that you see under a black light.

Scientists can use this glow to detect chemicals that form in the presence of life. SHERLOC will photograph the rocks it studies, then map the chemicals it detects across those images. That adds a spatial context to the layers of data Mars 2020 will collect.

"This kind of science requires texture and organic chemicals -- two things that our target meteorite will provide," said Rohit Bhartia of JPL, SHERLOC's deputy principal investigator.

No Flaky Meteorites

Martian meteorites are precious in their rarity. Only about 200 have been confirmed by The Meteoritical Society, which has a database listing these vetted meteorites.

To select the right one for SHERLOC, JPL turned to contacts at NASA's Johnson Space Center in Houston, as well as the Natural History Museum of London. Not just any Martian meteorite would do: its condition would need to be solid enough that it would not flake apart during the intensity of launch and landing.

It also needed to possess certain chemical features to test SHERLOC's sensitivity. These had to be reasonably easy to detect repeatedly for the calibration target to be useful.

Experts tried several samples, cutting off thin bits to test whether they would crumble. Using a "flaky" sample could damage the entire meteorite in the process.

The SHERLOC team ultimately agreed on using SaU008, a meteorite found in Oman in 1999. Besides being more rugged than other samples, a piece of it was available courtesy of Caroline Smith, principal curator of meteorites at London's Natural History Museum. "Every year, we provide hundreds of meteorite specimens to scientists all over the world for study," Smith said. "This is a first for us: sending one of our samples back home for the benefit of science."

SaU008 will be the first Martian meteorite to have a fragment return to the planet's surface -- though not the first on a return trip to Mars.

NASA's Mars Global Surveyor included a chunk of a meteorite known as Zagami. It's still floating around the Red Planet onboard the now-defunct orbiter.

Additionally, the team behind Mars2020's SuperCam instrument will be adding a Martian meteorite to their own calibration target.

Preparing for Humans on Mars

Along with its own Martian meteorite, SHERLOC's calibration target will include several interesting scientific samples for human spaceflight. These include materials that could be used to make spacesuit fabric, gloves and a helmet's visor.

By watching how they hold up under Martian weather, including radiation, NASA will be able to test these materials for future Mars missions.

"The SHERLOC instrument is a valuable opportunity to prepare for human spaceflight as well as to perform fundamental scientific investigations of the Martian surface," said Marc Fries, a SHERLOC co-investigator and curator of extraterrestrial materials at Johnson Space Center. "It gives us a convenient way to test material that will keep future astronauts safe when they get to Mars."

Source: NASA Return to Contents

Space Image of the Week

Galaxy NGC 474: Shells and Star Streams

Image Credit: CFHT, Coelum, MegaCam, J.-C. Cuillandre (CFHT) & G. A. Anselmi (Coelum)

Explanation: What's happening to galaxy NGC 474? The multiple layers of emission appear strangely complex and unexpected given the relatively featureless appearance of the elliptical galaxy in less deep images. The cause of the shells is currently unknown, but possibly tidal tails related to debris left over from absorbing numerous small galaxies in the past billion years. Alternatively the shells may be like ripples in a pond, where the ongoing collision with the spiral galaxy just above NGC 474 is causing density waves to ripple through the galactic giant.

Regardless of the actual cause, the featured image dramatically highlights the increasing consensus that at least some elliptical galaxies have formed in the recent past, and that the outer halos of most large galaxies are not really smooth but have complexities induced by frequent interactions with -- and accretions of -- smaller nearby galaxies. The halo of our own Milky Way Galaxy is one example of such unexpected complexity. NGC 474 spans about 250,000 light years and lies about 100 million light years distant toward the constellation of the Fish (Pisces).

Source: NASA APOD

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