Space News Update

— April 14, 2017 —

Contents

1. NASA Missions Provide New Insights into 'Ocean Worlds' in Our Solar System

Two veteran NASA missions are providing new details about icy, ocean-bearing moons of Jupiter and Saturn, further heightening the scientific interest of these and other "ocean worlds" in our solar system and beyond. The findings are presented in papers published Thursday by researchers with NASA's Cassini mission to Saturn and Hubble Space Telescope.

In the papers, Cassini scientists announce that a form of chemical energy that life can feed on appears to exist on Saturn's moon Enceladus, and Hubble researchers report additional evidence of plumes erupting from Jupiter's moon Europa.

"This is the closest we've come, so far, to identifying a place with some of the ingredients needed for a habitable environment," said Thomas Zurbuchen, associate administrator for NASA's Science Mission Directorate at Headquarters in Washington. "These results demonstrate the interconnected nature of NASA's science missions that are getting us closer to answering whether we are indeed alone or not."

The paper from researchers with the Cassini mission, published in the journal Science, indicates hydrogen gas, which could potentially provide a chemical energy source for life, is pouring into the subsurface ocean of Enceladus from hydrothermal activity on the seafloor.

The presence of ample hydrogen in the moon's ocean means that microbes – if any exist there – could use it to obtain energy by combining the hydrogen with carbon dioxide dissolved in the water. This chemical reaction, known as "methanogenesis" because it produces methane as a byproduct, is at the root of the tree of life on Earth, and could even have been critical to the origin of life on our planet.

Life as we know it requires three primary ingredients: liquid water; a source of energy for metabolism; and the right chemical ingredients, primarily carbon, hydrogen, nitrogen, oxygen, phosphorus and sulfur. With this finding, Cassini has shown that Enceladus – a small, icy moon a billion miles farther from the sun than Earth – has nearly all of these ingredients for habitability. Cassini has not yet shown phosphorus and sulfur are present in the ocean, but scientists suspect them to be, since the rocky core of Enceladus is thought to be chemically similar to meteorites that contain the two elements.

"Confirmation that the chemical energy for life exists within the ocean of a small moon of Saturn is an important milestone in our search for habitable worlds beyond Earth," said Linda Spilker, Cassini project scientist at NASA's Jet Propulsion Laboratory (JPL) in Pasadena, California.

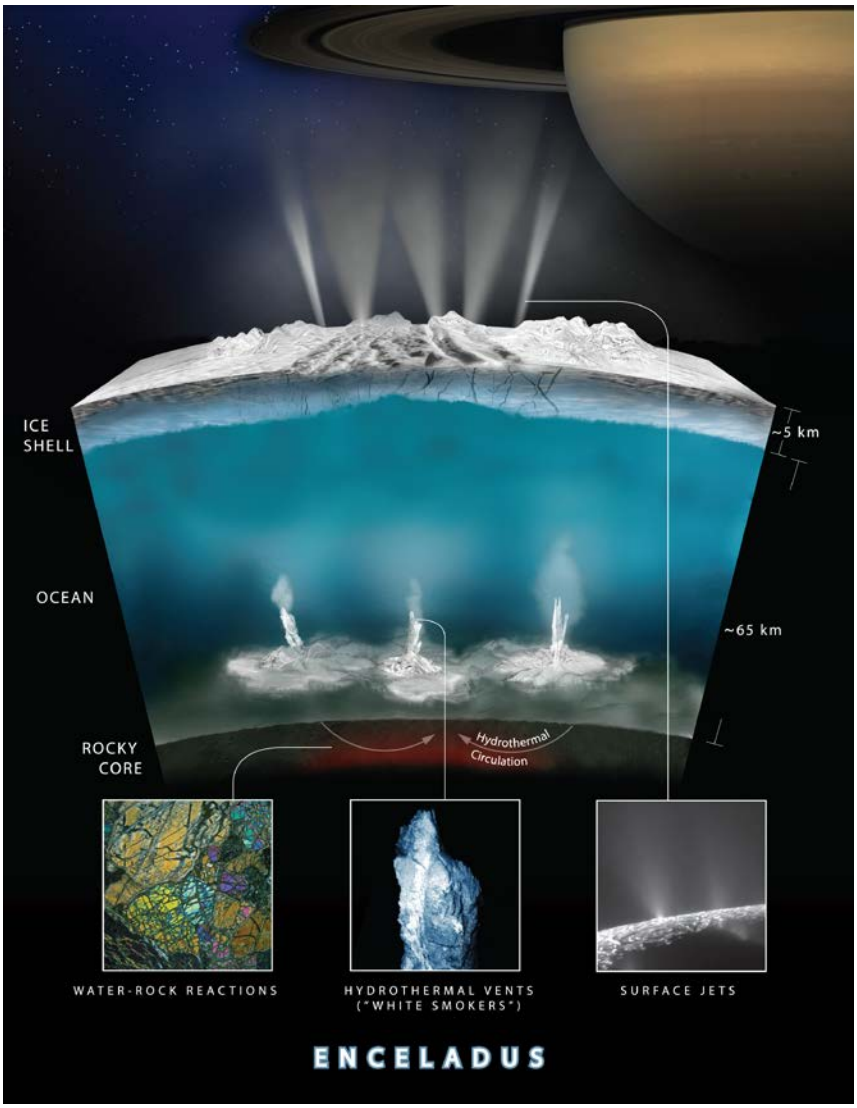
The Cassini spacecraft detected the hydrogen in the plume of gas and icy material spraying from Enceladus during its last, and deepest, dive through the plume on Oct. 28, 2015. Cassini also sampled the plume's composition during flybys earlier in the mission. From these observations scientists have determined that nearly 98 percent of the gas in the plume is water, about 1 percent is hydrogen and the rest is a mixture of other molecules including carbon dioxide, methane and ammonia.

The measurement was made using Cassini's Ion and Neutral Mass Spectrometer (INMS) instrument, which sniffs gases to determine their composition. INMS was designed to sample the upper atmosphere of Saturn's moon Titan. After Cassini's surprising discovery of a towering plume of icy spray in 2005, emanating from hot cracks near the south pole, scientists turned its detectors toward the small moon.

Cassini wasn't designed to detect signs of life in the Enceladus plume – indeed, scientists didn't know the plume existed until after the spacecraft arrived at Saturn.

"Although we can't detect life, we've found that there's a food source there for it. It would be like a candy store for microbes," said Hunter Waite, lead author of the Cassini study.

The new findings are an independent line of evidence that hydrothermal activity is taking place in the Enceladus ocean. Previous results, published in March 2015, suggested hot water is interacting with rock beneath the sea; the new findings support that conclusion and add that the rock appears to be reacting chemically to produce the hydrogen.



The paper detailing new Hubble Space Telescope findings, published in The Astrophysical Journal Letters, reports on observations of Europa from 2016 in which a probable plume of material was seen erupting from the moon's surface at the same location where Hubble saw evidence of a plume in 2014. These images bolster evidence that the Europa plumes could be a real phenomenon, flaring up intermittently in the same region on the moon's surface.

The newly imaged plume rises about 62 miles (100 kilometers) above Europa's surface, while the one observed in 2014 was estimated to be about 30 miles (50 kilometers) high. Both correspond to the location of an unusually warm region that contains features that appear to be cracks in the moon's icy crust, seen in the

late 1990s by NASA's Galileo spacecraft. Researchers speculate that, like Enceladus, this could be evidence of water erupting from the moon's interior.

"The plumes on Enceladus are associated with hotter regions, so after Hubble imaged this new plume-like feature on Europa, we looked at that location on the Galileo thermal map. We discovered that Europa's plume candidate is sitting right on the thermal anomaly," said William Sparks of the Space Telescope Science Institute in Baltimore, Maryland. Sparks led the Hubble plume studies in both 2014 and 2016.

The researchers say if the plumes and the warm spot are linked, it could mean water being vented from beneath the moon's icy crust is warming the surrounding surface. Another idea is that water ejected by the plume falls onto the surface as a fine mist, changing the structure of the surface grains and allowing them to retain heat longer than the surrounding landscape.

For both the 2014 and 2016 observations, the team used Hubble's Space Telescope Imaging Spectrograph (STIS) to spot the plumes in ultraviolet light. As Europa passes in front of Jupiter, any atmospheric features around the edge of the moon block some of Jupiter's light, allowing STIS to see the features in silhouette. Sparks and his team are continuing to use Hubble to monitor Europa for additional examples of plume candidates and hope to determine the frequency with which they appear.

NASA's future exploration of ocean worlds is enabled by Hubble's monitoring of Europa's putative plume activity and Cassini's long-term investigation of the Enceladus plume. In particular, both investigations are laying the groundwork for NASA's Europa Clipper mission, which is planned for launch in the 2020s.

"If there are plumes on Europa, as we now strongly suspect, with the Europa Clipper we will be ready for them," said Jim Green, Director of Planetary Science, at NASA Headquarters.

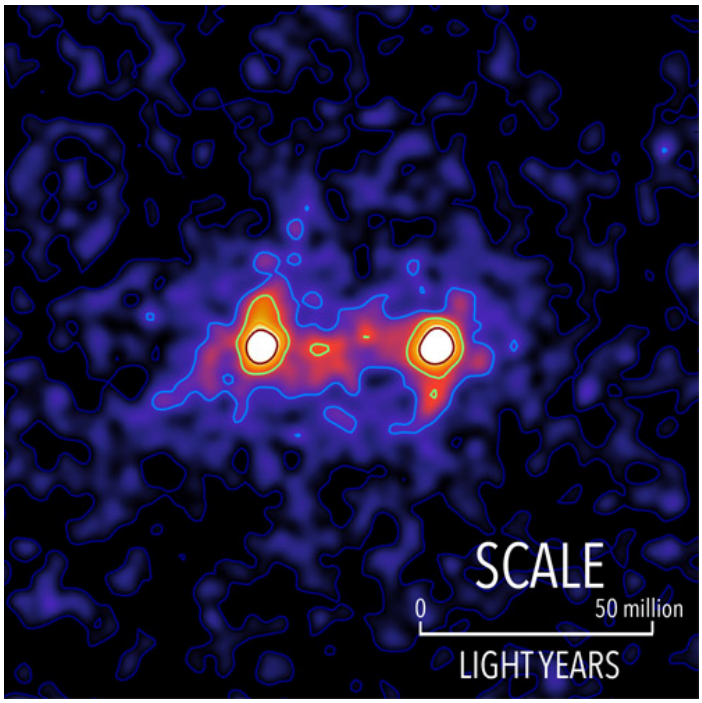
Hubble's identification of a site which appears to have persistent, intermittent plume activity provides a tempting target for the Europa mission to investigate with its powerful suite of science instruments. In addition, some of Sparks' co-authors on the Hubble Europa studies are preparing a powerful ultraviolet camera to fly on Europa Clipper that will make similar measurements to Hubble's, but from thousands of times closer. And several members of the Cassini INMS team are developing an exquisitely sensitive, next-generation version of their instrument for flight on Europa Clipper.

For more information on ocean worlds in our solar system and beyond, visit:

https://www.nasa.gov/specials/ocean-worlds

Source: NASA Return to Contents

2. First Image of a Dark Matter Web That Connects Galaxies



Researchers at the University of Waterloo have been able to capture the first composite image of a dark matter bridge that connects galaxies together.

The composite image, which combines a number of individual images, confirms predictions that galaxies across the universe are tied together through a cosmic web connected by dark matter that has until now remained unobservable.

Dark matter, a mysterious substance that comprises around 25 per cent of the universe, doesn't shine, absorb or reflect light. It has traditionally been largely undetectable, except through gravity.

"For decades, researchers have been predicting the existence of dark-matter filaments between galaxies that act like a web-like superstructure connecting galaxies together," said Mike Hudson, a professor of astronomy at the University of Waterloo. "This image moves us beyond predictions to something we can see and measure."

As part of their research, Hudson and co-author Seth Epps, a former master's student at the University of Waterloo, used a technique called weak gravitational lensing. It's an effect that causes the images of distant galaxies to warp slightly under the influence of an unseen mass such as a planet, a black hole, or in this case, dark matter. The effect was measured in images from a multi-year sky survey at the Canada-France-Hawaii Telescope.

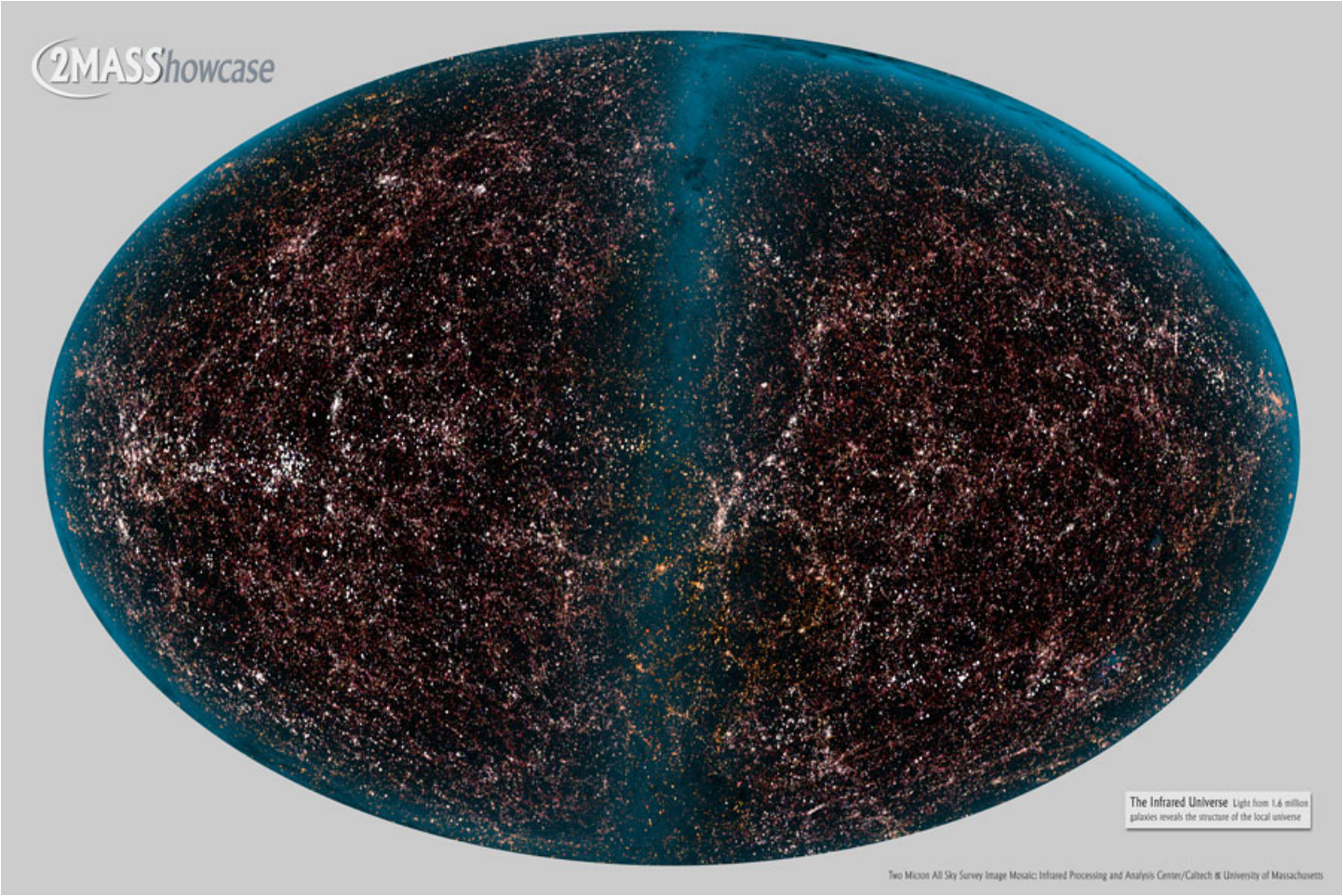
They combined lensing images from more than 23,000 galaxy pairs located 4.5 billion light-years away to create a composite image or map that shows the presence of dark matter between the two galaxies. Results show the dark matter filament bridge is strongest between systems less than 40 million light-years apart.

"By using this technique, we're not only to able to see that these dark matter filaments in the universe exist, we're able to see the extent to which these filaments connect galaxies together," said Epps.

Hudson and Epps' research appears in the Monthly Notices of the Royal Astronomical Society.

Source: SpaceRef.com Return to Contents

3. A Bored New Horizons Spacecraft Take Part-time Job to Fill the Time



The *New Horizons* probe made history in July of 2015, being the first mission to ever conduct a close flyby of Pluto. In so doing, the mission revealed some never-before-seen things about this distant world. This included information about its many surface features, it's atmosphere, magnetic environment, and its system of moons. It also provided images that allowed for the first detailed maps of the planet.

Having completed its rendezvous with Pluto, the probe has since been making its way towards its first encounter with a Kuiper Belt Object (KBO) – known as 2014 MU69. And in the meantime, it has been given a special task to keep it busy. Using archival data from the probe's Long Range Reconnaissance Imager (LORRI), a team of scientists is taking advantage of *New Horizon*'s position to conduct measurements of the Cosmic Optical Background (COB).

The COB is essentially the visible light from other galaxies which shines beyond the edge of the Milky Way. By measuring this light, astronomers are able to learn a great deal about the locations of stars, the size and density of galaxies, and test theories about the structure and formation of the Universe. This is no easy task, mind you, as any measurements conducted from inside the Solar System are subject to interference.

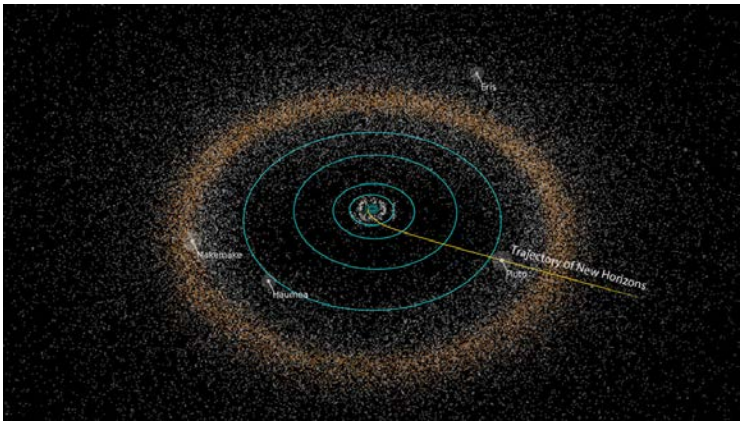
Whereas Earth-based telescopes experience interference from our atmosphere, space-based telescopes have to contend with the brightness of our Sun. In addition, interplanetary dust (IPD) has the effect of scattering light in the Solar System (known as Zodiacal Light) which can also obscure light coming from distant sources. But a probe like *New Horizons*, which is well into the outer Solar System, is not subject to such interference.

Hence why a team of researchers from the Rochester Institute of Technology (RIT), John Hopkins University Applied Physics Laboratory (JHUAPL), UC Irvine and UC Berkeley, chose to use its data to measure the COB. Their study, titled "Measurement of the cosmic optical background using the long range reconnaissance imager on New Horizons", was recently published in *Nature Communications.*

For the sake of this study, the team analyzed LORRI data obtained during NH's cruise phase between Jupiter and Uranus. After using data from four different isolated fields in the sky (captured between 2007 and 2010), the team was able to obtain a statistical upper limit on the optical background's brightness.

The study's lead author, Michael Zevkov, is an assistant professor in RIT's School of Physics and Astronomy and a member of RIT's Center for Detectors and Future Photon Initiative. As he stated in an RIT press release:

"This result shows some of the promise of doing astronomy from the outer solar system. What we're seeing is that the optical background is completely consistent with the light from galaxies and we don't see a need for a lot of extra brightness; whereas previous measurements from near the Earth need a lot of extra brightness. The study is proof that this kind of measurement is possible from the outer solar system, and that LORRI is capable of doing it."



Their results also showed that earlier measurements conducted by Hubble's Wide Field Planetary Camera 2 were excessively bright (owing to interference). However, their results *were* consistent with previous measurements that were based on data obtained by the *Pioneer 10* and *11* missions. Back in the 1970s, these probes managed to gather data on the Universe while swinging past Jupiter and exploring the outer Solar System.

By showing consistency with these results (and other measurements from over the years), the team demonstrated just how valuable missions like *New Horizons* are. It is hoped that before it wraps up in 2021, that scientists will have a chance to conduct more measurements of the COB. Considering how rare missions to the outer Solar System are, it is understandable why Zemcov and his colleagues want to take full advantage of this opportunity.

"NASA sends missions to the outer Solar System once a decade or so," he said. "What they send is typically going to planets and the instruments onboard are designed to look at them, not to do astrophysics. Measurements could be designed to optimize this technique while LORRI is still functioning... With a carefully designed survey, we should be able to produce a definitive measurement of the diffuse light in the local universe and a tight constraint on the light from galaxies in the optical wavebands."

In other mission-related news, *New Horizons* probe will be taking a nap as it approaches its next destination – 2014 MU69. On Friday, April 7th, at 15:32 EDT, mission controllers at the John Hopkins University APL verified that the probe had entered hibernation. It will remain in this state for the next 157 days, waking up again on September 11th, 2017, as it makes its approach to 2014 MU69.

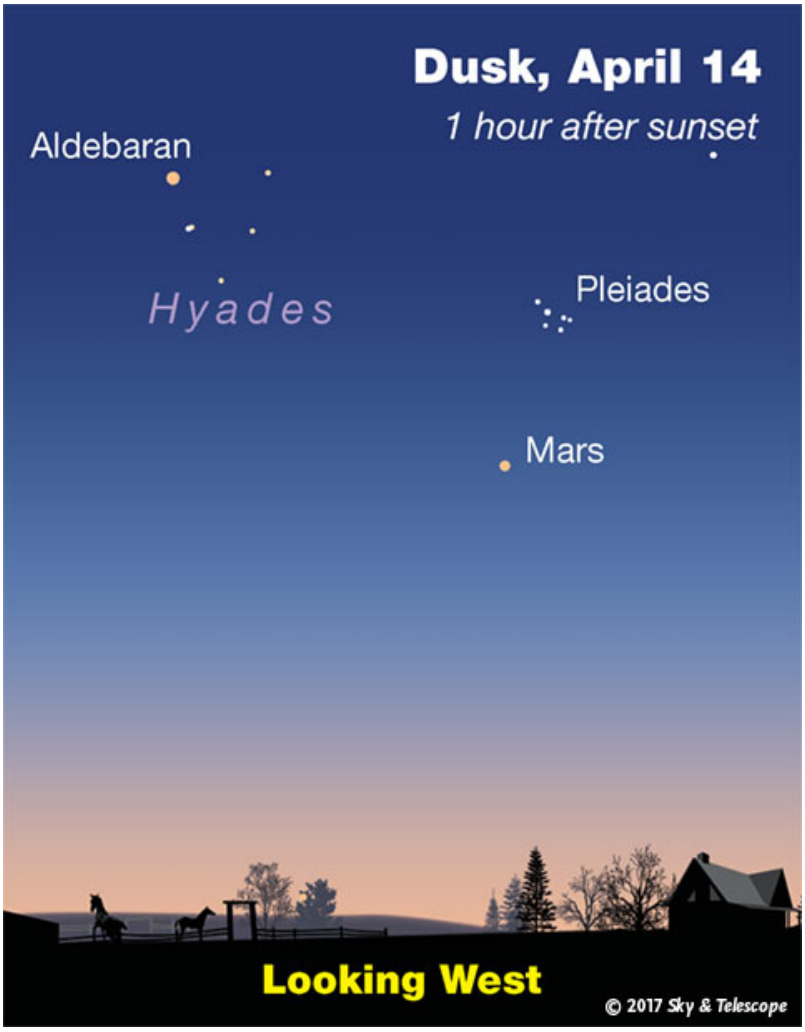
Originally, the New Horizons mission was scheduled to end after its historic encounter with Pluto. However, the mission was extended shortly thereafter to 2021 so the probe would also be able to make some more historic encounters. If, in the meantime, this probe can also shed new light on the mysteries of the Universe, it will surely be remembered as one of the most groundbreaking missions of all time.

Source: Universe Today Return to Contents

The Night Sky

Friday, April 14

• Arcturus shines brightly in the east these evenings, well to the left or upper left of even brighter Jupiter (by about three fists at arm's length). Arcturus forms the pointy end of a long, narrow kite asterism formed by the brightest stars of Bootes, the Cowherd. The kite is currently lying on its side to Arcturus's left. The head of the kite, at the far left, is bent slightly upward. The kite is 23° long: about two fists at arm's length.



Saturday, April 15

• Before and during early dawn Sunday morning, look for Saturn below or lower left of the waning gibbous Moon.

Sunday, April 16

• Jupiter's Moon Europa crosses the planet's face tonight from 10:05 p.m. to 12:28 a.m. EDT, followed by its tiny black shadow (much more easily visible) from 10:29 p.m. to 12:57 a.m. EDT. Then Jupiter's Great Red Spot crosses the planet's central meridian around 1:18 a.m. EDT.

Monday, April 17

• Bright Arcturus is climbing high in the east these evenings. Equally bright Capella is descending high in the northwest. They stand at exactly the same height above your horizon at some moment between about 9:00 and 10:30 p.m. daylight-saving time, depending mostly on how far east or west you live in your time zone. Can you time this event? Like everything star-related, it happens 4 minutes earlier every night.

Tuesday, April 18

• As twilight fades away, modest Mars glows less than 4° from the Pleiades from now through Sunday.

Source: Sky & Telescope

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ISS Sighting Opportunities

For Denver:

Date	Visible	Max Height	Appears	Disappears
Fri Apr 14, 8:25 PM	4 min	66°	44° above WNW	12° above SE
Sat Apr 15, 9:08 PM	3 min	13°	10° above W	10° above SSW
Sun Apr 16, 8:17 PM	3 min	24°	22° above WSW	11° above S
Tue Apr 18, 8:09 PM	< 1 min	10°	10° above SW	10° above SW

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

NASA-TV Highlights

(all times Eastern Daylight Time)

- **8 p.m., 10 p.m., Friday, April 14 -** Replay of the NASA Television Video File Feed of the ISS Expedition 51-52 Crew's Pre-Launch Final Soyuz Fit Check and Launch Site Activities at the Baikonur Cosmodrome in Kazakhstan (Fischer, Yurchikhin; recorded April 14) (all channels)
- **10 a.m., 6 p.m., Saturday, April 15 -** Replay of STEM in 30: The Women Who Are Paving the Way to Mars (NTV-1 (Public))
- **4 p.m., 8 p.m., Saturday, April 15** - Replay of the NASA Oceans Beyond Earth News Conference (all channels)
- **5 p.m., Saturday, April 15 -** Replay of the NASA Television Video File Feed of the ISS Expedition 51-52 Crew's Pre-Launch Activities at the Baikonur Cosmodrome in Kazakhstan (Fischer, Yurchikhin; recorded from April 5-13) (all channels)
- **10 a.m., 5 p.m., Sunday, April 16 -** Replay of the NASA Oceans Beyond Earth News Conference (all channels)
- **2 p.m., 6 p.m., Sunday, April 16 -** Replay of the NASA Television Video File Feed of the ISS Expedition 51-52 Crew's Pre-Launch Activities at the Baikonur Cosmodrome in Kazakhstan (Fischer, Yurchikhin; recorded from April 5-13) (all channels)
- **4 p.m., 8 p.m., Sunday, April 16 -** Replay of STEM in 30: The Women Who Are Paving the Way to Mars (NTV-1 (Public))
- **8 a.m., Monday, April 17 -** ISS Expedition 51 ESA In-Flight Event with RTL Television, Cologne, Germany and Flight Engineer Thomas Pesquet of the European Space Agency (Interpretation on NTV-1; native language on NTV-3) (starts at 8:20 a.m.) (all channels)
- **10:30 a.m., 4 p.m., 8 p.m., Monday, April 17 -** Orbital ATK CRS-7 Pre-Launch News Conference (all channels)

- **12 p.m., 6 p.m., 10 p.m., Monday, April 17 -** NASA Television Video File Feed of the ISS Expedition 51-52/ Soyuz Vehicle Mating and Rollout to the Launch Pad at the Baikonur Cosmodrome in Kazakhstan (Fischer, Yurchikhin; includes activities from April 16-17) (all channels)
- **1 p.m., 5 p.m., 9 p.m., Monday, April 17 -** Orbital ATK CRS-7 What's on Board Science Briefing (all channels)
- **8 a.m., Tuesday, April 18 -** Replay of the Orbital ATK CRS-7 Pre-Launch News Conference (all channels)
- **9 a.m., Tuesday, April 18 -** Replay of the Orbital ATK CRS-7 What's on Board Science Briefing (all channels)
- **10 a.m., Tuesday, April 18 -** Coverage of the Launch of the Orbital ATK Cygnus Cargo Craft to the ISS (Launch scheduled at 11:11 a.m. ET) (all channels)
- **12:30 p.m., Tuesday, April 18 -** Coverage of Solar Array Deployment for the Orbital ATK Cygnus Cargo Craft (starts at 12:40 p.m.) (all channels)
- **2 p.m., 4 p.m., 8 p.m., 10 p.m., Tuesday, April 18 -** Orbital ATK Cygnus Post-Launch News Conference (all channels)

Watch NASA TV on the Net by going to the NASA website. Return to Contents

Space Calendar

- Apr 14 - Comet 144P/Kushida At Opposition (1.675 AU)
- Apr 14 - Comet P/2007 T2 (Kowalski) At Opposition (3.369 AU)
- Apr 14 - Comet 304P/Ory At Opposition (4.084 AU)
- Apr 14 - Amor Asteroid 2017 FH63 Near-Earth Flyby (0.091 AU)
- Apr 14 - Atira Asteroid 2014 FO47 Closest Approach To Earth (1.418 AU)
- Apr 14 - Asteroid 327 Columbia Closest Approach To Earth (1.795 AU)
- Apr 14 - Asteroid 5682 Beresford Closest Approach To Earth (1.851 AU)
- Apr 14 - Asteroid 84882 Table Mountain Closest Approach To Earth (2.381 AU)
- Apr 14 - Valentin Lebedev's 75th Birthday (1942)
- Apr 15 - Comet 54P/de Vico-Swift-NEAT Perihelion (2.185 AU)
- Apr 15 - Comet 48P/Johnson At Opposition (2.714 AU)
- Apr 15 - Comet 113P/Spitaler At Opposition (3.505 AU)
- Apr 15 - Asteroid 3182 Shimanto Occults HIP 98633 (5.7 Magnitude Star)
- Apr 15 - Aten Asteroid 2017 GO4 Near-Earth Flyby (0.035 AU)
- Apr 15 - Asteroid 3169 Ostro Closest Approach To Earth (1.016 AU)
- Apr 15 - Asteroid 2034 Bernoulli Closest Approach To Earth (1.433 AU)
- Apr 15 - Samuel Hoffman's 115th Birthday (1902)
- Apr 15 - Leonhard Euler's 310th Birthday (1707)
- Apr 15 - Leonardo DaVinci's 565th Birthday (1452)
- Apr 16 - Easter Sunday
- Apr 16 - Asteroid 5316 Filatov Occults HIP 27511 (4.9 Magnitude Star)
- Apr 16 - Apollo Asteroid 2017 FV128 Near-Earth Flyby (0.074 AU)
- Apr 16 - Asteroid 1034 Mozartia Closest Approach To Earth (1.523 AU)
- Apr 16 - Asteroid 6433 Enya Closest Approach To Earth (1.882 AU)
- Apr 16 - Asteroid 3784 Chopin Closest Approach To Earth (2.060 AU)
- Apr 16 - 45th Anniversary (1972), Apollo 16 Launch (Manned Moon Landing)
- Apr 16 - Wilbur Wright's 150th Birthday (1867)
- Apr 16 - Robert Luther's 195th Birthday (1822)
- Apr 16 - John Hadley's 335th Birthday (1682)
- Apr 17 - 

[Apr 11] 50th Anniversary (1967), Surveyor 3 Launch (Moon Lander)
- Apr 17 - Comet 73P-AE/Schwassmann-Wachmann Closest Approach To Earth (0.453 AU)
- Apr 17 - Comet 73P-AS/Schwassmann-Wachmann Closest Approach To Earth (1.040 AU)
- Apr 17 - Comet 261P/Larson At Opposition (3.570 AU)
- Apr 17 - Asteroid 9621 Michaelpalin Closest Approach To Earth (1.417 AU)
- Apr 17 - Asteroid 3115 Baily Closest Approach To Earth (1.838 AU
- Apr 18 - 

[Apr 11] OA-7 (S.S. John Glenn)/ Atlas 5 Launch (International Space Station)
- Apr 18 - Cassini, Orbital Trim Maneuver #469 (OTM-469)
- Apr 18 - Asteroid 11949 Kagayayutaka Occults HIP 42353 (6.5 Magnitude Star)
- Apr 18 - Apollo Asteroid 143404 (2003 BD44) Near-Earth Flyby (0.056 AU)
- Apr 18 - Apollo Asteroid 2006 HE2 Near-Earth Flyby (0.062 AU)
- Apr 18 - Asteroid 1743 Schmidt Closest Approach To Earth (1.152 AU)
- Apr 18 - Asteroid 1193 Africa Closest Approach To Earth (1.360 AU)
- Apr 18 - Asteroid 416 Vaticana Closest Approach To Earth (1.389 AU)
- Apr 18 - Asteroid 7536 Fahrenheit Closest Approach To Earth (1.848 AU)
- Apr 18 - Charles Elachi's 70th Birthday (1947)
- Apr 18 - Brian Mason's 100th Birthday (1917)

Source: JPL Space Calendar

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Food for Thought

New Method for 3-D Printing Extraterrestrial Materials

When humans begin to colonize the moon and Mars, they will need to be able to make everything from small tools to large buildings using the limited surrounding resources.

Northwestern University's Ramille Shah and her Tissue Engineering and Additive Manufacturing (TEAM) Laboratory have demonstrated the ability to 3D-print structures with simulants of Martian and lunar dust. This work uses an extension of their "3D-painting process," a term that Shah and her team use for their novel 3D inks and printing method, which they previously employed to print hyperelastic "bone", 3D graphene and carbon nanotubes, and metals and alloys.

"For places like other planets and moons, where resources are limited, people would need to use what is available on that planet in order to live," said Shah, assistant professor of materials science and engineering at Northwestern's McCormick School of Engineering and of surgery in the Feinberg School of Medicine. "Our 3D paints really open up the ability to print different functional or structural objects to make habitats beyond Earth."

Partially supported by a gift from Google and performed at Northwestern's Simpson Querrey Institute, the research was recently published in Nature Scientific Reports. Adam Jakus, a Hartwell postdoctoral fellow in Shah's TEAM lab, was the paper's first author.

Shah's research uses NASA-approved lunar and Martian dust simulants, which have similar compositions, particle shapes, and sizes to the dusts found on lunar and Martian surfaces. Shah's team created the lunar and Martian 3D paints using the respective dusts, a series of simple solvents, and biopolymer, then 3D printed them with a simple extrusion process. The resulting structures are over 90 percent dust by weight.

Despite being made of rigid micro-rocks, the resulting 3D-painted material is flexible, elastic, and tough -- similar to rubber. This is the first example of rubber-like or soft materials resulting from lunar and Martian simulant materials. The material can be cut, rolled, folded, and otherwise shaped after being 3D painted, if desired.

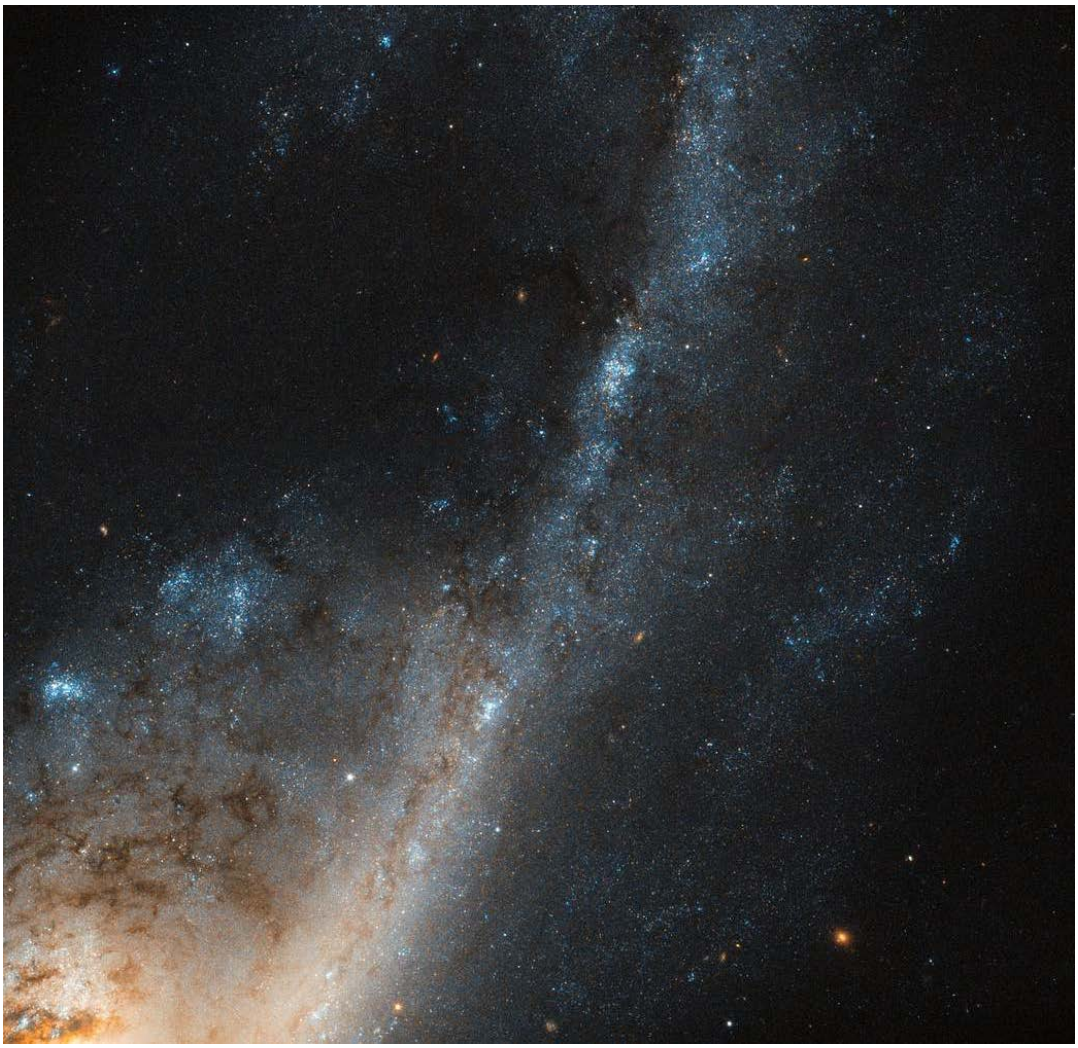
"We even 3D-printed interlocking bricks, similar to Legos, that can be used as building blocks," Shah said.

Shah and David Dunand, the James N. and Margie M. Krebs Professor of Materials Science and Engineering, are currently collaborating to optimize ways to fire these 3D-painted structures in a furnace, which is an optional process that can transform the soft, rubbery objects into hard, ceramic-like structures. In the context of the broader 3D-painting technology, this work highlights the potential to use a single 3D printer on another planet to create structures from all kinds of materials.

Even though colonizing other planets might take a while, Shah believes that it's never too soon to start planning.

Source: SpaceRef Return to Contents

Space Image of the Week



Hubble Sees Starbursts in Virgo

Although galaxy formation and evolution are still far from being fully understood, the conditions we see within certain galaxies — such as so-called starburst galaxies — can tell us a lot about how they have evolved over time. Starburst galaxies contain a region (or many regions) where stars are forming at such a breakneck rate that the galaxy is eating up its gas supply faster than it can be replenished!

NGC 4536 is such a galaxy, captured here in beautiful detail by the Hubble's Wide Field Camera 3 (WFC3). Located roughly 50 million light-years away in the constellation of Virgo (The Virgin), it is a hub of extreme star formation. There are several different factors that can lead to such an ideal environment in which stars can form at such a rapid rate. Crucially, there has to be a sufficiently massive supply of gas. This might be acquired in a number of ways — for example by passing very close to another galaxy, in a full-blown galactic collision, or as a result of some event that forces lots of gas into a relatively small space.

Star formation leaves a few tell-tale fingerprints, so astronomers can tell where stars have been born. We know that starburst regions are rich in gas. Young stars in these extreme environments often live fast and die young, burning extremely hot and exhausting their gas supplies fairly quickly. These stars also emit huge amounts of intense ultraviolet light, which blasts the electrons off any atoms of hydrogen lurking nearby (a process called ionization), leaving behind often colorful clouds of ionized hydrogen (known in astronomer-speak as HII regions).

Source: NASA

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