Space News Update

— August 20, 2019 —

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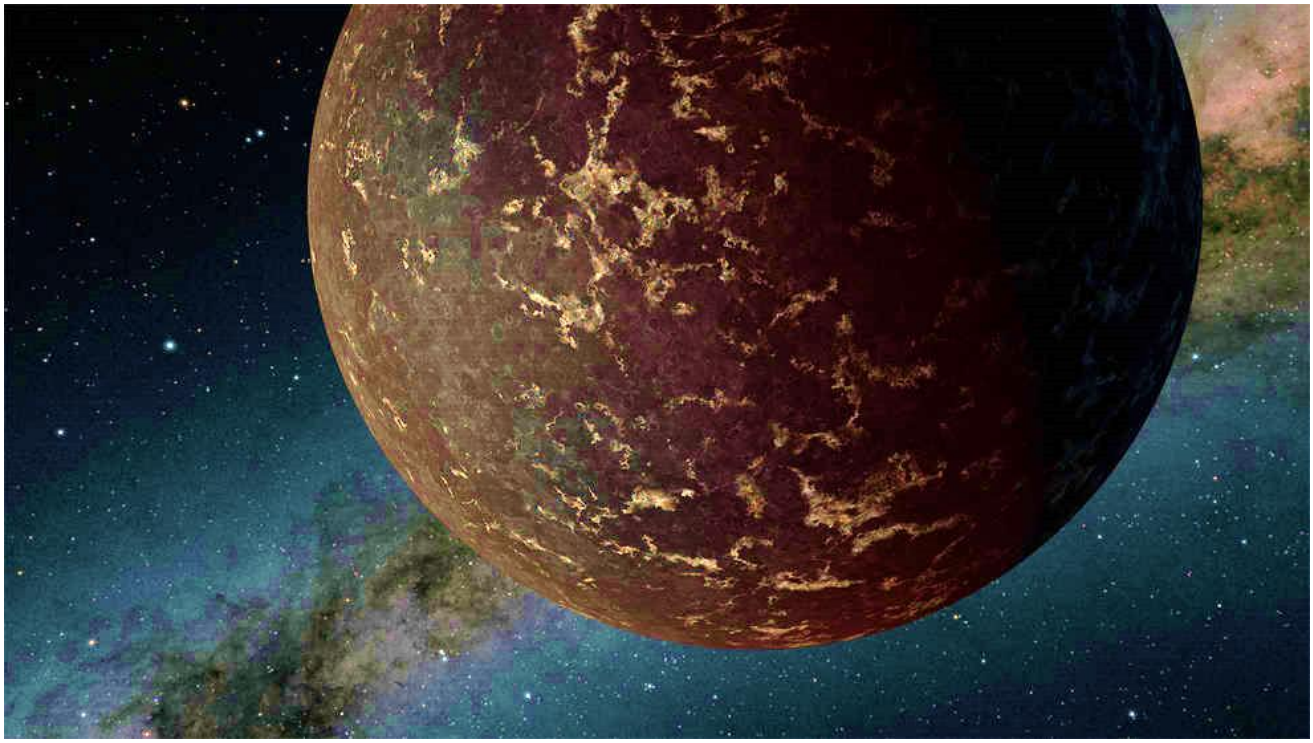
1. NASA Gets a Rare Look at a Rocky Exoplanet's Surface



This artist's illustration depicts the exoplanet LHS 3844b, which is 1.3 times the mass of Earth and orbits an M dwarf star. The planet's surface may be covered mostly in dark lava rock, with no apparent atmosphere, according to observations by NASA's Spitzer Space Telescope. Credits: NASA/JPL-Caltech/R. Hurt (IPAC)

A new study using data from NASA's Spitzer Space Telescope provides a rare glimpse of conditions on the surface of a rocky planet orbiting a star beyond the Sun. The study, published today in the journal Nature, shows that the planet's surface may resemble those of Earth's Moon or Mercury: The planet likely has little to no atmosphere and could be covered in the same cooled volcanic material found in the dark areas of the Moon's surface, called mare.

Discovered in 2018 by NASA's Transiting Exoplanet Satellite Survey (TESS) mission, planet LHS 3844b is located 48.6 light-years from Earth and has a radius 1.3 times that of Earth. It orbits a small, cool type of star called an M dwarf — especially noteworthy because, as the most common and long-lived type of star in the Milky Way galaxy, M dwarfs may host a high percentage of the total number of planets in the galaxy.

TESS found the planet via the transit method, which involves detecting when the observed light of a parent star dims because of a planet orbiting between the star and Earth. Detecting light coming directly from a planet's surface — another method — is difficult because the star is so much brighter and drowns out the planet's light.

But during follow-up observations, Spitzer was able to detect light from the surface of LHS 3844b. The planet makes one full revolution around its parent star in just 11 hours. With such a tight orbit, LHS 3844b is most likely "tidally locked," which is when one side of a planet permanently faces the star. The star-facing side, or dayside, is about 1,410 degrees Fahrenheit (770 degrees Celsius). Being extremely hot, the planet radiates a lot of infrared light, and Spitzer is an infrared telescope. The planet's parent star is relatively cool (though still much hotter than the planet), making direct observation of LHS 3844b's dayside possible.

This observation marks the first time Spitzer data have been able to provide information about the atmosphere of a terrestrial world around an M dwarf.

The Search for Life

By measuring the temperature difference between the planet's hot and cold sides, the team found that there is a negligible amount of heat being transferred between the two. If an atmosphere were present, hot air on the

dayside would naturally expand, generating winds that would transfer heat around the planet. On a rocky world with little to no atmosphere, like the Moon, there is no air present to transfer heat.

"The temperature contrast on this planet is about as big as it can possibly be," said Laura Kreidberg, a researcher at the Harvard and Smithsonian Center for Astrophysics in Cambridge, Massachusetts, and lead author of the new study. "That matches beautifully with our model of a bare rock with no atmosphere."

Understanding the factors that could preserve or destroy planetary atmospheres is part of how scientists plan to search for habitable environments beyond our solar system. Earth's atmosphere is the reason liquid water can exist on the surface, enabling life to thrive. On the other hand, the atmospheric pressure of Mars is now less than 1% of Earth's, and the oceans and rivers that once dotted the Red Planet's surface have disappeared.

"We've got lots of theories about how planetary atmospheres fare around M dwarfs, but we haven't been able to study them empirically," Kreidberg said. "Now, with LHS 3844b, we have a terrestrial planet outside our solar system where for the first time we can determine observationally that an atmosphere is not present."

Compared to Sun-like stars, M dwarfs emit high levels of ultraviolet light (though less light overall), which is harmful to life and can erode a planet's atmosphere. They're particularly violent in their youth, belching up a large number of flares, or bursts of radiation and particles that could strip away budding planetary atmospheres.

The Spitzer observations rule out an atmosphere with more than 10 times the pressure of Earth's. (Measured in units called bars, Earth's atmospheric pressure at sea level is about 1 bar.) An atmosphere between 1 and 10 bars on LHS 3844b has been almost entirely ruled out as well, although the authors note there's a slim chance it could exist if the stellar and planetary properties were to meet some very specific and unlikely criteria. They also argue that with the planet so close to a star, a thin atmosphere would be stripped away by the star's intense radiation and outflow of material (often called stellar winds).

"I'm still hopeful that other planets around M dwarfs could keep their atmospheres," Kreidberg said. "The terrestrial planets in our solar system are enormously diverse, and I expect the same will be true for exoplanet systems."

A Bare Rock

Spitzer and NASA's Hubble Space Telescope have previously gathered information about the atmospheres of multiple gas planets, but LHS 3844b appears to be the smallest planet for which scientists have used the light coming from its surface to learn about its atmosphere (or lack thereof). Spitzer previously used the transit method to study the seven rocky worlds around the TRAPPIST-1 star (also an M dwarf) and learn about their possible overall composition; for instance, some of them likely contain water ice.

The authors of the new study went one step further, using LHS 3844b's surface albedo (or its reflectiveness) to try to infer its composition.

The Nature study shows that LHS 3844b is "quite dark," according to co-author Renyu Hu, an exoplanet scientist at NASA's Jet Propulsion Laboratory in Pasadena, California, which manages the Spitzer Space Telescope. He and his co-authors believe the planet is covered with basalt, a kind of volcanic rock. "We know that the mare of the Moon are formed by ancient volcanism," Hu said, "and we postulate that this might be what has happened on this planet."

JPL manages the Spitzer Space Telescope mission for NASA's Science Mission Directorate in Washington. Science operations are conducted at the Spitzer Science Center at Caltech in Pasadena. Space operations are based at Lockheed Martin Space in Littleton, Colorado. Data are archived at the Infrared Science Archive housed at IPAC at Caltech. Caltech manages JPL for NASA.

Source: NASA Return to Contents

2. Young Jupiter Was Smacked Head-On By Massive Newborn Planet

A rendering shows the effect of a major impact on the core of a young Jupiter, as suggested by scientists at Rice and Sun Yat-sen universities. They say the collision about 4.5 billion years ago could explain surprising readings from NASA's Juno spacecraft. Illustration by Shang-Fei Liu/Sun Yat-sen University

A colossal, head-on collision between Jupiter and a still-forming planet in the early solar system, about 4.5 billion years ago, could explain surprising readings from NASA's Juno spacecraft, according to a study this week in the journal Nature.

Astronomers from Rice University and China's Sun Yat-sen University say their head-on impact scenario can explain Juno's previously puzzling gravitational readings, which suggest that Jupiter's core is less dense and more extended that expected.

"This is puzzling," said Rice astronomer and study co-author Andrea Isella. "It suggests that something happened that stirred up the core, and that's where the giant impact comes into play."

Isella said leading theories of planet formation suggest Jupiter began as a dense, rocky or icy planet that later gathered its thick atmosphere from the primordial disk of gas and dust that birthed our sun.

Isella said he was skeptical when study lead author Shang-Fei Liu first suggested the idea that the data could be explained by a giant impact that stirred Jupiter's core, mixing the dense contents of its core with less dense layers above. Liu, a former postdoctoral researcher in Isella's group, is now a member of the faculty at Sun Yat-sen in Zhuhai, China.

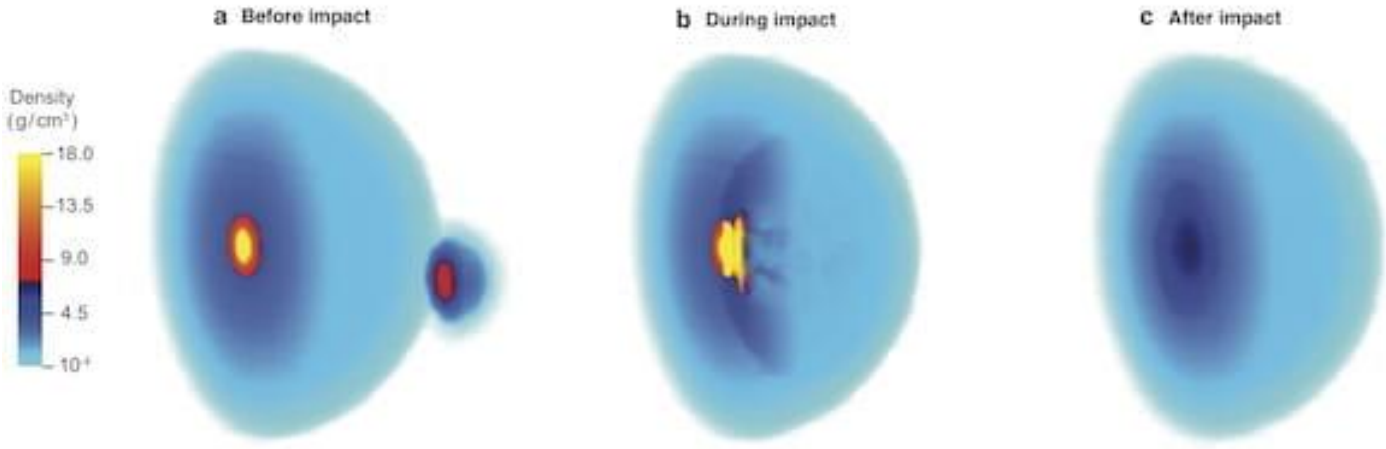
"It sounded very unlikely to me," Isella recalled, "like a one-in-a-trillion probability. But Shang-Fei convinced me, by shear calculation, that this was not so improbable."

The research team ran thousands of computer simulations and found that a fast-growing Jupiter can have perturbed the orbits of nearby "planetary embryos," protoplanets that were in the early stages of planet formation.

Liu said the calculations included estimates of the probability of collisions under different scenarios and distribution of impact angles. In all cases, Liu and colleagues found there was at least a 40% chance that Jupiter would swallow a planetary embryo within its first few million years. In addition, Jupiter mass-produced "strong gravitational focusing" that made head-on collisions more common than grazing ones.

Isella said the collision scenario became even more compelling after Liu ran 3D computer models that showed how a collision would affect Jupiter's core.

"Because it's dense, and it comes in with a lot of energy, the impactor would be like a bullet that goes through the atmosphere and hits the core head-on," Isella said. "Before impact, you have a very dense core, surrounded by atmosphere. The head-on impact spreads things out, diluting the core."



A rendering shows the effect of a major impact on the core of a young Jupiter, as suggested by scientists at Rice and Sun Yat-sen universities. They say the collision about 4.5 billion years ago could explain surprising readings from NASA's Juno spacecraft. Illustration by Shang-Fei Liu/Sun Yat-sen University

Isella said the calculations suggest that even if this impact happened 4.5 billion years ago, "it could still take many, many billions of years for the heavy material to settle back down into a dense core under the circumstances suggested by the paper."

Isella, who is also a co-investigator on the Rice-based, NASA-funded CLEVER Planets project, said the study's implications reach beyond our solar system.

"There are astronomical observations of stars that might be explained by this kind of event," he said.

"This is still a new field, so the results are far from solid, but as some people have been looking for planets around distant stars, they sometimes see infrared emissions that disappear after a few years," Isella said. "One idea is that if you are looking at a star as two rocky planets collide head-on and shatter, you could create a cloud of dust that absorbs stellar light and reemits it. So, you kind of see a flash, in the sense that now you have this cloud of dust that emits light. And then after some time, the dust dissipates and that emission goes away."

The Juno mission was designed to help scientists better understand Jupiter's origin and evolution. The spacecraft, which launched in 2011, carries instruments to map Jupiter's gravitational and magnetic fields and probe the planet's deep, internal structure.

Additional co-authors of the study include Yasunori Hori of the Astrobiology Center of Japan, Simon Müller and Ravit Helled of the University of Zurich, Xiaochen Zheng of Tsinghua University in Beijing and Doug Lin of both the University of California, Santa Cruz, and Tsinghua University in Beijing.

Source: Rice University

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3. ExoMars Parachute Failures Could Jeopardize 2020 Launch Date

The deployment of the large 35 m-wide parachute of the upcoming ExoMars mission was tested previously in a low-altitude drop test earlier this month. The image captures the inflated ring-slot parachute with the drop test vehicle suspended underneath.

The European Space Agency has confirmed a parachute for the ExoMars rover mission set for launch next July failed during a test over Sweden earlier this month, the project's second parachute test accident since May.

The failure during a high-altitude parachute test Aug. 5 was a setback for the ExoMars team as engineers work toward a 19-day launch window that opens July 25, 2020. It was the second parachute failure ExoMars engineers have encountered in pre-launch testing, following a similar accident May 28.

Four parachutes — two pilot chutes and supersonic and subsonic main chutes — will slow the ExoMars lander after it enters the Martian atmosphere. The lander will jettison the parachutes and ignite braking rockets to slowly settle onto the surface of Mars.

Engineers implemented changes to the critical parachute system after the May 28 accident, but the follow-up test also ran into trouble, ESA said in a statement Monday. ESA and industrial teams conducted both tests from the Esrange Space Center, operated by the Swedish Space Corp. in far northern Sweden.

"Preliminary assessment shows that the initial steps were completed correctly, however damages to the canopy were observed prior to inflation, similar to the previous test," ESA said of the Aug. 5 test. "As a result, the test module descended under the drag of the pilot chute alone."

During the May 28 test, engineers tested all four parachutes in the ExoMars landing system after dropping a test vehicle from a stratospheric balloon around 29 kilometers (95,000 feet) in altitude.

During a normal landing sequence, a pilot chute is supposed to pull out and unfurl a 15-meter (49-foot) supersonic main parachute, a larger version of the disc-gap parachute successfully flown on Europe's Huygens probe at Saturn's moon Titan. Once the vehicle slows below the speed of sound, a second pilot chute will extract a 35-meter

(114-foot) subsonic main parachute, which will be the largest ever flown on Mars and uses a different "ring-slot" design intended to produce more drag.

In a statement Monday, ESA said the "overall sequence" was completed during the May 28 test, and all deployment mechanisms functioned as intended. Both main parachute canopies suffered tears in their fabric, but the chutes did generate a "good level of the expected aerodynamic drag," ESA said.

After making changes to the parachutes and their bags, ground crews proceeded with a second high-altitude test Aug. 5, focusing on just the larger, subsonic main parachute, ESA said. That test also produced an unsatisfactory result.

"It is disappointing that the precautionary design adaptations introduced following the anomalies of the last test have not helped us to pass the second test successfully, but as always we remain focused and are working to understand and correct the flaw in order to launch next year," said Francois Spoto, ESA's ExoMars team leader.

ESA said engineers have recovered all hardware from the Aug. 5 test for inspections. Teams are also analyzing video and telemetry from the test to determine what went wrong.

Two more high-altitude parachute tests, one for each main parachute, are planned later this year and in early 2020. Those tests must produce good results — and remain close to their current schedules — if the ExoMars lander is to remain on track to launch in July or August 2020, officials said.

High-altitude parachute tests are expensive and require advance planning. ESA said the ExoMars team is looking at the possibility of manufacturing additional parachute test models and conducting ground-based simulations to "mimic the dynamic nature of parachute extraction." ESA is also looking to NASA's expertise in Mars parachute design.

The larger of the ExoMars mission's two main parachutes worked as designed during a low-altitude drop test in Sweden last year. The 35-meter parachute for the ExoMars mission is manufactured the Italian company Arescosmo. The British engineering form Vorticity Ltd. carries out the test campaign in Sweden under the supervision of Thales Alenia Space's French division, which has overall responsibility for the ExoMars parachute system.

"Getting to Mars and in particular landing on Mars is very difficult," Spoto said in a statement. "We are committed to flying a system that will safely deliver our payload to the surface of the Mars in order to conduct its unique science mission."

If the ExoMars lander and rover miss the launch window next year, the next opportunity to depart Earth on a direct flight to Mars will come in late 2022. Mars planetary launch windows open about once every 26 months, when Earth and Mars are located in the right positions in the solar system to make a direct trip possible.

The ambitious ExoMars program is a partnership between ESA and Roscosmos, the Russian space agency. The ExoMars program consists of two parts. The ExoMars Trace Gas Orbiter launched in March 2016 and is now surveying the Martian atmosphere with suite of scientific instruments to search for methane, and a camera to map changes on the planet's surface. The Trace Gas Orbiter launched aboard a Russian Proton rocket in tandem with a landing craft named Schiaparelli, which crashed on the Red Planet on final descent.

Like its orbiter precursor, the second ExoMars mission will launch on a Russian Proton booster from the Baikonur Cosmodrome in Kazakhstan. A European-made carrier module will shepherd the ExoMars lander from Earth to Mars, where a Russian-made descent stage will deliver the European ExoMars rover to the surface.

The Russian descent stage will remain operational as a stationary lander platform — named Kazachok, Russian for "little Cossack" — to conduct its own scientific measurements, while the European rover will drive several kilometers and drill to a depth of 2 meters (6.6 feet) to collect core samples for analysis in the mobile robot's on-board laboratory.

Source: Spaceflight Now Return to Contents

The Night Sky

Tuesday, August 20

• August is prime Milky Way time now that the Moon is finally leaving the evening sky. After twilight fully ends, the Milky Way runs from Sagittarius in the south, up and left across Aquila and through the big Summer Triangle very high in the east, and on down through Cassiopeia to Perseus rising low in the north-northeast.

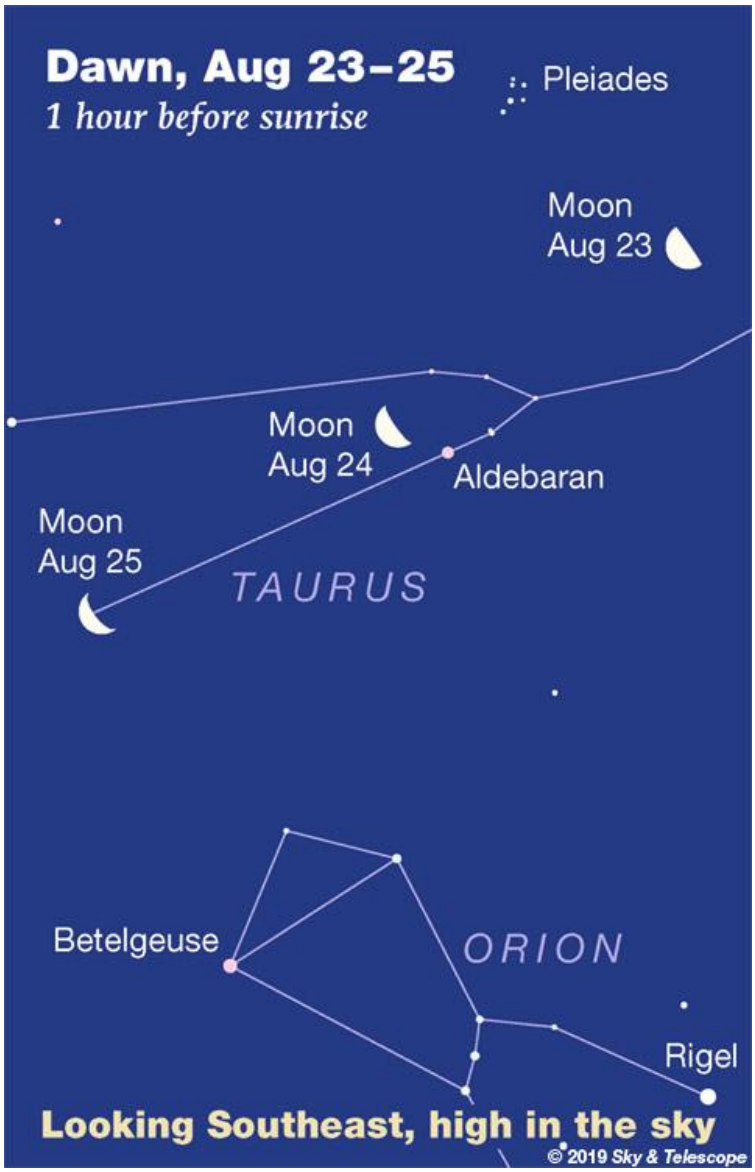
Wednesday, August 21

• Different people have an easier or harder time seeing star colors, especially subtle ones. To me, the tints of bright stars stand out a little better in a sky that's still the deep blue of late twilight.

For instance, the two brightest stars of summer are Vega, overhead at that time, and Arcturus, shining in the west. Vega is white with just a touch of blue. Arcturus is a yellow-orange giant. Do their colors stand out a little better for you in late twilight? Could this be a contrast effect of seeing yellow, orange, or orange-red stars on a blue background?

Thursday, August 22

• Take advantage of these moonless late evenings to use your scope to pick out the asteroids Eunomia (now magnitude 8.4), Laetitia (9.4), and Psyche (9.8) just north of the Capricornus star pattern — using the article and chart in the August *Sky & Telescope*, page 48.



As seen in early dawn, the waning Moon now crosses Taurus.

Friday, August 23

• Last-quarter Moon (exactly so at 10:56 a.m. on this date). The Moon rises tonight around midnight or so (depending on your location), below the Pleiades. Accompanying the Moon will be orange Aldebaran. By the beginning of dawn Saturday morning, they all stand high in the southeast.

Saturday, August 24

• In the early-morning hours of Sunday, the waning Moon is even closer to 3rd-magnitude Zeta Tauri, one of the Taurus horn-tips. The bright limb of the Moon occults the star for the western US and Mexico before or during dawn; see the August *Sky & Telescope*, page 50. Detailed timetables.

Source: Sky and Telescope

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ISS Sighting Opportunities (from Denver)

ISS sightings are not possible at Denver through Friday Aug 23, 2019

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

NASA-TV Highlights (all times Eastern Time Zone)

August 20, Tuesday

- 5 p.m. -Replay of the Sixth Meeting of the National Space Council (All Channels)

August 21, Wednesday

- 6:30 a.m. - Coverage of the International Space Station Expedition 60 international docking adapter-3 installation spacewalk (Hague and Morgan); spacewalk scheduled to begin at 8:20 a.m. ET and will last around 6 ½ hours (All Channels)
- 11:15 p.m. – Coverage of the Launch of the unpiloted Soyuz MS-14 Spacecraft on a 2.1a Soyuz Booster from the Baikonur Cosmodrome, Kazakhstan; launch scheduled at 11:38 p.m. ET (All Channels)

August 22, Thursday

- 12 p.m. – Video File of the unpiloted Soyuz MS-14 launch from the Baikonur Cosmodrome in Kazakhstan (Media Channel)

Watch NASA TV online by going to the NASA website.

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Space Calendar

- **Aug 20 -Chandrayaan 2, Moon Orbit Insertion**
- Aug 20 - 6th Meeting of the National Space Council, Chantilly, Virginia
- Aug 20 - Comet P/2015 X6 (PANSTARRS) At Opposition (1.836 AU)
- Aug 20 - Asteroid 10093 Diesel Closest Approach To Earth (1.194 AU)
- Aug 20 - Asteroid 2044 Wirt Closest Approach To Earth (2.033 AU)
- **Aug 21 - Soyuz MS-14 Soyuz-2.1a Launch (International Space Station 60S)**
- Aug 21 - Comet P/2008 Y12 (SOHO) Closest Approach To Earth (0.620 AU)
- Aug 21 - Aten Asteroid 2008 PR9 Near-Earth Flyby (0.044 AU)
- Aug 21 - Asteroid 3590 Holst Closest Approach To Earth (1.406 AU)
- Aug 21-22 - Workshop: Manipulating the Sun - Picturing Astronomical Miracles from the Bible in the Early Modern Era, Wuppertal, Germany
- Aug 21-23 - Astro2020 Meeting: Panel on Cosmology, Washington DC
- Aug 21-23 - Meeting: Panel on Stars, the Sun, and Stellar Populations (Astro2020), Washington DC
- Aug 21-29 - 8th International Conference on New Frontiers in Physics (ICNFP 2019), Kolymbari, Crete, Greece
- **Aug 22 - GPS 3A-02 Delta 4 Launch**
- Aug 22 - Asteroid 78453 Bullock Closest Approach To Earth (1.798 AU)
- Aug 22-28 - 19th Lomonosov Conference on Elementary Particle Physics, Moscow, Russia
- Aug 23 - Asteroid 21 Lutetia Occults UCAC5 447-000892 (12.0 Magnitude Star)
- Aug 23 - Asteroid 3635 Kreutz Closest Approach To Earth (1.032 AU)
- Aug 23 - Asteroid 3494 Purple Mountain Closest Approach To Earth (1.066 AU)
- Aug 23 - Asteroid 25399 Vonnegut Closest Approach To Earth (1.820 AU)
- Aug 23 - Asteroid 70713 Sethmacfarlane Closest Approach To Earth (1.912 AU)
- Aug 23 - Dark Sky Festival, Sequoia and Kings Canyon National Parks, Three Rivers, California
- Aug 24 - Venus Passes 0.3 Degrees From Mars
- **Aug 24 - Apollo Asteroid 162173 Ryugu Closest Approach To Earth (1.566 AU)**
- Aug 24 - Asteroid 203 Pompeja Closest Approach To Earth (1.684 AU)
- Aug 24 - Asteroid 8734 Warner Closest Approach To Earth (1.783 AU)
- Aug 24 - Jupiter Trojan 911 Agamemnon At Opposition (4.239 AU)
- Aug 24 - 2019 StarFest, Hopewell Furnace National Historic Site, Elverson, Pennsylvania
- Aug 24-25 - 3rd Annual Yukon Star Party, Yukon, Canada
- Aug 24-27 - 5th Beijing Earth and Planetary Interiors Symposium, Beijing, China
- Aug 24-31 - Merritt Summer Star Quest, Vancouver, Canada

Source: JPL Space Calendar Return to Contents

Food for Thought

Why Build Big Rockets at All? It's Time for Orbital Refueling

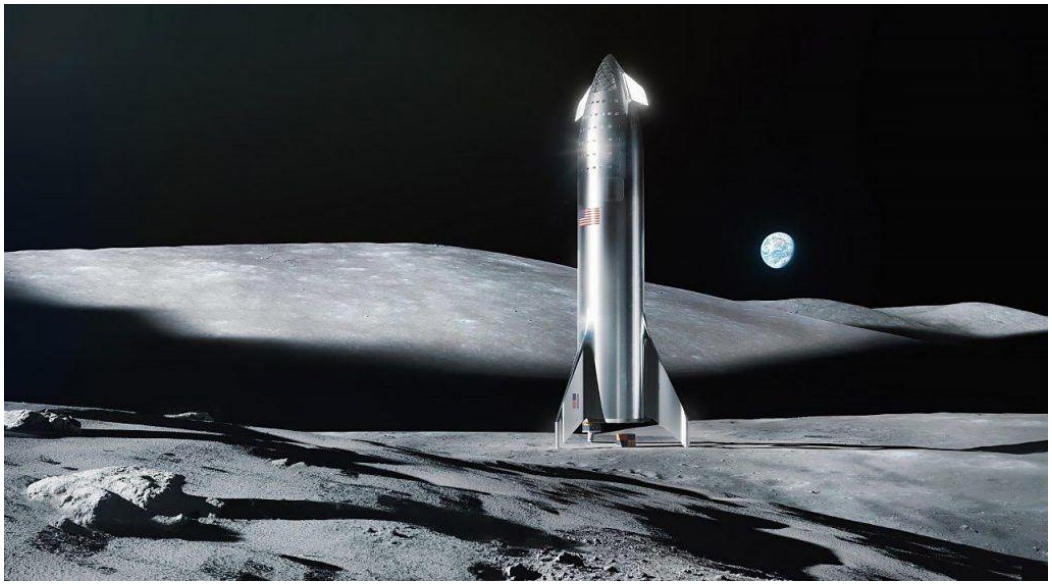


Illustration of a stainless steel Starship on the Moon. Credit: SpaceX

On Tuesday, July 30th, NASA announced 19 different partnerships with 13 different companies to use their expertise to help them develop space technologies, from advanced communications systems to new methods of entry, descent and landing. Instead of contracting out specific projects, NASA will make its employees, facilities, hardware and software available to these companies, for free.

One of the most notable of these partnerships will be with SpaceX and NASA's Glenn and Marshall Centers to help advance the technology of transferring propellant in orbit. In other words, NASA is going to help SpaceX figure out how to refuel a spacecraft while it's in space. And if they can figure this out, it could completely change the way missions are launched and flown.

Think about the way a modern rocket mission is flown. The rocket is filled up with all the propellant it's going to need for its journey. The first stage, second stage, etc., each of these contain propellant tanks filled with rocket fuel. These lower stages are discarded, and once the upper stages get to orbit, the rest of the spacecraft has to complete its mission with whatever propellant it has left on board.

NASA's New Horizons spacecraft weighed less than a ton, but it required the largest Atlas rocket with 5 strap-on solid rocket boosters to get the velocity it needed to make the journey to Pluto.

There are many fascinating missions in the planning stages, an orbital mission to Neptune, the LUVOIR space telescope, but these will require the upgraded Block II version of the Space Launch System, capable of launching 130 tons into low Earth orbit.

Imaging going on a road trip, and needing to fill your car with all the fuel you'll need for the entire trip. It doesn't make sense. You stop and refuel your car that makes sense. Thanks to SpaceX, and its boosters that return to Earth and land under their own propulsion, it's clear that the future is reusable, and that means that orbital refueling can become a reality.

Refueling the SpaceX Starship

The SpaceX Starship, formerly known as the BFR, will depend on orbital refueling to complete many of its missions. Once developed, the Starship will consist of two stages. There's the first stage, which is now called the Super Heavy. This is the equivalent of the Falcon-9's first stage.

This stage will be 63 meters long and 9 meters in diameter. It'll have a total mass of over 3,000 tons, with fuel tanks of liquid methane and oxygen. It'll be powered by 35 Raptor engines, fueled by methane.

Just like the Falcon-9, the Super Heavy will get the whole stack off the ground, detach from the upper stage and then return to Earth, ideally landing on its launch pad again, ready for another flight.

The upper stage Starship will be 55 meters tall and have several different configurations. There'll be a version that takes humans to Mars or the Moon. And a cargo version that will launch satellites into various orbits.

And there will be a tanker version that does nothing but carry tons propellant to orbit, to refuel Starships for their various missions. According to SpaceX, one, two and even five of these tanker Starships could launch to orbit to completely refill a Starship's fuel tanks with more methane and oxygen. With one tankers' worth of fuel, a Starship could travel to the Moon, land on the surface, and then return to Earth.

Completely fuel its propellant tanks with 5 refills, and you could carry hundreds of tons of people, equipment and supplies to Mars, not to mention enormous interplanetary robotic spacecraft that could seriously explore other worlds.

These missions will depend on being able to safely transfer fuels in the difficult environment of space. That's why NASA's help will be so valuable.

Refueling ISS

For all the missions that have flown to space, and the number of times that spacecraft have docked with each other, orbital refueling isn't much of a consideration. It's most commonly done today with the Russian Progress spacecraft which docks with and resupplies the International Space Station. This is based on technology the Russians developed to keep their Mir space station refueled.

Each Progress M1 Refueling Module has eight propellant tanks on board, which can carry 1,740 kilograms of fuel and oxidizer. When it docks with the International Space Station, the Progress transfers the fuel and oxidizer to the Space Station's propulsion system through fluid connectors in the docking ring.

NASA has also gotten even more complicated, testing out the equivalent of a full-service gas station in orbit. The Robotic Refueling Mission is a multi-phase test carried out using the International Space Station as a platform to test out refueling and satellite servicing methods.

The RRM consists of a washing machine-sized box with all hardware that would be used as part of a refueling procedure. The station's robotic arm demonstrated that it could act as an orbital service station attendant, peeling back protective thermal blankets, unscrewing caps, turning valves, and transferring fluid.

In other words, NASA has already tested out many of the technologies that SpaceX would need to make their orbital refueling ideas a reality. They're providing all this hardware and expertise for free as part of this new agreement.

United Launch Alliance and the Advanced Common Evolved Stage

In 2010, Frank Zegler and Bernard Kutter from United Launch Alliance presented their ambitious plans to develop an orbital propellant depot at the AIAA Space 2010 conference in Anaheim California. According to their calculations, 70% of the mass that actually makes it to low-Earth orbit is simply propellant.

Unlike the complex hardware for keeping humans alive, deploying robots or powering a spacecraft, we're talking about pressure vessels containing rocket fuel. This is the simplest cargo that could be carried to orbit, and should be a commodity at this point.

The problem is that the technology hasn't been developed to receive, store and then provide these propellants to other spacecraft when they need them.

According to Zegler and Kutter, the thinking had been that these orbital depots would need to be enormous, International Space Station-scale structures built by many launches and assembled in space by robots or astronauts. But they proposed that depots could actually be much smaller.

The key is to use them. Keep the fuel flowing. The total capacity of a refueling depot might be 120 tons of propellant, but it could provide over 300 tons to various missions over the course of a year.

A low-Earth orbit fuel depot would be helpful. An even better place might be the Earth-Moon L2 Lagrange point. This is a region of stability located about 60,000 kilometers beyond the Moon. From this point, it only takes a little bit of fuel to completely escape Earth orbit.

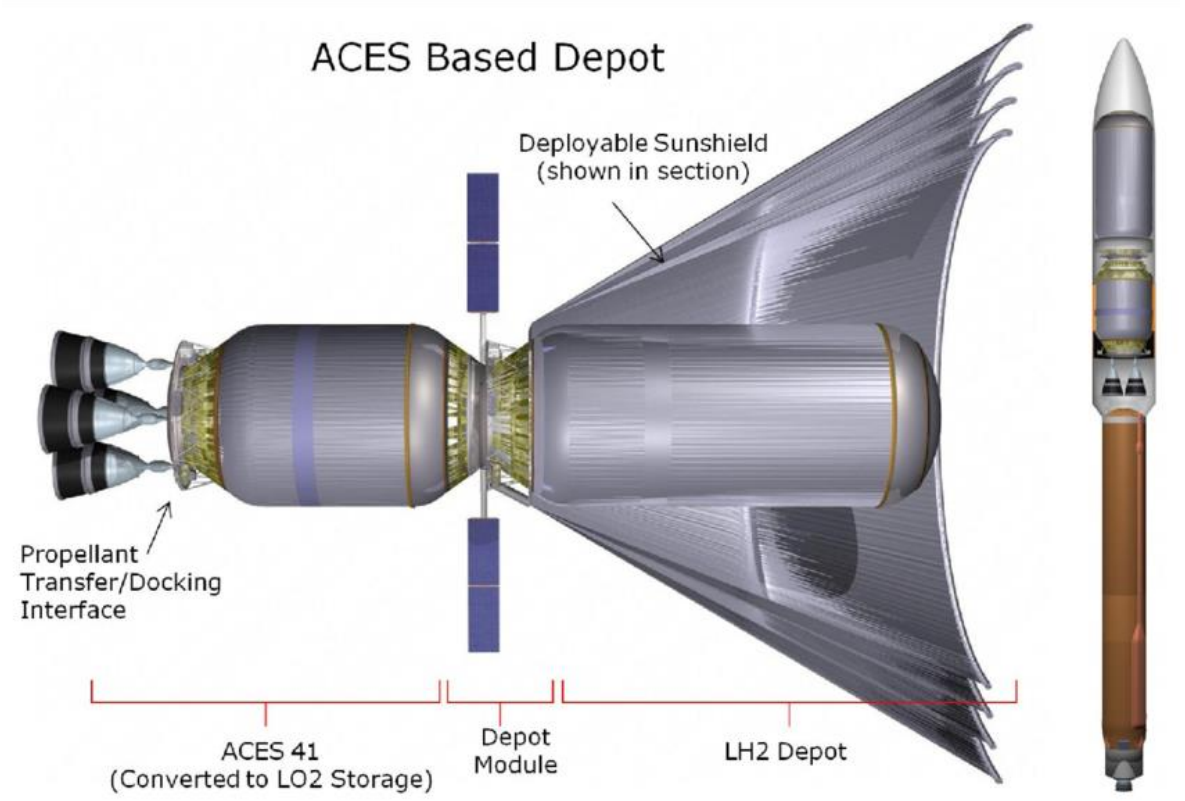
There are challenges, of course. Liquid hydrogen and oxygen need to be kept at incredibly cold temperatures, or they'll evaporate because of the heat from the Sun and Earth. But block the light of the Sun with a sunshade, and you can reduce those boil-off rates to essentially zero.

United Launch Alliance proposed the Advanced Common Evolved Stage, or ACES based on technology developed a few years earlier by Boeing and Lockheed Martin. Each ACES upper stage would contain twice the propellant of a traditional Centaur upper stage booster – 41 metric tons of fuel. And a stretched version would have 73 tons on board.

The fuel depot itself would consist of two of these upper stages mated together, with a sunshield to protect it from the heat of the Sun. Then bulk propellant could be launched to the depot in 26 ton increments, filling it up and providing the fuel storage for future missions.

ULA proposed a test for the ACES system in 2011 that would have cost less than $100 million, but political issues snared up the program, delaying any further development. Which is too bad, because it's clearly the future. It's only now that SpaceX is seriously considering orbital refueling, and this technology could have been a decade ahead.

In a recent interview with Ars Technica, ULA president Tory Bruno said that the development of ACES is still on the roadmap, but it'll happen after their next generation Vulcan rocket flies. So that'll be years.



A Single Launch, Dual-Fluid Propellant Depot. Credit: ULA

Source: Universe Today

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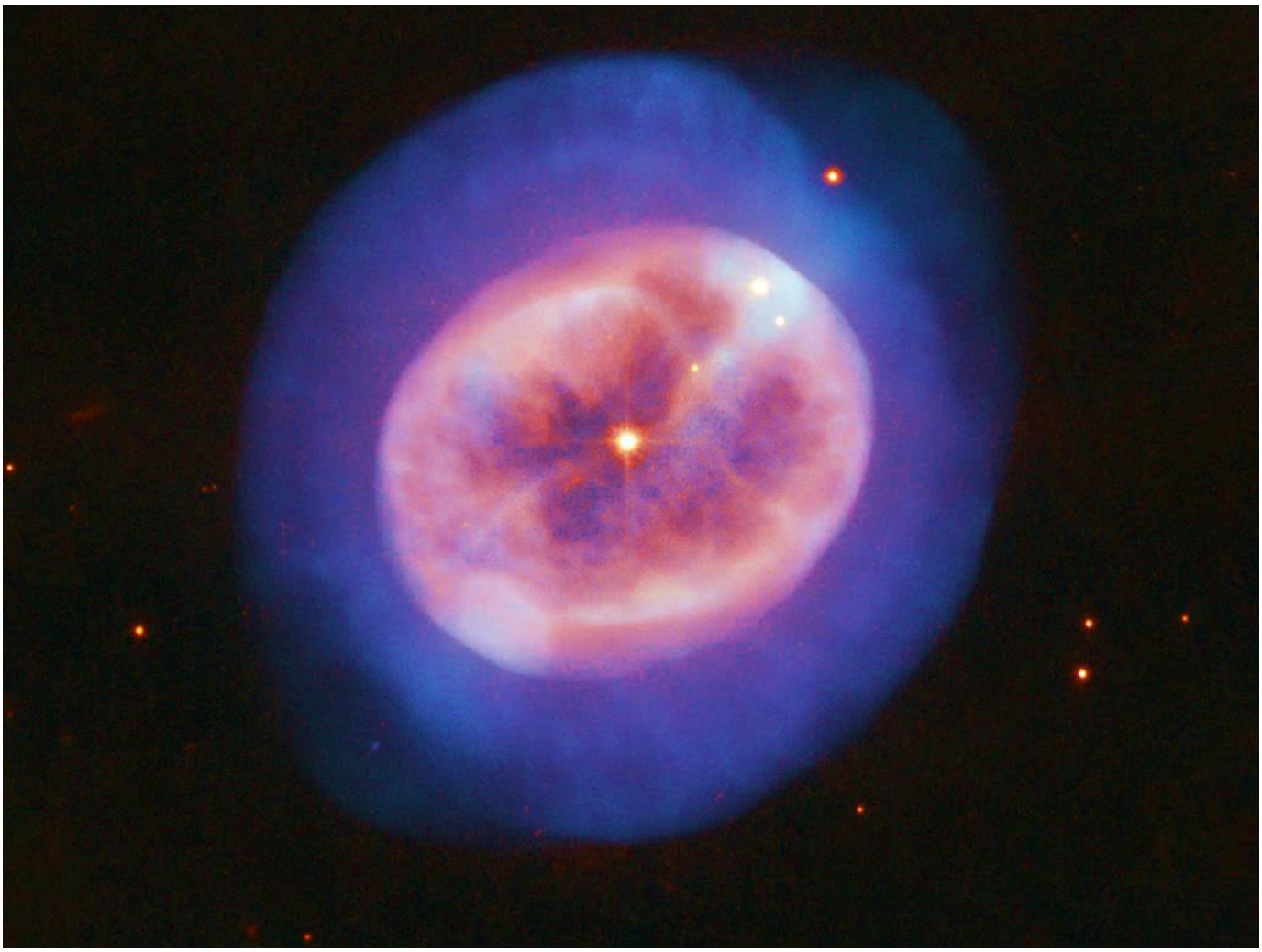
Space Image of the Week



Hubble’s Portrait of Star’s Gaseous Glow

Text credit: ESA (European Space Agency)
Image credit: ESA/Hubble & NASA, R. Wade

Explanation: Although it looks more like an entity seen through a microscope than a telescope, this rounded object, named NGC 2022, is certainly not algae or tiny, blobby jellyfish. Instead, it is a vast orb of gas in space, cast off by an aging star. The star is visible in the orb's center, shining through the gases it formerly held onto for most of its stellar life.

When stars like the Sun grow advanced in age, they expand and glow red. These so-called red giants then begin to lose their outer layers of material into space. More than half of such a star's mass can be shed in this manner, forming a shell of surrounding gas. At the same time, the star's core shrinks and grows hotter, emitting ultraviolet light that causes the expelled gases to glow.

This type of object is called, somewhat confusingly, a planetary nebula, though it has nothing to do with planets. The name derives from the rounded, planet-like appearance of these objects in early telescopes.

NGC 2022 is located in the constellation of Orion (the Hunter).

Source: NASA Return to Contents