Contents

In the News

Story 1:
NASA’s OSIRIS-REx Mission Explains Bennu’s Mysterious Particle Events

Story 2:
Hidden Giant Planet Revealed Around Tiny White Dwarf Star

Story 3:
Sun’s Close-Up Reveals Atmosphere Hopping with Highly Energetic Particles

Departments

The Night Sky
ISS Sighting Opportunities
Space Calendar
NASA-TV Highlights
Food for Thought
Space Image of the Week
1. NASA’s OSIRIS-REx Mission Explains Bennu’s Mysterious Particle Events

Shortly after NASA’s OSIRIS-REx spacecraft arrived at asteroid Bennu, an unexpected discovery by the mission’s science team revealed that the asteroid could be active, or consistently discharging particles into space. The ongoing examination of Bennu – and its sample that will eventually be returned to Earth – could potentially shed light on why this intriguing phenomenon is occurring.

The OSIRIS-REx team first observed a particle ejection event in images captured by the spacecraft’s navigation cameras taken on Jan. 6, just a week after the spacecraft entered its first orbit around Bennu. At first glance, the particles appeared to be stars behind the asteroid, but on closer examination, the team realized that the asteroid was ejecting material from its surface. After concluding that these particles did not compromise the spacecraft’s safety, the mission began dedicated observations in order to fully document the activity.

“Among Bennu’s many surprises, the particle ejections sparked our curiosity, and we’ve spent the last several months investigating this mystery,” said Dante Lauretta, OSIRIS-REx principal investigator at the University of Arizona, Tucson. “This is a great opportunity to expand our knowledge of how asteroids behave.”

After studying the results of the observations, the mission team released their findings in a Science paper published Dec. 6. The team observed the three largest particle ejection events on Jan. 6 and 19, and Feb. 11, and concluded that the events originated from different locations on Bennu’s surface. The first event originated in the southern hemisphere, and the second and third events occurred near the equator. All three events took place in the late afternoon on Bennu.

The team found that, after ejection from the asteroid’s surface, the particles either briefly orbited Bennu and fell back to its surface or escaped from Bennu into space. The observed particles traveled up to 10 feet (3 meters) per second, and measured from smaller than an inch up to 4 inches (10 cm) in size. Approximately 200 particles were observed during the largest event, which took place on Jan. 6.

The team investigated a wide variety of possible mechanisms that may have caused the ejection events, and narrowed the list to three candidates: meteoroid impacts, thermal stress fracturing, and released of water vapor.
Meteoroid impacts are common in the deep space neighborhood of Bennu, and it is possible that these small fragments of space rock could be hitting Bennu where OSIRIS-REx is not observing it, shaking loose particles with the momentum of their impact.

The team also determined that thermal fracturing is another reasonable explanation. Bennu’s surface temperatures vary drastically over its 4.3-hour rotation period. Although it is extremely cold during the night hours, the asteroid’s surface warms significantly in the mid-afternoon, which is when the three major events occurred. As a result of this temperature change, rocks may begin to crack and break down, and eventually particles could be ejected from the surface. This cycle is known as thermal stress fracturing.

Water release may also explain the asteroid’s activity. When Bennu’s water-locked clays are heated, the water could begin to release and create pressure. It is possible that as pressure builds in cracks and pores in boulders where absorbed water is released, the surface could become agitated, causing particles to erupt.

But nature does not always allow for simple explanations. "It could be that more than one of these possible mechanisms are at play," said Steve Chesley, an author on the paper and Senior Research Scientist at NASA's Jet Propulsion Laboratory in Pasadena, Calif. "For example, thermal fracturing could be chopping the surface material into small pieces, making it far easier for meteoroid impacts to launch pebbles into space."

If thermal fracturing, meteoroid impacts, or both, are in fact the causes of these ejection events, then this phenomenon is likely happening on all small asteroids, as they all experience these mechanisms. However, if water release is the cause of these ejection events, then this phenomenon would be specific to asteroids that contain water-bearing minerals, like Bennu.

Bennu’s activity presents larger opportunities once a sample is collected and returned to Earth for study. Many of the ejected particles are small enough to be collected by the spacecraft’s sampling mechanism, meaning that the returned sample may possibly contain some material that was ejected and returned to Bennu’s surface. Determining that a particular particle had been ejected and returned to Bennu might be a scientific feat similar to finding a needle in a haystack. The material returned to Earth from Bennu, however, will almost certainly increase our understanding of asteroids and the ways they are both different and similar, even as the particle ejection phenomenon continues to be a mystery whose clues we’ll also return home with in the form of data and further material for study.

Sample collection is scheduled for summer 2020, and the sample will be delivered to Earth in September 2023.

NASA’s Goddard Space Flight Center in Greenbelt, Maryland provides overall mission management, systems engineering, and the safety and mission assurance for OSIRIS-REx. Dante Lauretta of the University of Arizona, Tucson, is the principal investigator, and the University of Arizona also leads the science team and the mission’s science observation planning and data processing. Lockheed Martin Space in Denver built the spacecraft and is providing flight operations. Goddard and KinetX Aerospace are responsible for navigating the OSIRIS-REx spacecraft. OSIRIS-REx is the third mission in NASA’s New Frontiers Program, which is managed by NASA’s Marshall Space Flight Center in Huntsville, Alabama, for the agency’s Science Mission Directorate in Washington.

Source: NASA
The first evidence of a giant planet orbiting a dead white dwarf star has been found in the form of a disc of gas formed from its evaporating atmosphere.

The Neptune-like planet orbits a star a quarter of its size about once every ten days, leaving a comet-like tail of gas comprised of hydrogen, oxygen and sulphur in its wake.

The discovery by astronomers from the University of Warwick's Department of Physics and the Millennium Nucleus for Planet Formation (NPF) at the University of Valparaíso is published today (4 December) in the journal Nature. It is the first evidence of a giant planet orbiting a white dwarf star and suggests that there could be many more planets around such stars waiting to be discovered.

Until now, there has never been evidence of a planet that has survived a star's transition to a white dwarf.

The star WDJ0914+1914 was identified in a survey of ten thousand white dwarfs observed by the Sloan Digital Sky Survey. Scientists at Warwick analysed subtle variations in the light emitted from the system to identify the elements present around the star.

They detected very minute spikes of hydrogen in the data, which was unusual in itself, but also of oxygen and sulphur, which they had never seen before. Using the Very Large Telescope of the European Southern Observatory in Chile to obtain more observations of this star, they found that the shape of the hydrogen, oxygen and sulphur features are typical indicators of a ring of gas.

Lead author Dr Boris Gaensicke, from the University of Warwick, said: "At first, we thought that this was a binary star with an accretion disc formed from mass flowing between the two stars. However, our observations show that it is a single white dwarf with a disc around it roughly ten times the size of our sun, made solely of
hydrogen, oxygen and sulphur. Such a system has never been seen before, and it was immediately clear to me that this was a unique star."

When the astronomers averaged all the spectra they obtained over two nights in Chile it was clear that WDJ0914+1914 was accreting sulphur and oxygen from the disc. Analysing the data, they were able to measure the composition of the disc, and concluded that it matches what scientists expect for the deeper layers of our own solar system's ice giants, Uranus and Neptune.

Dr Matthias Schreiber from the University of Valparaíso showed through a set of calculations that the 28,000 degrees Celsius hot white dwarf is slowly evaporating this hidden icy giant by bombarding it with high energy photons and pulling its lost mass into a gas disc around the star at a rate of over 3,000 tons per second.

Dr Gaensicke said: "This star has a planet that we can't see directly, but because the star is so hot it is evaporating the planet, and we detect the atmosphere it is losing. There could be many cooler white dwarfs that have planets but lacking the high-energy photons necessary to drive evaporation, so we wouldn't be able to find them with the same method. However, some of those planets might detectable using the transit method once the Large Synoptic Survey Telescope goes on sky.

"This discovery is major progress because over the past two decades we had growing evidence that planetary systems survive into the white dwarf stage. We've seen a lot of asteroids, comets and other small planetary objects hitting white dwarfs, and explaining these events requires larger, planet-mass bodies further out. Having evidence for an actual planet that itself was scattered in is an important step."

Dr Schreiber adds: "In a sense, WDJ0914+1914 is providing us with a glimpse into the very distant future of our own solar system."

The white dwarf we see today was once a star similar to the sun but eventually ran out of fuel, swelled up into a red giant, a few 100 times the size of the sun. During that phase of its life the star will have lost about half of its mass and what was left has shrunk dramatically ending up size of the Earth - the white dwarf is essentially the burnt-out core of the former star.

Extraordinarily, today's orbit of the planet around the white dwarf would have been deep inside the red giant, so scattering with some other planets in the system, a kind of cosmic pool game, moved it close to the white dwarf after the red giant's outer layers were lost.

Once our own sun runs out of fuel in about 4.5 billion years it will shed its outer layers, destroying Mercury, Venus, and probably the Earth, and eventually expose the burnt-out core - the white dwarf. In a companion paper led by Dr Schreiber and Dr Gaensicke and published in Astrophysical Journal Letters, they detail how this will radiate enough high energy photons to evaporate Jupiter, Saturn, Uranus and Neptune. Just as on WDJ0914+1914, some of that atmospheric gas will end up on the white dwarf left behind by the sun, and will be observable for future generations of alien astronomers.

The astronomers argue that this planetary evaporation and subsequent accretion by young white dwarfs is probably a relatively common process and that it might open a new window towards studying the chemical composition of the atmospheres of extrasolar gas giant planets.

Dr Schreiber comments: "We were stunned when we realised that when observing hot white dwarfs, we are potentially seeing signatures from extrasolar planet atmospheres. While this hypothesis needs further confirmation, it might indeed open the doors towards understanding extrasolar planet atmospheres."

Source:  Spaceref.com  Return to Contents
Outbursts of energetic particles that hurtle out from the sun and can disrupt space communications may be even more varied and numerous than previously thought, according to results from the closest-ever flyby of the sun.

The new findings, which help us understand the sun's activity and ultimately could provide an early warning for solar storms, come from one of the four instrument suites aboard NASA's Parker Solar Probe, a spacecraft that has completed its first passes near the fiery orb. Results from all four suites appear today in a set of articles published in the journal *Nature*.

The finding that these energetic particle events are more varied and numerous than previously known was one of several discoveries made by the instrument suite known as the Integrated Science Investigation of the Sun (ISOIS), a project led by Princeton University that involves multiple institutions as well as NASA.

"This study marks a major milestone with humanity's reconnaissance of the near-sun environment," said David McComas, the principal investigator for the ISOIS instrument suite, a Princeton professor of astrophysical sciences and the vice president for the Princeton Plasma Physics Laboratory. "It provides the first direct observations of the energetic particle environment in the region just above the sun's upper atmosphere, the corona.

"Seeing these observations has been a continuous 'eureka moment,'" McComas said. "Whenever we receive new data from the spacecraft, we are witnessing something that no one has ever seen before. That is about as good as it gets!"

ISOIS seeks to find out how the particles become so fast moving, and what is pushing them to accelerate. The scientists searching for these answers includes ISOIS team members at the California Institute of Technology (Caltech), John Hopkins University Applied Physics Laboratory (APL), NASA Goddard Space Flight Center, NASA Jet Propulsion Laboratory, the University of New Hampshire, Southwest Research Institute, the University of
Highly energetic particles can disrupt communications and global positioning systems (GPS) satellites. These streams of particles, made up primarily of protons, have two sources. The first is from outside our solar system, generated when exploding stars release streams of particles known as cosmic rays. The other is our sun. Both can damage the electrical systems of spacecraft and are forms of radiation that can harm astronauts’ health.

These energetic particles fly much faster than the solar wind, which is the roughly million mile-per-hour flow of hot electrically charged gas that whips off the sun. If the solar wind were a stream, the energetic particles would be fish that leap out and jump ahead of the flow. The particles travel along pathways—called magnetic flux tubes—that extend from the corona out into the solar wind.

Understanding these particles could improve space weather forecasts and give early warning of the massive storms that can disrupt Earthly communications and space travel.

"The answer to questions about how energetic particles form and accelerate is incredibly important," said Ralph McNutt, who oversaw the building of the lower energy of the suite's two instruments and is chief scientist in the Space Exploration Sector at APL. "These particles affect our activities on Earth and our ability to get our astronauts out into space. We are making history with this mission."

Due to their speed, the particles act as an early warning signal for space weather, said Jamey Szalay, an associate research scholar in the Department of Astrophysical Sciences at Princeton who leads the data visualization efforts for ISOIS. "These particles are moving fast, so if there is a big solar storm on its way, these particles are the first indicators."

Most previous studies of solar energetic particles relied on detectors located in space about the same distance from the Sun as is the Earth—93 million miles from the sun. By the time the particles get to those detectors, it is hard to track where they came from, because the particles from various sources have interacted and intermixed.

"It's a bit like cars coming from crowded tunnels and bridges and spreading out onto interstate highways," McComas said. "They get faster as they move away, but they also get mixed and interact in ways that it is impossible to tell who came from where as you move farther and farther away from the sources."

In its first trips around the sun, the Parker Solar Probe travelled twice as close to the sun as any previous spacecraft has ever been. At its closest, the spacecraft was 14 million miles—or 35 solar radii, which is 17.5 widths of the sun—from the fiery surface.

Getting close to the sun is essential for unraveling how these particles form and gain high energies, said Eric Christian, the deputy principal investigator on ISOIS and a senior research scientist at NASA Goddard. "It is like trying to measure what is happening in a mountain by studying the base of the mountain. To know what is happening, you have to go where the action is: You have to go up on the mountain."

A potential concern of the researchers was that the sun's 11-year cycle of activity is presently at a low. But the low activity level turned out to be an advantage.

"The fact that the sun was quiet allowed us to analyze events that are extremely isolated," said Nathan Schwadron, a professor of physics and astronomy and the head of the ISOIS science operation center at the Delaware and the University of Arizona, as well as collaborators at the University of California-Berkeley, Imperial College London, the University of Michigan, Smithsonian Astrophysical Observatory and the National Center for Scientific Research in France.
University of New Hampshire. "These are events that haven't been seen from farther away because they are just clobbered by the solar wind activity."

During its first two orbits, ISOIS observed several fascinating phenomena. One was a burst of energetic particle activity that coincided with a coronal mass ejection, a violent eruption of energized and magnetized particles from the corona. Prior to the ejection, ISOIS detected a buildup of relatively low energetic particles, whereas after the ejection there was a buildup of high energetic particles. These events were small and not detectable from the Earth's orbit.

Another observation from ISOIS was particle activity indicating a sort of solar wind traffic jam, which happens when the solar wind suddenly slows down, causing fast-moving solar wind to pile up behind it and forming a compressed region of particles. This buildup, which astrophysicists call a co-rotating interaction region, occurred out beyond Earth's orbit and sent high energy particles back toward the sun where they were observed by ISOIS.

Researchers are eager to understand the mechanisms by which the sun accelerates particles to high speeds. ISOIS's detection of each particle's identity—whether it is hydrogen, helium, carbon, oxygen, iron or another element—will help researchers further explore this question.

"There are two kinds of acceleration mechanisms, one that occurs in solar flares when magnetic fields reconnect, and another that occurs when you get shocks and compressions of the solar wind, but the details of how they cause particle acceleration are not that well understood," said Mark Wiedenbeck, a principal scientist at NASA's Jet Propulsion Laboratory, who oversaw the development of the higher energy instrument in the ISOIS suite. "The composition of the particles is a key diagnostic to tell us the acceleration mechanism."

ISOIS made its third brush by the sun on Sept. 1, and will make its next on Jan. 29, 2020. As the mission continues, the satellite will make a total of 24 orbits, each time getting closer to the solar surface, until it is roughly five sun-widths from the star. The researchers hope that future flybys will reveal insights into the source of the energetic particles. Do they start as "seed particles" that go on to attain higher energies?

Jamie Sue Rankin, a postdoctoral researcher at Princeton working in the McComas group, began working on the higher energy ISOIS instrument as a graduate student at Caltech.

"It has been neat to see this whole process develop over the past decade," Rankin said. "It is like surfing a wave: We built these instruments, made sure they were working, made adjustments to make sure the calibrations were right—and now comes the exciting part, answering the questions that we set out to address."

"With any spacecraft, when you go out into space, you think you know what to expect, but there are always wonderful surprises that complicate our lives in the best way," she said. "That is what keeps us doing what we do."

Explore further: Effects of the solar wind

Source: Phys.org
The Night Sky

Friday, Dec. 6

• The Moon shines lower left of the Great Square of Pegasus.

• Gulf Coast asteroid occultation tonight. David Dunham of the International Occultation Timing Association (IOTA) writes, "One of the brighter asteroidal occultations of the year will occur just before 11 p.m. CST across southern Texas, just south of New Orleans, and over Jacksonville, Florida. This will be the occultation of 6.5-magnitude 18 Aurigae by the 72-km asteroid 55 Pandora. Clear skies are predicted for southern Texas, and it may be clear enough to observe it from Jacksonville as well." Further details can be found on IOTA's webpage.

Saturday, Dec. 7

• Vega is still the brightest star in the west-northwest in early evening. The brightest over it is Deneb. Farther to Vega's left is Altair, midway in brightness between Vega and Deneb.

These three form the Summer Triangle, and when the Summer Triangle finds itself here, you can look for the Great Square of Pegasus crossing the meridian high in the south.

• Earliest sunset of the year, if you live near latitude 40° north. Even though we're still two weeks from the winter solstice.

This offset of the earliest sunset from the solstice date is balanced out by the opposite happening at sunrise: The Sun doesn't come up its latest until January 4th. Why? Blame the tilt of Earth's axis and the eccentricity of Earth's orbit.

Sunday, Dec. 8

• Orion fully clears the eastern horizon by 7 or 8 p.m. now, depending on how far east or west you live in your time zone. High above Orion shines orange Aldebaran. Above Aldebaran is the little Pleiades cluster, the size of your fingertip at arm's length.

Far left of Aldebaran and the Pleiades shines bright Capella.

Down below Orion, brilliant Sirius now rises around 8 or 9.

Monday, Dec. 9

• At this time of year the Big Dipper lies down lowest soon after dark, due north. It's entirely below the north horizon if you're as far south as Miami.

But by midnight, the Dipper stands straight up on its handle in fine view high in the northeast!

Source: Sky & Telescope
ISS Sighting Opportunities

For Denver:

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Sighting information for other cities can be found at NASA’s [Satellite Sighting Information](file:///C:/Users/username/Downloads/satellite-sighting-information.html).

**NASA-TV Highlights**

*(all times Eastern Daylight Time)*

No Special Programming

Watch NASA TV on the Net by going to the [NASA website](http://nasa.gov).
Space Calendar

- Dec 06  [Dec 06] **Progress MS-13 Soyuz-2.1a Launch** (International Space Station 74P), Successful
- Dec 06  [Dec 04] **Apollo Asteroid 2019 XN** Near-Earth Flyby (0.006 AU)
- Dec 06  [Nov 30] **Apollo Asteroid 2019 WR3** Near-Earth Flyby (0.036 AU)
- Dec 06  [Dec 02] **Apollo Asteroid 2019 WB5** Near-Earth Flyby (0.048 AU)
- Dec 06  [Dec 03] **Kuiper Belt Object 229762 G!kun'l'homdim** At Opposition (40.938 AU)
- Dec 06 - Clyde Cowan's 100th Birthday (1919)
- Dec 07 - **Comet P/2006 H1 (McNaught)** Perihelion (2.423 AU)
- Dec 07 - **Asteroid 55 Pandora** Occults HIP 24832 (6.5 Magnitude Star)
- Dec 07  [Dec 05] **Apollo Asteroid 2019 XP** Near-Earth Flyby (0.014 AU)
- Dec 07  [Dec 04] **Apollo Asteroid 2019 WJ6** Near-Earth Flyby (0.019 AU)
- Dec 07 - **Apollo Asteroid 2019 VH5** Near-Earth Flyby (0.046 AU)
- Dec 07 - **Asteroid 73769 Delphi** Closest Approach To Earth (2.587 AU)
- Dec 07 - **Kuiper Belt Object 2018 VG18** At Opposition (124.647 AU)
- Dec 07 - **Griffith Observatory Public Star Party**, Los Angeles, California
- Dec 08  [Dec 03] **Starlink 3 (60)** Falcon 9 Launch
- Dec 08  [Dec 01] **Interstellar Comet 2I/2019 Q4 (Borisov)** Perihelion (2.007 AU)
- Dec 08 - **Comet P/2013 EW90 (Tenagra)** At Opposition (2.938 AU)
- Dec 08 - **Apollo Asteroid 2015 XN55** Near-Earth Flyby (0.059 AU)
- Dec 08 - **Amor Asteroid 3552 Don Quixote** Closest Approach To Earth (4.233 AU)
- Dec 08 - 70th Anniversary (1949), V2 Launch (Albert IV the Rhesus Monkey)
- Dec 09 - **Hyperbolic Object A/2019 G2** Perihelion (2.293 AU)
- Dec 09 - **Comet P/2018 L5 (Leonard)** At Opposition (2.952 AU)
- Dec 09  [Dec 06] **Apollo Asteroid 2019 XY** Near-Earth Flyby (0.008 AU)
- Dec 09 - **Apollo Asteroid 2019 WQ2** Near-Earth Flyby (0.012 AU)
- Dec 09  [Nov 30] **Apollo Asteroid 2019 WT3** Near-Earth Flyby (0.025 AU)
- Dec 09  [Dec 04] **Aten Asteroid 2019 XB** Near-Earth Flyby (0.044 AU)
- Dec 09 - **Asteroid 14413 Geiger** Closest Approach To Earth (1.025 AU)
- Dec 09 - **Asteroid 17942 Whiterabbit** Closest Approach To Earth (1.677 AU)
- Dec 09 - **Asteroid 5405 Neverland** Closest Approach To Earth (2.324 AU)
- Dec 09 - **Centaur Object 60558 Echeclus** At Opposition (8.257 AU)
- Dec 09 - **Kuiper Belt Object 145451 (2005 RM43)** At Opposition (36.251 AU)
- Dec 09 - 75th Anniversary (1944), Wallops Island Launch Site Founded

*Clyde Cowan, co-discoverer of the neutrino*
Food for Thought

IKEA’s New Collection is Inspired by the Challenges of Living on Mars

The Mars Desert Research Station (MDRS) is a simulated Martian habitat in Utah. It’s owned by the Mars Society, and it’s the society’s second such station. The MDRS is a research facility, and while there, scientists must live as if they were on Mars, including wearing simulated space suits.

One group of visitors wasn’t there for science, but for interior design. Two years ago, a trio of Ikea designers spent three days at the MDRS to develop Ikea products for small spaces. As it turns out, they ended up using their experience at the MDRS to help outfit the MDRS itself.

The Ikea team wanted to know how thinking like a spaceship or space station designer could help them design products for tiny living quarters in the World’s mega-cities. Places like Hong Kong feature tiny apartments, spaces so small it would make the average North American claustrophobic.

Tiny living quarters are a reality for many people in the world. The question for the designers was: Could they learn valuable lessons from or space habitats like the MDRS that could translate into private living quarters? Those tiny apartments are people’s homes, and they not only need to provide for day to day living, they need to be psychologically comfortable. The same is true for astronauts on long-duration space missions.

Two years ago, after they left the station, Ikea designer Christina Levenborn said “It was very apparent that all the human values that we take for granted weren’t taken into consideration, like eating together, enjoying entertaining activities and, especially your personal privacy.”
That’s not surprising, especially from someone who specializes in design. Spaceships, space stations, and research stations like MDRS are designed with technical considerations at the forefront. It’s the same with the pods at the research station, and that’s the way it has to be. As another of the designers said, “Of course there’s a lot technically that needs to play a big part of these pods, but more interesting is the fact that the technical aspect can fail at any given moment because of the emotional climate in the pod.”

Like a home, a research station contains both group spaces and private spaces. The Ikea designers focused on making both spaces more inviting, more comfortable, and more practical. Flexibility and modularity was key.

They developed what they’re calling the Rumtid line. Rumtid translates as space time, and those two words are part of the theme behind Rumtid. Ikea’s Rumtid actually encompasses four words: space, time, water, and air.

But the designers’ work didn’t end with a new product line. They also returned the favor to the MDRS. They came up with interior layouts and design strategies to make the place more livable, more effective, and more psychologically comfortable.

“When we first got there, the condition of that pod was a bit surprising. We expected it to be more modern,” Robert explains. So the Ikea team set out to modernize it. Not with fancy, extraneous items, but with practical ideas.

They worked to create harmonious group spaces alongside a sense of privacy in personal spaces. That’s not easy in such cramped quarters. They used modular furniture on wheels, and shelving and warm lighting to make the space more home-like.

“We tried to work with products for small space living situation that could be arranged in a flexible and multi-functional way. For the habitat, we brought products on wheels for mobile living, stools for seating and table surfaces and stackable chairs for saving space,” designer Christina Levenborn said in the Ikea blog.

It’ll be a while before people are spending time at a real Mars outpost. But these things have a way of creeping up on us. Successful missions depend on getting the technical requirements right. But astronauts are still people, and though they’re remarkably focused, providing them with some sense of psychological comfort in their surroundings is just setting them up for success. It’s common sense.

Source: Universe Today
**Electric Night**

**Explanation**  It may appear, at first, like the Galaxy is producing the lightning, but really it's the Earth. The featured nighttime landscape was taken from a southern tip of the Italian Island of Sardinia in early June. The foreground rocks and shrubs are near the famous Capo Spartivento Lighthouse, and the camera is pointed south toward Algeria in Africa. In the distance, across the Mediterranean Sea, a thunderstorm is threatening, with several electric lightning strokes caught together during this 25-second wide-angle exposure. Much farther in the distance, strewn about the sky, are hundreds of stars in the neighborhood of our Sun in the Milky Way Galaxy. Farthest away, and slanting down from the upper left, are billions of stars that together compose the central band of our Milky Way.

**Image Credit & Copyright:** Ivan Pedretti

Source: APOD