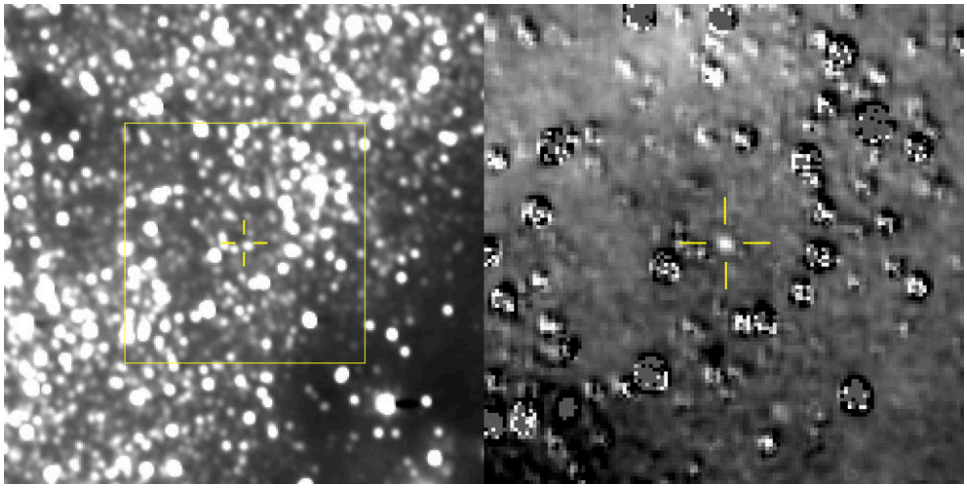
Space News Update

— August 31, 2018 —

Contents

1. Ultima in View: NASA's New Horizons Makes First Detection of Kuiper Belt Flyby Target



NASA's New Horizons spacecraft has made its first detection of its next flyby target, the Kuiper Belt object nicknamed Ultima Thule, more than four months ahead of its New Year's 2019 close encounter.

Mission team members were thrilled – if not a little surprised – that New Horizons' telescopic Long Range Reconnaissance Imager (LORRI) was able to see the small, dim object while still more than 100 million miles away, and against a dense background of stars. Taken Aug. 16 and transmitted home through NASA's Deep Space Network over the following days, the set of 48 images marked the team's first attempt to find Ultima with the spacecraft's own cameras.

"The image field is extremely rich with background stars, which makes it difficult to detect faint objects," said Hal Weaver, New Horizons project scientist and LORRI principal investigator from the Johns Hopkins Applied Physics Laboratory in Laurel, Maryland. "It really is like finding a needle in a haystack. In these first images, Ultima appears only as a bump on the side of a background star that's roughly 17 times brighter, but Ultima will be getting brighter – and easier to see – as the spacecraft gets closer."

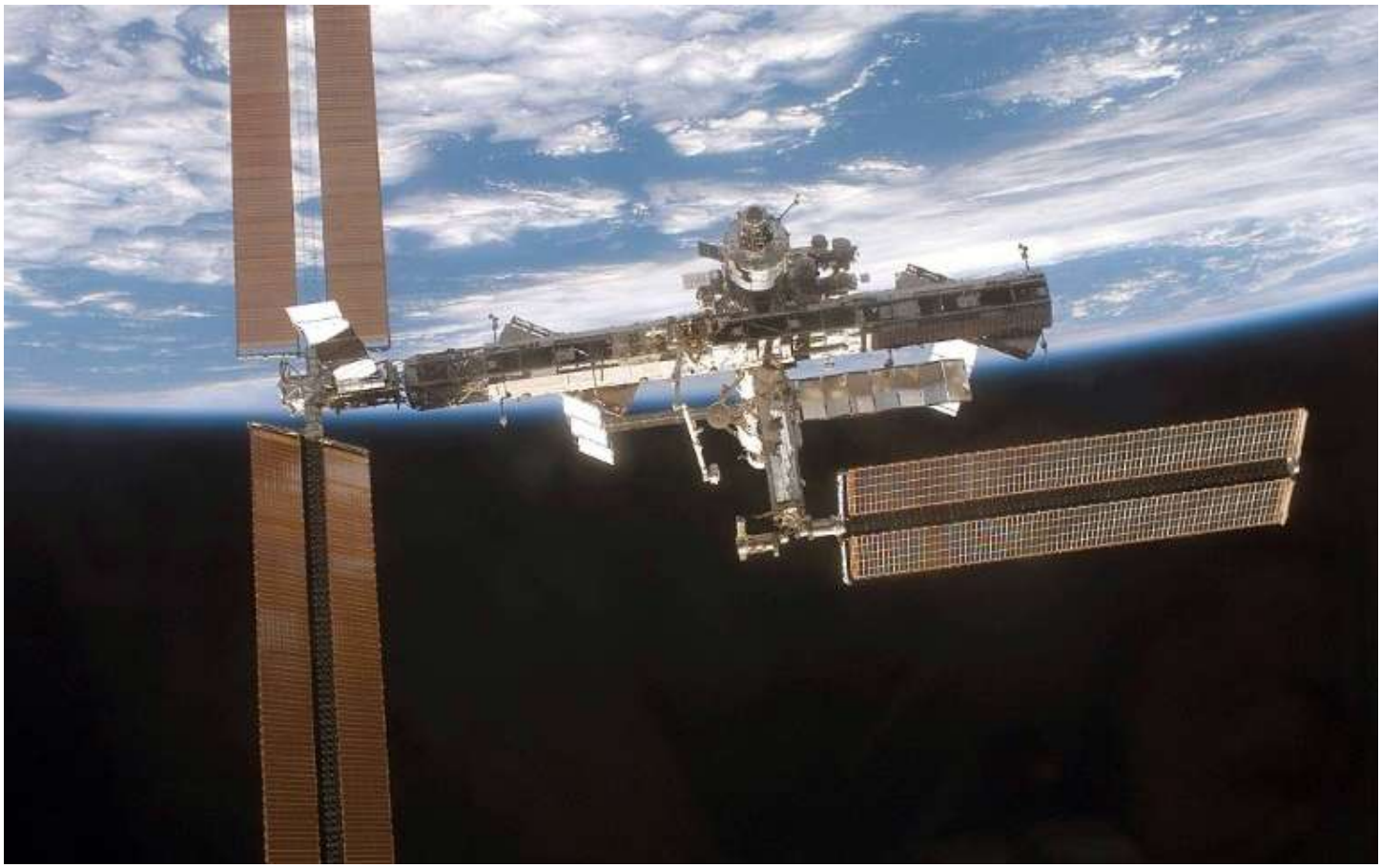
This first detection is important because the observations New Horizons makes of Ultima over the next four months will help the mission team refine the spacecraft's course toward a closest approach to Ultima, at 12:33 a.m. EST on Jan. 1, 2019. That Ultima was where mission scientists expected it to be – in precisely the spot they predicted, using data gathered by the Hubble Space Telescope – indicates the team already has a good idea of Ultima's orbit.

The Ultima flyby will be the first-ever close-up exploration of a small Kuiper Belt object and the farthest exploration of any planetary body in history, shattering the record New Horizons itself set at Pluto in July 2015 by about 1 billion miles. These images are also the most distant from the Sun ever taken, breaking the record set by Voyager 1's "Pale Blue Dot" image of Earth taken in 1990. (New Horizons set the record for the most distant image from Earth in December 2017.)

"Our team worked hard to determine if Ultima was detected by LORRI at such a great distance, and the result is a clear yes," said New Horizons Principal Investigator Alan Stern, of the Southwest Research Institute in Boulder, Colorado. "We now have Ultima in our sights from much farther out than once thought possible. We are on Ultima's doorstep, and an amazing exploration awaits!"

Source: NASA Return to Contents

2. Space Station Reports 'Leak', Crew Not in Danger



The International Space Station crew on Thursday was repairing a small "leak" most likely caused by a collision with a small meteorite, the head of the Russian space agency said, adding the incident presented no danger.

"Overnight and in the morning there was an abnormal situation—a pressure drop, an oxygen leak at the station," Roscosmos chief Dmitry Rogozin was quoted as saying by Russian news agencies.

"A micro fracture was found, most likely it is damage from the outside. The design engineers believe it is the result of a micrometeorite," he said.

He said the fracture was found on the Soyuz ship that brought astronauts to the ISS in June for a six-month mission and is currently docked with the space station. The fracture will be patched from the inside, he said.

NASA confirmed the problem, saying it consisted of a "minute pressure leak" and that the crew was repairing it.

"The leak has been isolated to a hole about two millimetres in diameter" and slowed through application of thermoresistant tape, but a more permanent solution was in development.

Six men are currently orbiting Earth aboard the ISS, including NASA astronauts Drew Feustel, Ricky Arnold and Serena Aunon, as well as Alexander Gerst of the European Space Agency and two Russian cosmonauts—Oleg Artemyev and Sergei Prokopyev.

Source: Phys.org Return to Contents

3. Light from Ancient Quasars Helps Confirm Quantum Entanglement

Physicists have provided strong support for quantum entanglement, the seemingly far-out idea that two particles, no matter how distant from each other in space and time, can be inextricably linked, in a way that defies the rules of classical physics.

Take, for instance, two particles sitting on opposite edges of the universe. If they are truly entangled, then according to the theory of quantum mechanics their physical properties should be related in such a way that any measurement made on one particle should instantly convey information about any future measurement outcome of the other particle -- correlations that Einstein skeptically saw as "spooky action at a distance."

In the 1960s, the physicist John Bell calculated a theoretical limit beyond which such correlations must have a quantum, rather than a classical, explanation.

But what if such correlations were the result not of quantum entanglement, but of some other hidden, classical explanation? Such "what-ifs" are known to physicists as loopholes to tests of Bell's inequality, the most stubborn of which is the "freedom-of-choice" loophole: the possibility that some hidden, classical variable may influence the measurement that an experimenter chooses to perform on an entangled particle, making the outcome look quantumly correlated when in fact it isn't.

Last February, the MIT team and their colleagues significantly constrained the freedom-of-choice loophole, by using 600-year-old starlight to decide what properties of two entangled photons to measure. Their experiment proved that, if a classical mechanism caused the correlations they observed, it would have to have been set in motion more than 600 years ago, before the stars' light was first emitted and long before the actual experiment was even conceived.

Now, in a paper published today in Physical Review Letters, the same team has vastly extended the case for quantum entanglement and further restricted the options for the freedom-of-choice loophole. The researchers used distant quasars, one of which emitted its light 7.8 billion years ago and the other 12.2 billion years ago,

to determine the measurements to be made on pairs of entangled photons. They found correlations among more than 30,000 pairs of photons, to a degree that far exceeded the limit that Bell originally calculated for a classically based mechanism.

"If some conspiracy is happening to simulate quantum mechanics by a mechanism that is actually classical, that mechanism would have had to begin its operations -- somehow knowing exactly when, where, and how this experiment was going to be done -- at least 7.8 billion years ago. That seems incredibly implausible, so we have very strong evidence that quantum mechanics is the right explanation," says co-author Alan Guth, the Victor F. Weisskopf Professor of Physics at MIT.

"The Earth is about 4.5 billion years old, so any alternative mechanism -- different from quantum mechanics -- that might have produced our results by exploiting this loophole would've had to be in place long before even there was a planet Earth, let alone an MIT," adds David Kaiser, the Germeshausen Professor of the History of Science and professor of physics at MIT. "So we've pushed any alternative explanations back to very early in cosmic history."

Guth and Kaiser's co-authors include Anton Zeilinger and members of his group at the Austrian Academy of Sciences and the University of Vienna, as well as physicists at Harvey Mudd College and the University of California at San Diego.

A Decision, Made Billions of Years Ago

In 2014, Kaiser and two members of the current team, Jason Gallicchio and Andrew Friedman, proposed an experiment to produce entangled photons on Earth -- a process that is fairly standard in studies of quantum mechanics. They planned to shoot each member of the entangled pair in opposite directions, toward light detectors that would also make a measurement of each photon using a polarizer. Researchers would measure the polarization, or orientation, of each incoming photon's electric field, by setting the polarizer at various angles and observing whether the photons passed through -- an outcome for each photon that researchers could compare to determine whether the particles showed the hallmark correlations predicted by quantum mechanics.

The team added a unique step to the proposed experiment, which was to use light from ancient, distant astronomical sources, such as stars and quasars, to determine the angle at which to set each respective polarizer. As each entangled photon was in flight, heading toward its detector at the speed of light, researchers would use a telescope located at each detector site to measure the wavelength of a quasar's incoming light. If that light was redder than some reference wavelength, the polarizer would tilt at a certain angle to make a specific measurement of the incoming entangled photon -- a measurement choice that was determined by the quasar. If the quasar's light was bluer than the reference wavelength, the polarizer would tilt at a different angle, performing a different measurement of the entangled photon.

In their previous experiment, the team used small backyard telescopes to measure the light from stars as close as 600 light-years away. In their new study, the researchers used much larger, more powerful telescopes to catch the incoming light from even more ancient, distant astrophysical sources: quasars whose light has been traveling toward the Earth for at least 7.8 billion years -- objects that are incredibly far away and yet are so luminous that their light can be observed from Earth.

Tricky Timing

On Jan. 11, 2018, "the clock had just ticked past midnight local time," as Kaiser recalls, when about a dozen members of the team gathered on a mountaintop in the Canary Islands and began collecting data from two large, 4-meter-wide telescopes: the William Herschel Telescope and the Telescopio Nazionale Galileo, both situated on the same mountain and separated by about a kilometer.

One telescope focused on a particular quasar, while the other telescope looked at another quasar in a different patch of the night sky. Meanwhile, researchers at a station located between the two telescopes created pairs of entangled photons and beamed particles from each pair in opposite directions toward each telescope.

In the fraction of a second before each entangled photon reached its detector, the instrumentation determined whether a single photon arriving from the quasar was more red or blue, a measurement that then automatically adjusted the angle of a polarizer that ultimately received and detected the incoming entangled photon.

"The timing is very tricky," Kaiser says. "Everything has to happen within very tight windows, updating every microsecond or so."

Demystifying a Mirage

The researchers ran their experiment twice, each for around 15 minutes and with two different pairs of quasars. For each run, they measured 17,663 and 12,420 pairs of entangled photons, respectively. Within hours of closing the telescope domes and looking through preliminary data, the team could tell there were strong correlations among the photon pairs, beyond the limit that Bell calculated, indicating that the photons were correlated in a quantum-mechanical manner.

Guth led a more detailed analysis to calculate the chance, however slight, that a classical mechanism might have produced the correlations the team observed.

He calculated that, for the best of the two runs, the probability that a mechanism based on classical physics could have achieved the observed correlation was about 10 to the minus 20 -- that is, about one part in one hundred billion billion, "outrageously small," Guth says. For comparison, researchers have estimated the probability that the discovery of the Higgs boson was just a chance fluke to be about one in a billion.

"We certainly made it unbelievably implausible that a local realistic theory could be underlying the physics of the universe," Guth says.

And yet, there is still a small opening for the freedom-of-choice loophole. To limit it even further, the team is entertaining ideas of looking even further back in time, to use sources such as cosmic microwave background photons that were emitted as leftover radiation immediately following the Big Bang, though such experiments would present a host of new technical challenges.

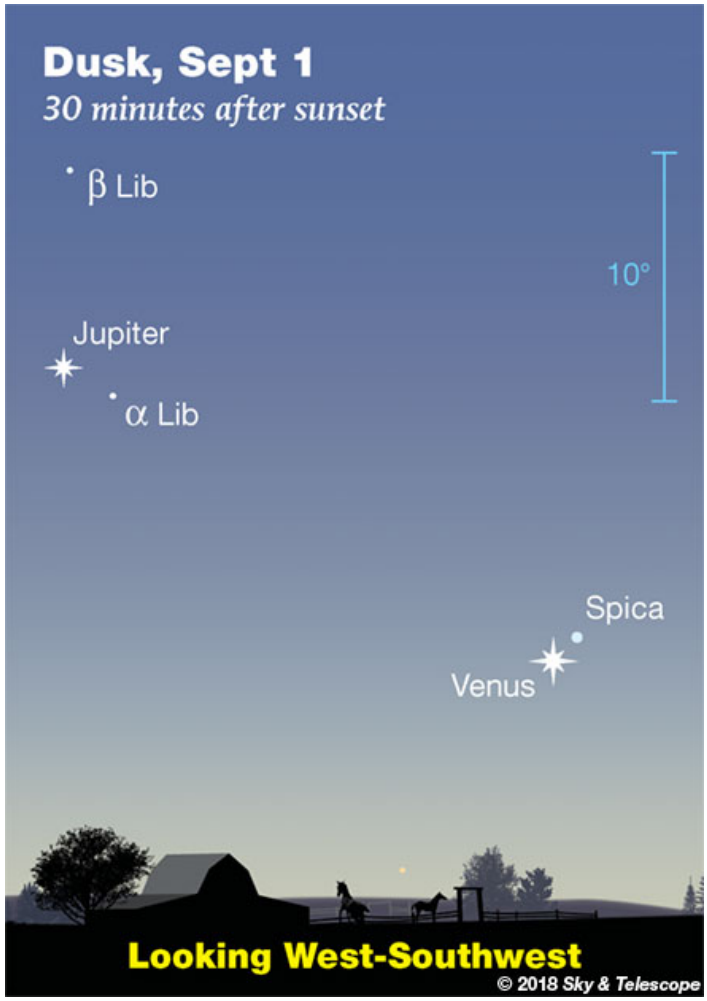
"It is fun to think about new types of experiments we can design in the future, but for now, we are very pleased that we were able to address this particular loophole so dramatically. Our experiment with quasars puts extremely tight constraints on various alternatives to quantum mechanics. As strange as quantum mechanics may seem, it continues to match every experimental test we can devise," Kaiser says.

Reference: "Cosmic Bell Test Using Random Measurement Settings from High-Redshift Quasars," Dominik Rauch et al., 2018 Aug. 20, Physical Review Letters [https://doi.org/10.1103/PhysRevLett.121.080403, preprint: https://arxiv.org/abs/1611.06985]. This research was supported in part by the Austrian Academy of Sciences, the Austrian Science Fund, the U.S. National Science Foundation, and the U.S. Department of Energy.

Source: Spaceref.com Return to Contents

The Night Sky

Friday, August 31



• Four bright planets still await you in twilight this week, though the brightest is getting lower and more difficult. From right to left, they are Venus very low in the west-southwest, Jupiter in the southwest upper left of Venus, Saturn higher in the south, and bright Mars in the south-southeast. Best overall view: about 40 minutes after sunset. Here's a wide-field image of the four taken August 17th over the skyline of Rome, courtesy of Gianluca Masi.

• Look for bright Vega passing the zenith as twilight fades out, if you live in the world's mid-northern latitudes. Vega goes right through your zenith if you're at latitude 39° north (near Baltimore, Kansas City, Lake Tahoe, Sendai, Beijing, Athens, Lisbon).

Then Deneb follows two hours behind. For Deneb to pass exactly through your zenith you need to be a little farther north, at latitude 45°: near Bangor, Montreal, Minneapolis, mid-Oregon, northernmost Japan, Bucharest, Milan.

Saturday, September 1

• As twilight fades this evening, spot Venus very low in the west-southwest as shown here. Upper right of it by just 1.3° is Spica, a 1st-magnitude star but less than 1% as bright as Venus. Can you see Spica naked-eye through the twilight? They're about a finger-width at arm's length apart. Try binoculars.

• After dark at this time of year, the Great Square of Pegasus looms up in the east, balancing on one corner. Its stars are only 2nd and 3rd magnitude. Extending leftward from the Square's left corner is the main line of the constellation Andromeda. It's made of three stars (including the corner) that are about as bright as the ones forming the Square.

This whole giant pattern was named "the Andromegasus Dipper" by the late *Sky & Telescope* columnist George Lovi. Shaped sort of like a giant Little Dipper with an extra-big bowl, it's currently lifting its contents upward.

The actual Little Dipper, meanwhile, has tipped over leftward in the north. It's only 40% as long as the Andromegasus Dipper, and most of it is much fainter. You'll always find the Little Dipper oriented more than 90° counterclockwise compared to Andromegasus.

Sunday, September 2

• Mars shines fire-color in the south-southeast after dark this week. High above it, by three or four fists at arm's length, sparkles white Altair.

And a finger width above Altair is fainter Tarazed, an orange giant that's actually more luminous than Altair but far in the background. The two are 17 and 390 light-years away.

• The last-quarter Moon tonight rises in the east around 11 or 11:30 p.m., depending on your location. It's in Taurus. As dawn begins to brighten on Monday the 3rd, the Moon shines high in the southeast with Aldebaran to its left and Orion below it.

Monday, September 3

• How soon after sunset can you see the big Summer Triangle? Face southeast and look high. There's Altair, currently the triangle's bottom point. Vega, the Triangle's brightest star, is nearly at the zenith (as seen from mid-northern latitudes). Deneb is a bit farther to Altair's upper left.

Then look down below Altair. Saturn and Mars form a big triangle with it that's almost a mirror image of the Summer Triangle above. Altair is the *top* point of this brighter, temporary "Summer of 2018 Triangle."

Source: Sky & Telescope Return to Contents

ISS Sighting Opportunities

For Denver: No sighting opportunities

Date	Visible	Max Height	Appears	Disappears
Sat Sep 1, 4:00 AM	1 min	15°	15° above E	10° above E
Sat Sep 1, 5:33 AM	4 min	37°	17° above W	15° above NNE
Sun Sep 2, 4:43 AM	2 min	68°	68° above NNW	23° above NE
Mon Sep 3, 3:53 AM	< 1 min	17°	17° above ENE	17° above ENE
Mon Sep 3, 5:26 AM	4 min	21°	14° above WNW	10° above NNE

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

NASA-TV Highlights

(all times Eastern Daylight Time)

No special programming

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

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Space Calendar

- Aug 31 - Comet C/2018 O1 (ATLAS) Perihelion (1.558 AU)
- Aug 31 - Comet 266P/Christensen At Opposition (2.880 AU)
- Aug 31 - Comet P/2009 WX51 (Catalina) At Opposition (4.237 AU)
- Aug 31 - Aten Asteroid 136818 Selqet Closest Approach To Earth (0.290 AU)
- Aug 31 - Asteroid 8722 Schirra Closest Approach To Earth (0.777 AU)
- Aug 31 - Asteroid 1743 Schmidt Closest Approach To Earth (1.744 AU)
- Aug 31 - Asteroid 2127 Tanya Closest Approach To Earth (2.155 AU)
- Aug 31 - Kuiper Belt Object 307982 (2004 PG115) At Opposition (37.432 AU)
- Aug 31 - Pavel Vinogradov's 65th Birthday (1953)
- Aug 31 - Bernard Lovell's 105th Birthday (1913)
- Sep 01 - Comet 2P/Encke At Opposition (3.055 AU)
- Sep 01 - Apollo Asteroid 2017 RL16 Near-Earth Flyby (0.096 AU)
- Sep 01 - Atira Asteroid 2015 DR215 Closest Approach To Earth (0.650 AU)
- Sep 01 - Asteroid 18932 Robinhood Closest Approach To Earth (0.841 AU)
- Sep 01 - Asteroid 3665 Fitzgerald Closest Approach To Earth (1.308 AU)
- Sep 01 - Apollo Asteroid 2201 Oljato Closest Approach To Earth (1.468 AU)
- Sep 01 - Asteroid 11195 Woomera Closest Approach To Earth (1.555 AU)
- Sep 01 - Asteroid 7291 Hyakutake Closest Approach To Earth (1.606 AU)
- Sep 01 - Asteroid 7307 Takei Closest Approach To Earth (1.979 AU)
- Sep 01 - Centaur Object 7066 Nessus At Opposition (27.311 AU)
- Sep 01 - Kuiper Belt Object 2003 QX113 At Opposition (59.148 AU)
- Sep 01 - Shawn Hermann's 45th Birthday (1973)
- Sep 01 - 90th Anniversary (1928), Discovery of the Winona Meteorite in Arizona
- Sep 01 - Osten Bergstrand's 145th Birthday (1873)
- Sep 02 - Apollo Asteroid 2001 RQ17 Near-Earth Flyby (0.049 AU)
- Sep 02 - Apollo Asteroid 2011 CX46 Near-Earth Flyby (0.061 AU)
- Sep 02 - Kuiper Belt Object 50000 Quaoar Occults 2UCAC 26280876 (12.6 Magnitude Star)
- Sep 02 - Plutino 175113 (2004 PF115) At Opposition (40.571 AU)
- Sep 02 - Christa McAuliffe's 70th Birthday (1948)
- Sep 02 - Valentin Glushko's 110th Birthday (1908)
- Sep 03 - Moon Occults Aldebaran
- Sep 03 - Apollo Asteroid 2015 FP118 Near-Earth Flyby (0.031 AU)
- Sep 03 - Apollo Asteroid 2018 QA Near-Earth Flyby (0.045 AU)
- Sep 03 - Apollo Asteroid 2017 DQ35 Near-Earth Flyby (0.099 AU)
- Sep 03 - Asteroid 17681 Tweedledum Closest Approach To Earth (1.002 AU)
- Sep 03 - Asteroid 4758 Hermitage Closest Approach To Earth (1.649 AU)
- Sep 03 - Asteroid 42522 Chuckberry Closest Approach To Earth (1.764 AU)
- Sep 03 - Kuiper Belt Object 120178 (2003 OP32) At Opposition (41.368 AU)
- Sep 03 - Lyudmila Karachkina's 70th Birthday (1948)
-

Source: JPL Space Calendar

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Food for Thought

This Is the Habitat in Hawaii Helping Astronauts Preparing to Explore Mars

When it comes time to send astronauts to Mars, those who make the journey will need to be ready for a number of challenges. In addition to enduring about six-months in space both ways, the first astronauts to explore Mars will also need to be prepared to spend months living on the surface. This will consist of long periods spent in a pressurized habitat and regular forays to the surface wearing pressure suits.

Preparing astronauts for this kind of living situation is the purpose behind the NASA-funded Hawai'i Space Exploration Analog and Simulation (Hi-SEAS), an exercise that has been taking place since 2013 site on the Hawaiian mountain of Mauna Loa. In February of 2018, the Mission VI crew began an eight month-long research study of human behavior and performance, which will apparently involve a lot of spelunking!

Located on the northern slop of Mauna Loa, Hawaii's largest volcano, the Hi-SEAS habitat is situated at an abandoned quarry site roughly 2,400 meters (8,000 feet) above sea level. This barren area, which contains sparse vegetation and overlapping lava flows, was specifically selected because of the similarities it has to terrain on Mars – which also has large, gently sloping shield volcanoes and exposed lava flows.

The habitat itself sits on top the Pu'ukahiliku flow, which is the result of an eruption that took place about 1,800 years ago. This makes it older than the 'Ainahou flow (which formed 450 years ago) and the youngest flow which was the result of Mauna Loa's most recent eruption (in 1899). Since the Pu'ukahiliku flow is older, the ground has been subject to more weathering and erosion, resulting in a thin layer of soil.

Since 2013, crews of six people have taken up residence in the habitat, a semi-portable, two-floor dome structure that measures 10 meters (36 feet) in diameter and has a living area of about 93 square meters (1000 square feet). Most of this is taken up by the ground floor, which has just 81 square meters (878 square

feet) of usable space. The dome's second level is loftlike, which provides a high-ceiling feel that is crucial to combating long-term feelings of claustrophobia.

Nevertheless, things can get a bit cramped for the six-person crews spending months inside the domed structure. Christiane Heinicke was part of the Mission IVcrew which completed their year-long mission in August 2016. As she described their routine in an article with *Scientific American*:

"Cut off from civilization, we were dependent on ourselves and on each other. We had to perform any work that needed doing and fix anything that broke. All we had was the material contained in the storage unit dubbed the "sea can." The nearest supermarket was months away. We received news "from Earth" electronically—with a 20-minute delay. That is about how long it takes for signals to travel the maximum distance of 240 million miles between the two planets."

As such, every opportunity is taken to don mock space suits and venture outside to do a little exploring. These outings, which involve exploring the extensive lava flows, caves and rocky outcroppings, simulate the scientific work that would happen during a Mars mission. According to Heinicke, she and her team spent six months of their year-long mission exploring over 100 caves.

On her personal blog – Walking on Red Dust – she noted one cave in particular, a stable lava tube that had multiple skylights (openings to the surface). As she indicated, this kind of environment is one possible location for a future Mars habitat:

"Since our first exploratory visit we have returned to the cave multiple times. We have measured the cave, examined the rock more closely, and found a suitable shelter for a possible evacuation from the hab: On Mars this kind of lava tube is hoped to provide shelter to astronauts from the harmful space radiation, either as permanent settlement or as emergency shelter during a solar storm. The Martian ground definitely contains many promising skylights, they have just been inaccessible to today's rovers."

She also noted that the cave itself was a "geological wonderland" that had formed when the lava tube was still warm and soft. In addition to "small, furry patches of salt", the lava tube was also full of life – such as mosses and, in one case, a frond growing directly beneath a skylight. These latter finds were of particular interest since many scientists think that water and even microbial life could exist in stable lava tubes on Mars.

"At the same time, they may harbor more moisture than the surface and even provide a refuge for living organisms." she wrote in her article for *Scientific American*. "If such organisms ever existed on Mars, they would more likely have survived in caves." In this respect, spelunking not only provides an opportunity for the Hi-SEAS crews to get out and ward off cabin fever, it also allows them to take part in research that will one day assist in searching for life on Mars and establishing a human presence there.

But perhaps the biggest takeaway for Heindricke and her teammates from their year spent in Mars-like conditions was the need for a crew to be on the same wavelength and cooperate with each other. In addition, their time together also highlighted the importance of physical fitness to promote a healthy mindset and prepare human crews for what life would be like on the surface.

"It is hardly a secret that workouts help to decrease stress," she said. "But on a trip to Mars they would serve a second function as well. Weightlessness and the effects of reduced gravity have a harmful effect on health, and so astronauts will have to engage in intensive exercise to retain bone and muscle mass."

To this end, they turned their outdoor ventures into a combination of exercise and work. In addition to walking along rocky, uneven terrain in their 23 kg (50 lbs) suits and exploring caves, they also experimented with extracting water from the extremely dry lava rocks – which are about as dry as those on Mars. All of these activities helped the crew stay focused and active, and also promoted a sense of cohesion and cooperation.

As Heindricke explained, the benefits of this type of research go beyond space exploration, and include any situation where groups are forced to work together under what she calls “ICE conditions – isolated, confined, extreme”. But in the end, it’s chief goal is to prepare human beings for eventual trips to Mars. As she indicated, this includes members of the general public, and not just professional astronauts:

“The question of whether life exists or ever existed on the red planet is one of the key reasons for sending an expedition there. But even aside from that, human beings have always endured hardships in the service of understanding our own planet. Non-government initiatives such as Mars One or the ambitious plans for SpaceX show that many people are ready to take on the rigors of the dangerous journey. Presumably, liftoff is only a matter of time.

“Studies such as HI-SEAS are designed to increase the chances that the first Mars crew will survive and to create a setting in which its members can concentrate on seeking out signs of life rather than squandering their energies in conflicts and petty competition.”

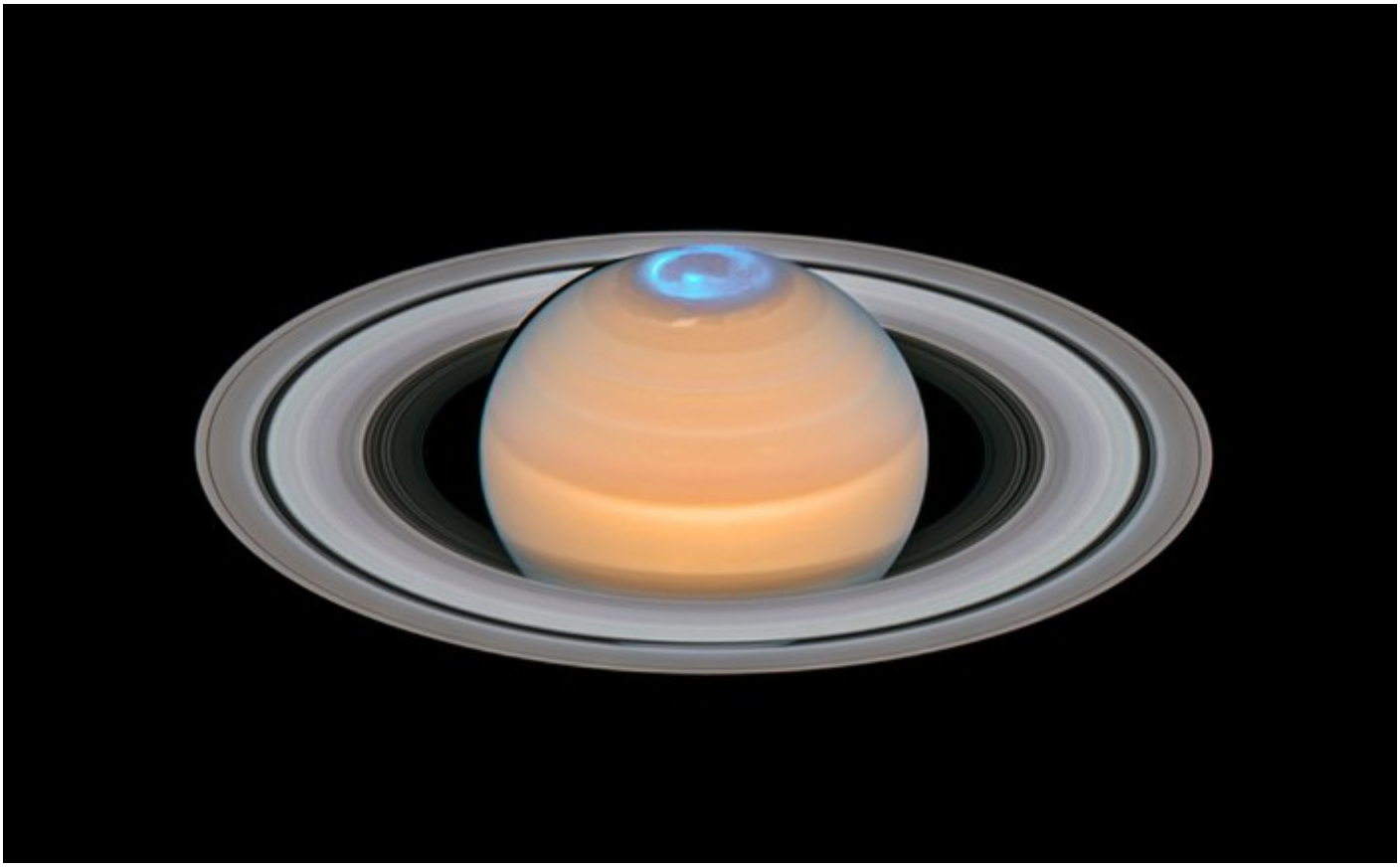
The current Hi-SEAS mission (Mission VI) began on Thursday, February 15th, 2018, and will continue until October of this year. The lessons learned from these missions are sure to be of use for the first crewed missions to Mars, not to mention plans for establishing permanent settlements there. When the first “Martians” do finally set up shop on the Red Planet, we can imagine that their lives will consist of plenty of hard work and exercise.

And more than likely, some of this will involve a visit to the local lava tubes to see if they are anything like the lava tubes here on Earth. And while these adventurous individuals are at it, they might just find something growing in these lave tubes too!

Further Reading: NASA – Earth Observatory, Scientific American, Walking on the Red Dust

Source: Universe Today Return to Contents

Space Image of the Week



Hubble Observes Energetic Lightshow at Saturn's North Pole

Explanation In 2017, over a period of seven months, the NASA/ESA Hubble Space Telescope took images of auroras above Saturn's north pole region using the Space Telescope Imaging Spectrograph. The observations were taken before and after the Saturnian northern summer solstice. These conditions provided the best achievable viewing of the northern auroral region for Hubble.

On Earth, auroras are mainly created by particles originally emitted by the Sun in the form of solar wind. When this stream of electrically charged particles gets close to our planet, it interacts with the magnetic field, which acts as a gigantic shield. While it protects Earth's environment from solar wind particles, it can also trap a small fraction of them. Particles trapped within the magnetosphere — the region of space surrounding Earth in which charged particles are affected by its magnetic field — can be energised and then follow the magnetic field lines down to the magnetic poles. There, they interact with oxygen and nitrogen atoms in the upper layers of the atmosphere, creating the flickering, colourful lights visible in the polar regions here on Earth [1].

However, these auroras are not unique to Earth. Other planets in our Solar System have been found to have similar auroras. Among them are the four gas giants Jupiter, Saturn, Uranus and Neptune. Because the atmosphere of each of the four outer planets in the Solar System is — unlike the Earth — dominated by hydrogen, Saturn's auroras can only be seen in ultraviolet wavelengths; a part of the electromagnetic spectrum which can only be studied from space.

Hubble allowed researchers to monitor the behaviour of the auroras at Saturn's north pole over an extended period of time. The Hubble observations were coordinated with the "Grand Finale" of the Cassini spacecraft, when the spacecraft simultaneously probed the auroral regions of Saturn [2]. The Hubble data allowed

astronomers to learn more about Saturn's magnetosphere, which is the largest of any planet in the Solar System other than Jupiter.

The images show a rich variety of emissions with highly variable localised features. The variability of the auroras is influenced by both the solar wind and the rapid rotation of Saturn, which lasts only about 11 hours. On top of this, the northern aurora displays two distinct peaks in brightness — at dawn and just before midnight. The latter peak, unreported before, seems specific to the interaction of the solar wind with the magnetosphere at Saturn's solstice.

The main image presented here is a composite of observations made of Saturn in early 2018 in the optical and of the auroras on Saturn's north pole region, made in 2017, demonstrating the size of the auroras along with the beautiful colours of Saturn.

Hubble has studied Saturn's auroras in the past. In 2004, it studied the southern auroras shortly after the southern solstice (heic0504) and in 2009 it took advantage of a rare opportunity to record Saturn when its rings were edge-on (heic1003). This allowed Hubble to observe both poles and their auroras simultaneously.

Notes

[1] The auroras here on Earth have different names depending on which pole they occur at. Aurora Borealis, or the northern lights, is the name given to auroras around the north pole and Aurora Australis, or the southern lights, is the name given for auroras around the south pole.

[2] Cassini was a collaboration between NASA, ESA and the Italian Space Agency. It spent 13 years orbiting Saturn, gathering information and giving astronomers a great insight into the inner workings of Saturn. Cassini took more risks at the end of its mission, travelling through the gap between Saturn and its rings. No spacecraft had previously done this, and Cassini gathered spectacular images of Saturn as well as new data for scientists to work with. On 15 September 2017 Cassini was sent on a controlled crash into Saturn.

Image credit: NASA, ESA & L. Lamy

Source: Spacetelescope.org Return to Contents