Space News Update

— December 5, 2017 —

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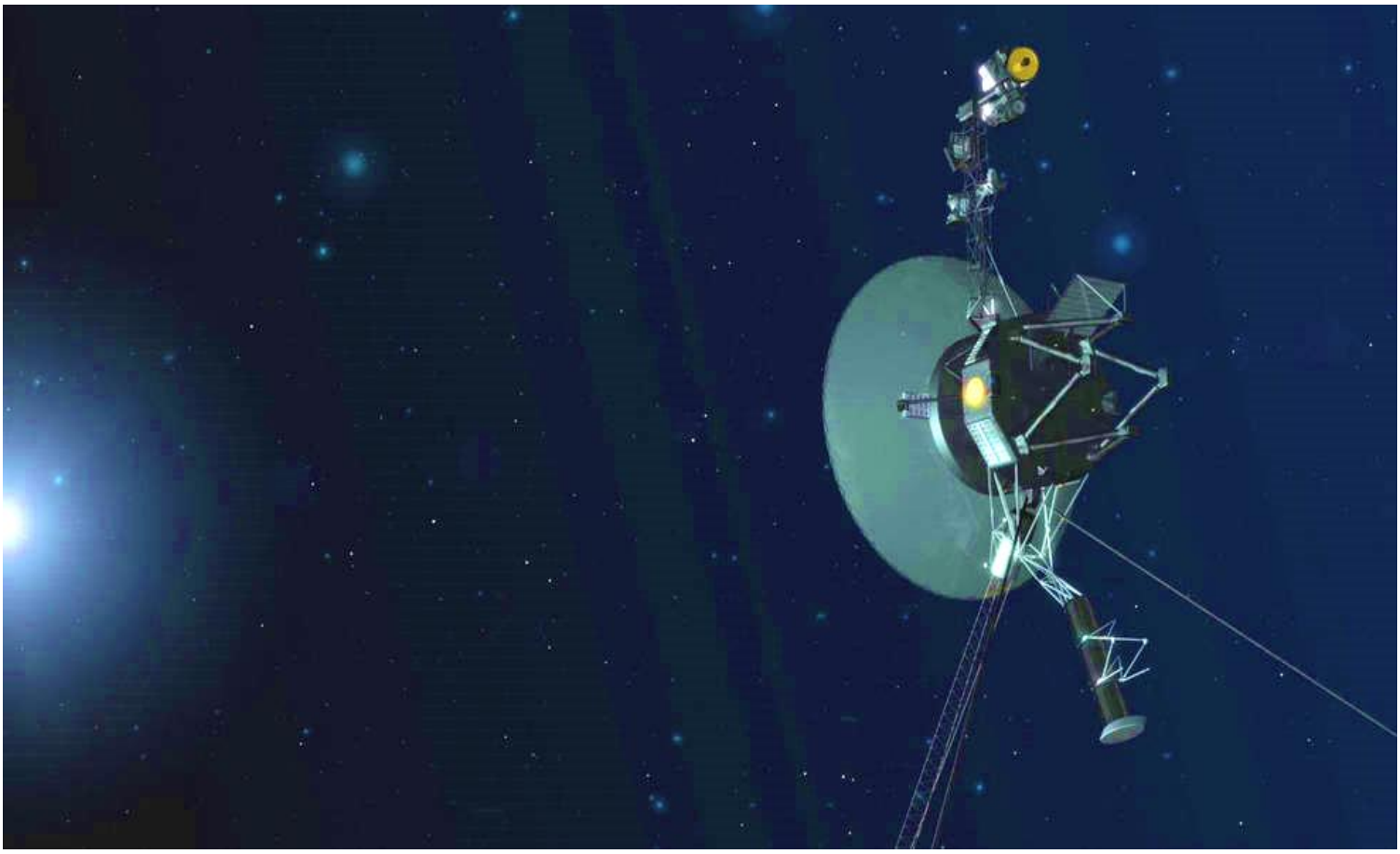
1. Voyager 1 Fires Up Thrusters After 37 Years



The twin Voyager spacecraft are celebrating 40 years of continual operation in August and September 2017. Credits: NASA/JPL-Caltech

If you tried to start a car that's been sitting in a garage for decades, you might not expect the engine to respond. But a set of thrusters aboard the Voyager 1 spacecraft successfully fired up Wednesday after 37 years without use.

Voyager 1, NASA's farthest and fastest spacecraft, is the only human-made object in interstellar space, the environment between the stars. The spacecraft, which has been flying for 40 years, relies on small devices called thrusters to orient itself so it can communicate with Earth. These thrusters fire in tiny pulses, or "puffs," lasting mere milliseconds, to subtly rotate the spacecraft so that its antenna points at our planet. Now, the Voyager team is able to use a set of four backup thrusters, dormant since 1980.

"With these thrusters that are still functional after 37 years without use, we will be able to extend the life of the Voyager 1 spacecraft by two to three years," said Suzanne Dodd, project manager for Voyager at NASA's Jet Propulsion Laboratory, Pasadena, California.

Since 2014, engineers have noticed that the thrusters Voyager 1 has been using to orient the spacecraft, called "attitude control thrusters," have been degrading. Over time, the thrusters require more puffs to give off the same amount of energy. At 13 billion miles from Earth, there's no mechanic shop nearby to get a tune-up.

The Voyager team assembled a group of propulsion experts at NASA's Jet Propulsion Laboratory, Pasadena, California, to study the problem. Chris Jones, Robert Shotwell, Carl Guernsey and Todd Barber analyzed options and predicted how the spacecraft would respond in different scenarios. They agreed on an unusual solution: Try giving the job of orientation to a set of thrusters that had been asleep for 37 years.

"The Voyager flight team dug up decades-old data and examined the software that was coded in an outdated assembler language, to make sure we could safely test the thrusters," said Jones, chief engineer at JPL.

In the early days of the mission, Voyager 1 flew by Jupiter, Saturn, and important moons of each. To accurately fly by and point the spacecraft's instruments at a smorgasbord of targets, engineers used "trajectory correction maneuver," or TCM, thrusters that are identical in size and functionality to the attitude control thrusters, and are located on the back side of the spacecraft. But because Voyager 1's last planetary encounter was Saturn, the Voyager team hadn't needed to use the TCM thrusters since November 8, 1980. Back then, the TCM thrusters were used in a more continuous firing mode; they had never been used in the brief bursts necessary to orient the spacecraft.

All of Voyager's thrusters were developed by Aerojet Rocketdyne. The same kind of thruster, called the MR-103, flew on other NASA spacecraft as well, such as Cassini and Dawn.

On Tuesday, Nov. 28, 2017, Voyager engineers fired up the four TCM thrusters for the first time in 37 years and tested their ability to orient the spacecraft using 10-millisecond pulses. The team waited eagerly as the test results traveled through space, taking 19 hours and 35 minutes to reach an antenna in Goldstone, California, that is part of NASA's Deep Space Network.

Lo and behold, on Wednesday, Nov. 29, they learned the TCM thrusters worked perfectly -- and just as well as the attitude control thrusters.

"The Voyager team got more excited each time with each milestone in the thruster test. The mood was one of relief, joy and incredulity after witnessing these well-rested thrusters pick up the baton as if no time had passed at all," said Barber, a JPL propulsion engineer.

The plan going forward is to switch to the TCM thrusters in January. To make the change, Voyager has to turn on one heater per thruster, which requires power -- a limited resource for the aging mission. When there is no longer enough power to operate the heaters, the team will switch back to the attitude control thrusters.

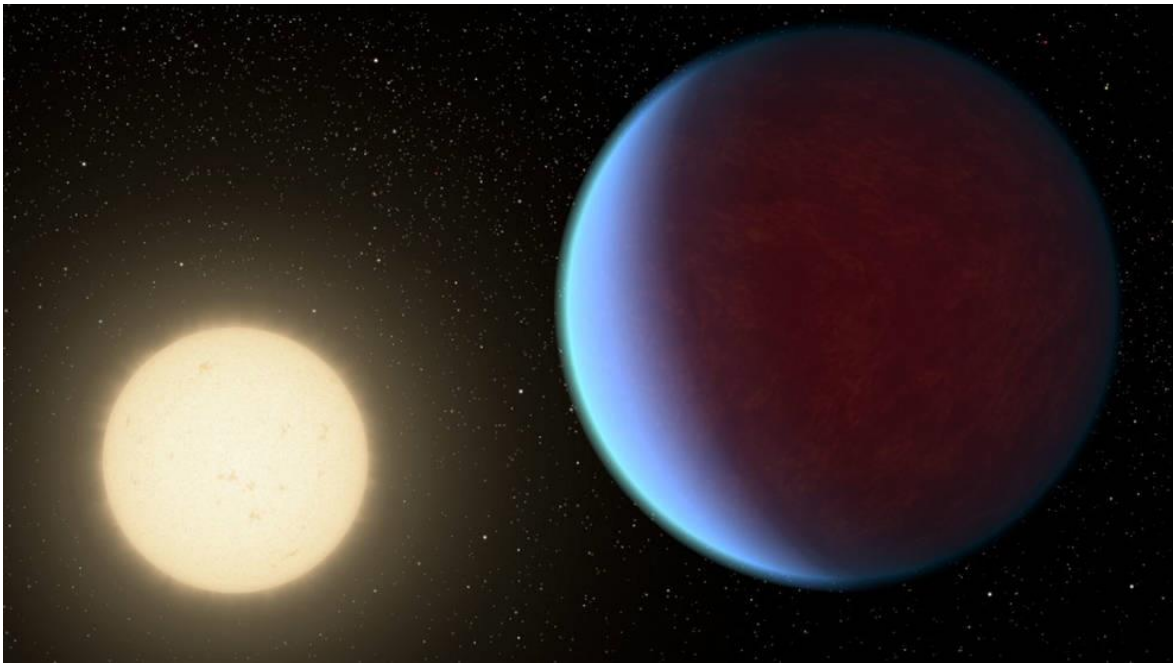
The thruster test went so well, the team will likely do a similar test on the TCM thrusters for Voyager 2, the twin spacecraft of Voyager 1. The attitude control thrusters currently used for Voyager 2 are not yet as degraded as Voyager 1's, however.

Voyager 2 is also on course to enter interstellar space, likely within the next few years.

The Voyager spacecraft were built by JPL, which continues to operate both. JPL is a division of Caltech in Pasadena. The Voyager missions are a part of the NASA Heliophysics System Observatory, sponsored by the Heliophysics Division of the Science Mission Directorate in Washington.

Source: NASA Return to Contents

2. Lava or Not, Exoplanet 55 Cancri e Likely to Have Atmosphere



The super-Earth exoplanet 55 Cancri e, depicted with its star in this artist's concept, likely has an atmosphere thicker than Earth's but with ingredients that could be similar to those of Earth's atmosphere. Credits: NASA/JPL-Caltech

Twice as big as Earth, the super-Earth 55 Cancri e was thought to have lava flows on its surface. The planet is so close to its star, the same side of the planet always faces the star, such that the planet has permanent day and night sides. Based on a 2016 study using data from NASA's Spitzer Space Telescope, scientists speculated that lava would flow freely in lakes on the starlit side and become hardened on the face of perpetual darkness. The lava on the dayside would reflect radiation from the star, contributing to the overall observed temperature of the planet.

Now, a deeper analysis of the same Spitzer data finds this planet likely has an atmosphere whose ingredients could be similar to those of Earth's atmosphere, but thicker. Lava lakes directly exposed to space without an atmosphere would create local hot spots of high temperatures, so they are not the best explanation for the Spitzer observations, scientists said.

"If there is lava on this planet, it would need to cover the entire surface," said Renyu Hu, astronomer at NASA's Jet Propulsion Laboratory, Pasadena, California, and co-author of a study published in The Astronomical Journal. "But the lava would be hidden from our view by the thick atmosphere."

Using an improved model of how energy would flow throughout the planet and radiate back into space, researchers find that the night side of the planet is not as cool as previously thought. The "cold" side is still quite toasty by Earthly standards, with an average of 2,400 to 2,600 degrees Fahrenheit (1,300 to 1,400 Celsius), and the hot side averages 4,200 degrees Fahrenheit (2,300 Celsius). The difference between the hot and cold sides would need to be more extreme if there were no atmosphere.

"Scientists have been debating whether this planet has an atmosphere like Earth and Venus, or just a rocky core and no atmosphere, like Mercury. The case for an atmosphere is now stronger than ever," Hu said.

Researchers say the atmosphere of this mysterious planet could contain nitrogen, water and even oxygen -- molecules found in our atmosphere, too -- but with much higher temperatures throughout. The density of the planet is also similar to Earth, suggesting that it, too, is rocky. The intense heat from the host star would be far too great to support life, however, and could not maintain liquid water.

Hu developed a method of studying exoplanet atmospheres and surfaces, and had previously only applied it to sizzling, giant gaseous planets called hot Jupiters. Isabel Angelo, first author of the study and a senior at the University of California, Berkeley, worked on the study as part of her internship at JPL and adapted Hu's model to 55 Cancri e.

In a seminar, she heard about 55 Cancri e as a potentially carbon-rich planet, so high in temperature and pressure that its interior could contain a large amount of diamond.

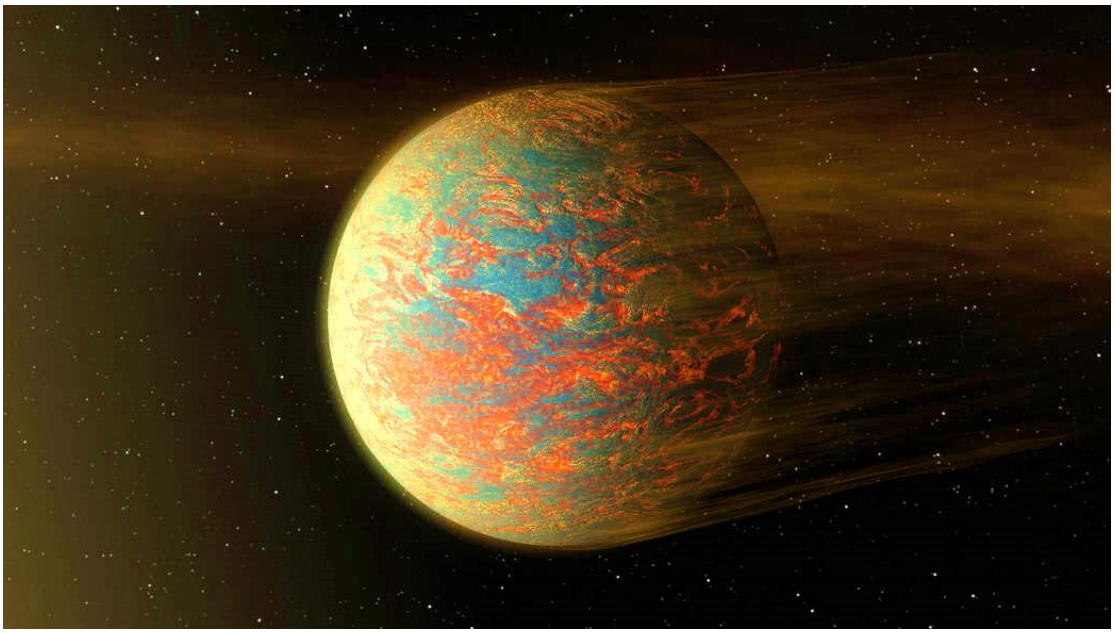
"It's an exoplanet whose nature is pretty contested, which I thought was exciting," Angelo said.

Spitzer observed 55 Cancri e between June 15 and July 15, 2013, using a camera specially designed for viewing infrared light, which is invisible to human eyes. Infrared light is an indicator of heat energy. By comparing changes in brightness Spitzer observed to the energy flow models, researchers realized an atmosphere with volatile materials could best explain the temperatures.

There are many open questions about 55 Cancri e, especially: Why has the atmosphere not been stripped away from the planet, given the perilous radiation environment of the star?

"Understanding this planet will help us address larger questions about the evolution of rocky planets," Hu said.

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



This illustration shows one possible scenario for the hot, rocky exoplanet called 55 Cancri e, which is nearly two times as wide as Earth. New data from NASA's Spitzer Space Telescope show that the planet has extreme temperature swings from one side to the other – and a possible reason for this might be the presence of lava pools. Source: NASA

Source: NASA

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3. NASA Builds its Next Mars Rover Mission

This artist's rendition depicts NASA's Mars 2020 rover studying a Mars rock outcrop. The mission will not only seek out and study an area likely to have been habitable in the distant past, but it will take the next, bold step in robotic exploration of the Red Planet by seeking signs of past microbial life itself. Credits: NASA/JPL-Caltech

In just a couple of years, NASA's newest rover will be flying to Mars. The Mars 2020 mission will use the next generation of science and landing technology to collect rock samples for possible return by a future mission.

At a glance, it looks a lot like its predecessor, the Curiosity Mars rover. But there's no doubt it's a souped-up science machine: It has seven new instruments, redesigned wheels and more autonomy. A drill will capture rock cores, while a caching system with a miniature robotic arm will seal up these samples. Then, they'll be deposited on the Martian surface for possible pickup by a future mission.

This new hardware is being developed at NASA's Jet Propulsion Laboratory, Pasadena, California, which manages the mission for the agency. It includes the Mars 2020 mission's cruise stage, which will fly the rover through space, and the descent stage, a rocket-powered "sky crane" that will lower it to the planet's surface. Both of these stages have recently moved into JPL's Spacecraft Assembly Facility.

Mars 2020 relies heavily on the system designs and spare hardware previously created for Mars Science Laboratory's Curiosity rover, which landed in 2012. Roughly 85 percent of the new rover's mass is based on this "heritage hardware."

"The fact that so much of the hardware has already been designed -- or even already exists -- is a major advantage for this mission," said Jim Watzin, director of NASA's Mars Exploration Program. "It saves us money, time and most of all, reduces risk."

Despite its similarities to Mars Science Laboratory, the new mission has very different goals. Mars 2020's instruments will seek signs of ancient life by studying terrain that is now inhospitable, but once held flowing rivers and lakes, more than 3.5 billion years ago.

To achieve these new goals, the rover has a suite of cutting-edge science instruments. It will seek out biosignatures on a microbial scale: An X-ray spectrometer will target spots as small as a grain of table salt, while an ultraviolet laser will detect the "glow" from excited rings of carbon atoms. A ground-penetrating radar will be the first instrument to look under the surface of Mars, mapping layers of rock, water and ice up to 30 feet (10 meters) deep, depending on the material.

The rover is getting some upgraded Curiosity hardware, including color cameras, a zoom lens and a laser that can vaporize rocks and soil to analyze their chemistry.

"Our next instruments will build on the success of MSL, which was a proving ground for new technology," said George Tahu, NASA's Mars 2020 program executive. "These will gather science data in ways that weren't possible before."

The mission will also undertake a marathon sample hunt: The rover team will try to drill at least 20 rock cores, and possibly as many as 30 or 40, for possible future return to Earth.

"Whether life ever existed beyond Earth is one of the grand questions humans seek to answer," said Ken Farley of JPL, Mars 2020's project scientist. "What we learn from the samples collected during this mission has the potential to address whether we're alone in the universe."

JPL is also developing a crucial new landing technology called terrain-relative navigation. As the descent stage approaches the Martian surface, it will use computer vision to compare the landscape with pre-loaded terrain maps. This technology will guide the descent stage to safe landing sites, correcting its course along the way.

A related technology called the ranger trigger will use location and velocity to determine when to fire the spacecraft's parachute. That change will narrow the landing ellipse by more than 50 percent.

"Terrain-relative navigation enables us to go to sites that were ruled too risky for Curiosity to explore," said Al Chen of JPL, the Mars 202 entry, descent and landing lead. "The range trigger lets us land closer to areas of scientific interest, shaving miles -- potentially as much as a year -- off a rover's journey."

This approach to minimizing landing errors will be critical in guiding any future mission dedicated to retrieving the Mars 2020 samples, Chen said.

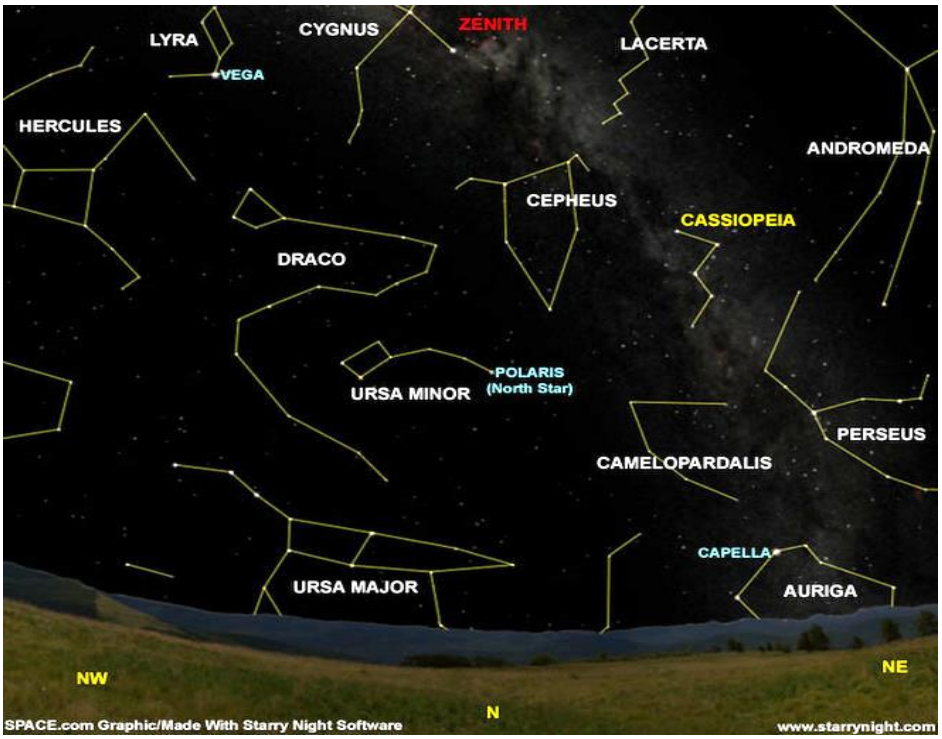
Site selection has been another milestone for the mission. In February, the science community narrowed the list of potential landing sites from eight to three. Those three remaining sites represent fundamentally different environments that could have harbored primitive life: an ancient lakebed called Jezero Crater; Northeast Syrtis, where warm waters may have chemically interacted with subsurface rocks; and a possible hot springs at Columbia Hills.

All three sites have rich geology and may potentially harbor signs of past microbial life. A final landing site decision is still more than a year away.

"In the coming years, the 2020 science team will be weighing the advantages and disadvantages of each of these sites," Farley said. "It is by far the most important decision we have ahead of us."

Source: NASA Return to Contents

The Night Sky



Riding high in the northeast sky as darkness descends is a striking zigzag row of five stars marking the Queen of Ethiopia, Cassiopeia. Source: Space.com

Tuesday, December 5

- Now the waning gibbous Moon doesn't rise until well after dark. Look for Pollux to its left, and Castor above Pollux. Later into the night, you'll find Procyon rising farther to the Moon's lower right.

Wednesday, December 6

- The five brightest stars of Cassiopeia are usually called a W, but late these nights Cas turns over to become a wide M, very high in the north.
- The late-evening waning Moon shines below Pollux and Castor and left of Procyon.

Thursday, December 7

- Earliest sunset of the year (if you're near latitude 40° north). By the time of the solstice and shortest day on December 21st, the Sun actually sets 3 minutes later than now. But the Sun doesn't *rise its latest* until January 4th. For these slight discrepancies, blame the tilt of Earth's axis and the ellipticity of Earth's orbit.

Friday, December 8

- Bright Vega still shines well up in the west-northwest after dark at this time of year. The brightest star above it is Deneb, the head of the big Northern Cross, which is formed by the brightest stars of Cygnus. At nightfall the shaft of the cross extends lower left from Deneb. By about 11 p.m., the cross plants itself more or less upright on the northwest horizon.

Saturday, December 9

- The W pattern of Cassiopeia stands on end in early evening, very high toward the northeast. The bottom star of the W is Epsilon (ε) Cassiopeiae. That's your starting point for hunting down the little-known star cluster Collinder 463, sparse and loose but visible in binoculars. It's 8° to Epsilon's north (the direction toward Polaris), and is surrounded by a nice quadrilateral of 4th- and 5th-magnitude stars about 3° wide.

Source: Sky and Telescope Return to Contents

ISS Sighting Opportunities (from Denver)

Date	Visible	Max Height	Appears	Disappears
Wed Dec 6, 5:28 PM	2 min	11°	10° above NNW	10° above N
Thu Dec 7, 6:13 PM	< 1 min	10°	10° above NNW	10° above N
Fri Dec 8, 5:21 PM	1 min	10°	10° above N	10° above NNE
Sat Dec 9, 6:05 PM	1 min	13°	10° above NNW	13° above N

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

NASA-TV Highlights (all times Eastern Time Zone)

Wednesday, December 6

- 7:30 a.m. - Coverage of the Departure of the Orbital/ATK Cygnus CRS-8 Cargo Ship from the ISS (Release of Cygnus is scheduled at 8:10 a.m. ET) (Starts at 7:45 a.m.) (all channels)

Thursday, December 7

- 11 a.m. - SpaceX/Dragon CRS-13 Cargo Resupply Mission Prelaunch News Conference (all channels)
- 2 p.m. - ISS Expedition 55-56 Crew News Conference (Artemyev, Arnold, Feustel) (all channels)
- 3:30 p.m. - SpaceX/Dragon CRS-13 Cargo Resupply Mission "What's on Board?" Science Briefing (all channels)

Friday, December 8

- 12:30 p.m. - Coverage of the Launch of the SpaceX/Dragon CRS-13 Mission (Launch scheduled at 1:20 p.m. ET) (Starts at 12:45 p.m.) (all channels)
- 3 p.m. - SpaceX/Dragon CRS-13 Post-Launch News Conference (all channels)

Watch NASA TV online by going to the NASA website.

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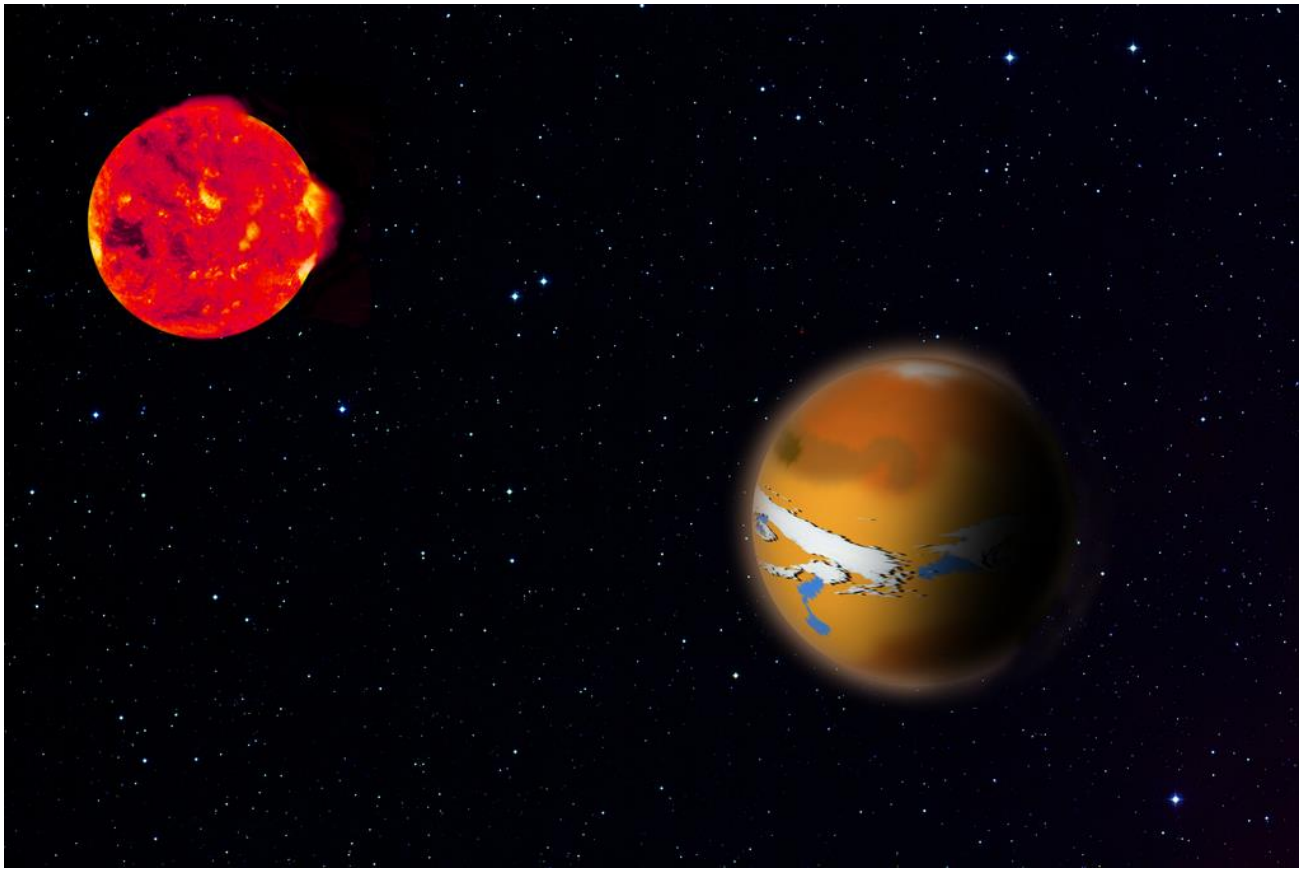
Space Calendar

- Dec 05 - Comet 54P/de Vico-Swift-NEAT At Opposition (1.776 AU)
- Dec 05 - Asteroid 5263 Arrius Occults HIP 17049 (6.7 Magnitude Star)
- Dec 05 - Apollo Asteroid 2017 WS13 Near-Earth Flyby (0.024 AU)
- Dec 05 - Aten Asteroid 2010 TK7 (Earth Trojan) Closest Approach To Earth (0.204 AU)
- Dec 05 - Amor Asteroid 1980 Tezcatlipoca Closest Approach To Earth (0.878 AU)
- Dec 05 - Kuiper Belt Object 145451 (2005 RM43) At Opposition (35.742 AU)
- Dec 05 - Colloquium: Alteration History of Mars and Implications for Water Reservoirs, Tucson, Arizona
- Dec 05-06 - Workshop: Research Opportunities on the Deep Space Gateway, Noordwijk, The Netherlands
- Dec 05-07 - Conference: The First Double Neutron Star Merger, Santa Barbara, California
- Dec 05-07 - Space Commerce Conference and Expo (SpaceCom), Houston, Texas
- Dec 05-08 - Astronomical Society of the Pacific (ASP) 129th Annual Meeting: Beyond the Eclipse - Engaging Diverse and Underserved Communities in Astronomy and STEM, St. Louis, Missouri
- Dec 06 - Comet 79P/du Toit-Hartley At Opposition (1.971 AU)
- Dec 06 - Comet C/2017 P2 (PANSTARRS) Perihelion (2.462 AU)
- Dec 06 - Apollo Asteroid 2017 WF28 Near-Earth Flyby (0.045 AU)
- Dec 06 - Amor Asteroid 2017 WA13 Near-Earth Flyby (0.076 AU)
- Dec 06 - Asteroid 3869 Norton Closest Approach To Earth (1.588 AU)
- Dec 06-09 - 8th OPTICON Gaia Science Alerts Workshop, Warsaw, Poland
- Dec 07 - Asteroid 2621 Goto Occults HIP 35842 (6.2 Magnitude Star)
- Dec 07 - Apollo Asteroid 2017 WP1 Near-Earth Flyby (0.058 AU)
- Dec 07 - Asteroid 2198 Ceplecha Closest Approach To Earth (1.159 AU)
- Dec 07 - Asteroid 134369 Sahara Closest Approach To Earth (1.537 AU)
- Dec 07 - Asteroid 14220 Alexgibbs Closest Approach To Earth (2.112 AU)
- Dec 07 - 2017 Bolton and Student Symposium, Sydney, Australia
- Dec 07 - Lecture: Jupiter's Deep Flows Revealed by Juno, Ithaca, New York
- Dec 07 - Lecture: Holiday Lights Show Culture from Space, Washington DC
- **Dec 07 - 45th Anniversary (1972), Apollo 17 Launch (Last Manned Mission to the Moon)**
- **Dec 07 – Test Flight, Electron Launch**
- Dec 08 - Comet C/2016 R2 (PANSTARRS) At Opposition (2.094 AU)
- Dec 08 - Apollo Asteroid 4450 Pan Closest Approach To Earth (1.276 AU)
- Dec 08 - Asteroid 6434 Jewitt Closest Approach To Earth (1.361 AU)
- Dec 08 - Centaur Object 8405 Asbolus At Opposition (20.229 AU)
- Dec 08 - Royal Astronomical Society Ordinary Meeting, London, United Kingdom
- Dec 08 - Meeting: Dynamic Coupling in the Terrestrial Atmosphere, London, United Kingdom
- Dec 08 - Meeting: The Link Between AGN and Galaxy Formation, London, United Kingdom
- Dec 08 - Stargazing Lecture: Brown Dwarfs - Too Small a Star; Too Massive a Planet, Pasadena, California
- **Dec 09 - CRS-13/ TSIS/ MISSE-FF 1/ SDS Falcon 9 Launch (International Space Station)**

Source: JPL Space Calendar Return to Contents

Food for Thought

Traces of Life on Nearest Exoplanets May Be Hidden in Equatorial Trap



Artist's impression of TRAPPIST 1d (right) and its host star TRAPPIST 1 (left). The new research shows how planets like this could hide traces of life from astronomers' observations. Credit: MPIA Graphics Department.

New simulations show that the search for life on other planets may well be more difficult than previously assumed, in research published today in the journal Monthly Notices of the Royal Astronomical Society. The study indicates that unusual air flow patterns could hide atmospheric components from telescopic observations, with direct consequences for formulating the optimal strategy for searching for (oxygen-producing) life such as bacteria or plants on exoplanets.

Current hopes of detecting life on planets outside of our own Solar System rest on examining the planet's atmosphere to identify chemical compounds that may be produced by living beings. Ozone – a variety of oxygen – is one such molecule, and is seen as one of the possible tracers that may allow us to detect life on another planet from afar.

In Earth's atmosphere, this compound forms the ozone layer that protects us from the Sun's harmful ultraviolet (UV) radiation. On an alien planet, ozone could be one piece in the puzzle that indicates the presence of oxygen-producing bacteria or plants.

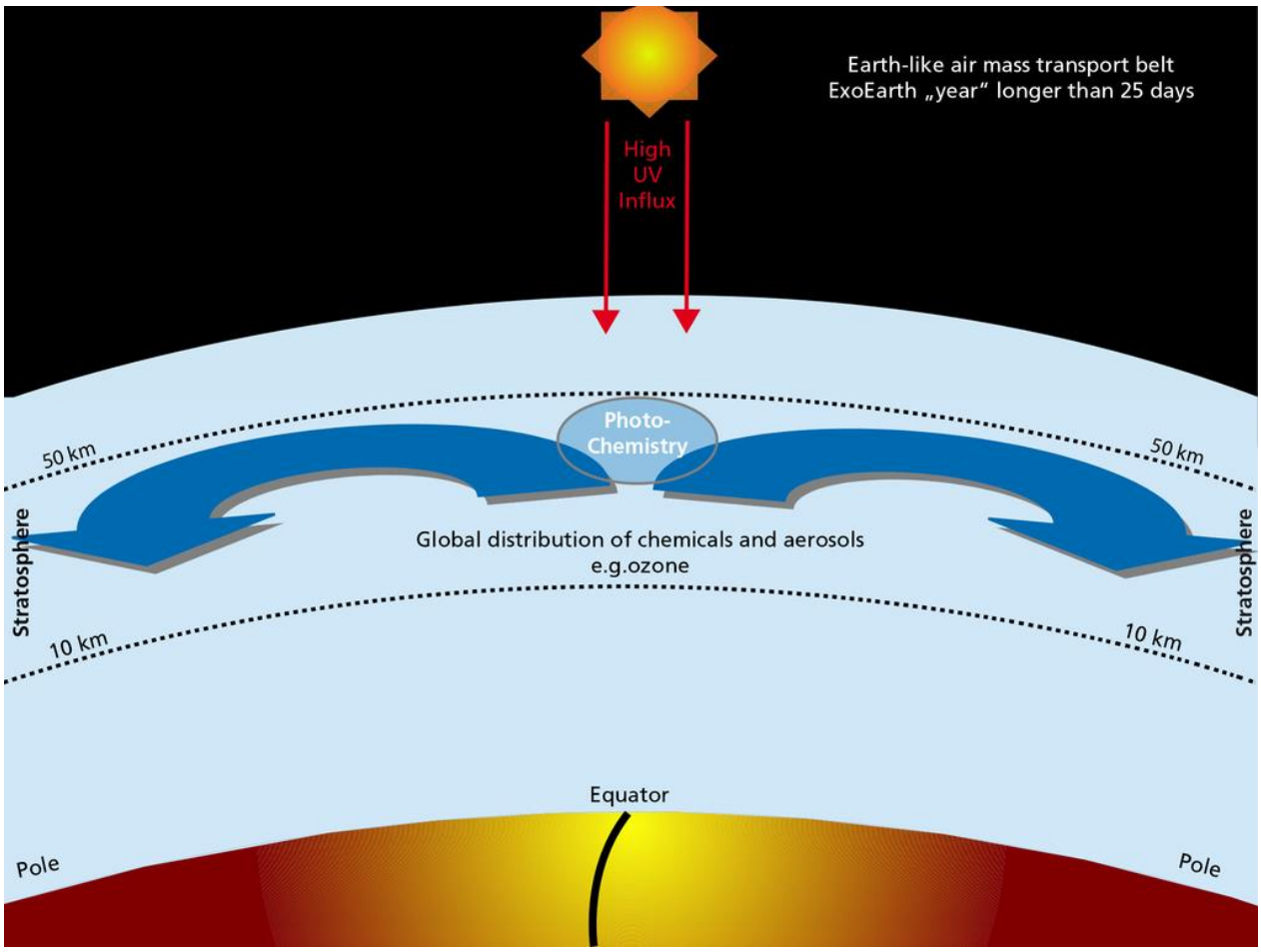
But now researchers, led by Ludmila Carone of the Max Planck Institute for Astronomy in Germany, have found that these tracers might be better hidden than we previously thought. Carone and her team considered some of the nearest exoplanets that have the potential to be Earth-like: Proxima b, which is orbiting the star nearest to the Sun (Proxima Centauri), and the most promising of the TRAPPIST-1 family of planets, TRAPPIST-1d.

These are examples of planets that orbit their host star in 25 days or fewer, and as a side effect have one side permanently facing their star, and the other side permanently facing away. Modelling the flow of air within the atmospheres of these planets, Carone and her colleagues found that this unusual day-night divide can have a marked effect on the distribution of ozone across the atmosphere: at least for these planets, the major air flow may lead from the poles to the equator, systematically trapping the ozone in the equatorial region.

Carone says: "Absence of traces of ozone in future observations does not have to mean there is no oxygen at all. It might be found in different places than on Earth, or it might be very well hidden."

Such unexpected atmospheric structures may also have consequences for habitability, given that most of the planet would not be protected against UV radiation. "In principle, an exoplanet with an ozone layer that covers only the equatorial region may still be habitable," Carone explains. "Proxima b and TRAPPIST-1d orbit red dwarfs, reddish stars that emit very little harmful UV light to begin with. On the other hand, these stars can be very temperamental, and prone to violent outbursts of harmful radiation including UV."

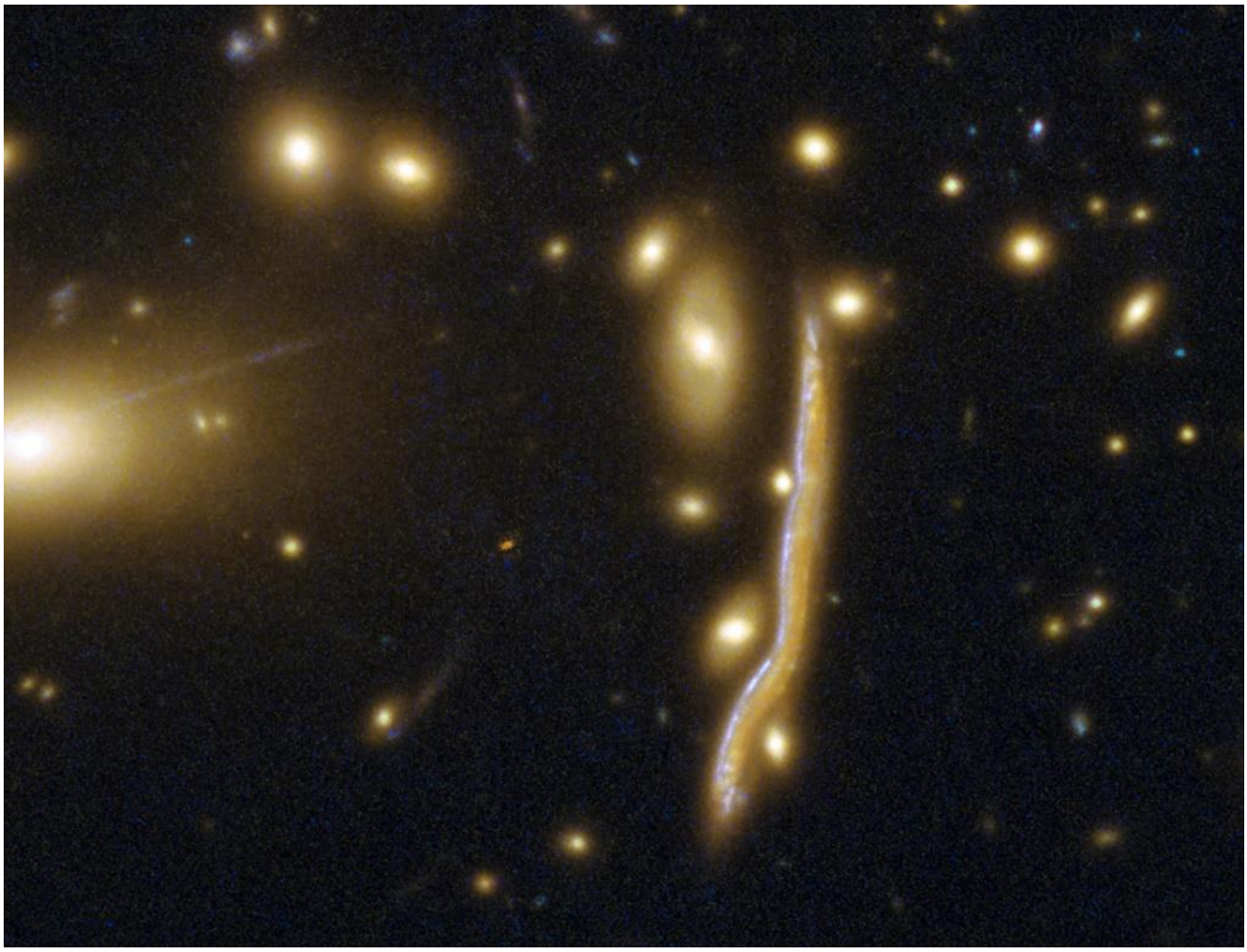
The combination of advances in modelling and much better data from telescopes like the James Webb Space Telescope is likely to lead to significant progress in this exciting field. "We all knew from the beginning that the hunt for alien life will be a challenge," says Carone. "As it turns out, we are only just scratching the surface of how difficult it really will be."



Earth's atmosphere has a "transportation belt" of air flows which move ozone from the main production areas near the equator towards the poles. This mechanism is important for creating Earth's global ozone layer. Credit: L. Carone / MPIA Graphics Department

Source: Royal Astronomical Society Return to Contents

Space Image of the Week



Cosmic Snake Pregnant With Stars

Credit: ESA/Hubble, NASA

Explanation: This NASA/ESA Hubble Space Telescope image reveals the Cosmic Snake, a distant galaxy peppered with clumpy regions of intense star formation that appear warped by the effect of gravitational lensing. This giant arc-like galaxy is actually behind the huge galaxy cluster MACSJ1206.2-0847, but thanks to the cluster's gravity, we can see it from Earth.

Light from the distant, high-redshift galaxy arrives at Earth, having been distorted by the gigantic gravitational influence of the intervening cluster. Fascinatingly, instead of making it more difficult to perceive cosmological objects, such strong lensing effects improve the resolution and depth of an image by magnifying the background object. Sometimes gravitational lensing can even produce multiple images of the object as light is bent in different directions around the foreground cluster.

Using Hubble, astronomers recently looked at several such images of the Cosmic Snake, each with a different level of magnification. Using this technique, the galaxy and its features could be studied on different scales. The highest-resolution images revealed that giant clumps in high-redshift galaxies are made up of a complex substructure of smaller clumps, which contributes to our understanding of star formation in distant galaxies.

Source: Hubble European Space Agency Information Centre Return to Contents