

# Space News Update – January 2019

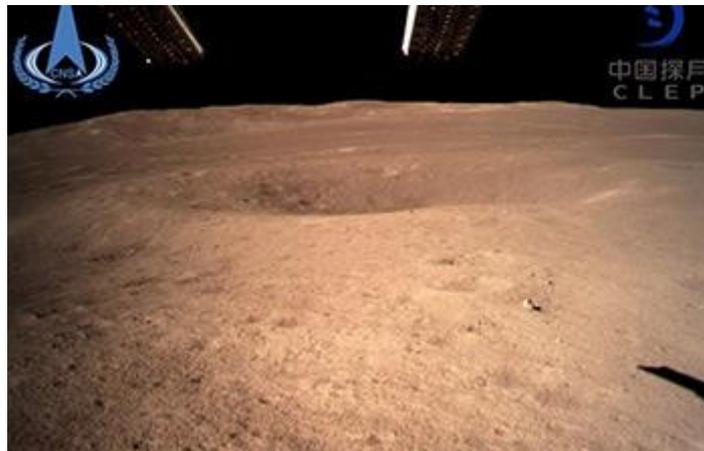
*By Pat Williams*

## IN THIS EDITION:

- China's Chang'e-4 probe takes first image of moon's far side.
- New Horizons' newest and best-yet view of Ultima Thule.
- Dark Energy Survey completes six-year mission.
- Solar flares: from emergence to eruption.
- Concrete in space.
- Scientists finally know what time it is on Saturn.
- Links to other space and astronomy news published in January 2019.

Disclaimer - I claim no authorship for the printed material; except where noted (PW).

## **CHINA'S CHANG'E-4 PROBE TAKES FIRST IMAGE OF MOON'S FAR SIDE**



*Photo provided by the China National Space Administration on Jan. 3, 2019 shows the first image of the moon's far side taken by China's Chang'e-4 probe. China's Chang'e-4 probe touched down on the far side of the moon, becoming the first spacecraft soft-landing on the moon's uncharted side never visible from Earth. The probe, comprising a lander and a rover, landed at the preselected landing area at 177.6 degrees east longitude and 45.5 degrees south latitude on the far side of the moon. China National Space Administration. (Xinhua)*

Over about 12 dramatic minutes, China's Chang'e-4 probe descended and softly touched down on a crater on the far side of the moon. The landing site is as rugged as the high mountains and lofty hills of southwest China's Sichuan Province. Chinese space experts chose the Von Karman Crater in the South Pole-Aitken Basin as the landing site of Chang'e-4. The area available for the landing is surrounded by mountains as high as 10 km. Chang'e-4 made an almost vertical landing. The whole process was automatic with no intervention from ground control, but the relay satellite transmitted images of the landing process back to Earth, When the process began, an engine was ignited to lower the craft's relative velocity from 1.7

km per second to close to zero, and the probe's attitude was adjusted to face the moon and descend vertically. When it descended to an altitude of about 2 km, its cameras took pictures of the lunar surface so the probe could identify large obstacles such as rocks or craters. At 100 meters above the surface, it hovered to identify smaller obstacles and measure the slopes on the lunar surface. After calculation, the probe found the safest site, and continued its descent. When it was 2 meters above the surface, the engine stopped, and the spacecraft landed with four legs cushioning against the shock.

[China's Chang'e-4 probe takes first image of moon's far side](#) (3 January 2019)

### **NEW HORIZONS' NEWEST AND BEST-YET VIEW OF ULTIMA THULE**



This image is the clearest view yet of this remarkable, ancient object in the far reaches of the solar system and the first small "KBO" ever explored by a spacecraft. Obtained with the wide-angle Multicolor Visible Imaging Camera (MVIC) component of New Horizons' Ralph instrument, this image was taken when the KBO was 4,200 miles (6,700 kilometres) from the spacecraft, on Jan. 1 just seven minutes before closest approach. With an original resolution of 440 feet (135 meters) per pixel, the image was stored in the spacecraft's data memory and transmitted to Earth on Jan. 18-19. Scientists then sharpened the image to enhance fine detail. (This process, known as deconvolution, also amplifies the graininess of the image when viewed at high contrast.) The oblique lighting of this image reveals new topographic details along the day/night boundary, or terminator, near the top. These details include numerous small pits up to about 0.4 miles (0.7 kilometres) in diameter. The large circular feature, about 4 miles (7 kilometres) across, on the smaller of the two lobes, also appears to be a deep depression. Not clear is whether these pits are impact craters or features resulting from other processes, such as "collapse pits" or the ancient venting of volatile materials. Both lobes also show many intriguing light and dark patterns of unknown origin, which may reveal clues about how this body was assembled during the formation of the solar system 4.5 billion years ago. One of the most striking of these is the bright "collar" separating the two lobes. This new image is starting to reveal differences in the geologic character of the two lobes of Ultima Thule and is presenting us with new mysteries as well. Over the next month there will be better colour and better resolution images that we hope will help unravel the many mysteries of Ultima Thule. New Horizons is approximately 4.13 billion miles (6.64 billion kilometres) from Earth, operating normally and speeding away from the Sun (and Ultima Thule) at more than 31,500 miles (50,700 kilometres) per hour. At that distance, a radio signal reaches Earth six hours and nine minutes after leaving the spacecraft. (JHUAPL)

[New Horizons' newest and best-yet view of Ultima Thule](#) (24 January 2019)

## **DARK ENERGY SURVEY COMPLETES SIX-YEAR MISSION**



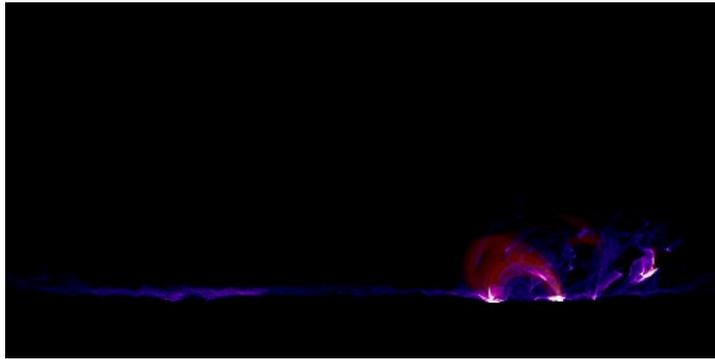
*The Dark Energy Camera is mounted on the 4-meter Blanco telescope at the Cerro Tololo Inter-American Observatory in Chile. The final day of data-taking for the Dark Energy Survey is Jan. 9. Photo: Fermilab*

Scientists' effort to map a portion of the sky in unprecedented detail is coming to an end, but their work to learn more about the expansion of the universe has just begun. The Dark Energy Camera is mounted on the 4-meter Blanco telescope at the Cerro Tololo Inter-American Observatory in Chile. After scanning in depth about a quarter of the southern skies for six years and cataloguing hundreds of millions of distant galaxies, the Dark Energy Survey (DES) will finish taking data on Jan. 9. The survey is an international collaboration that began mapping a 5,000-square-degree area of the sky on Aug. 31, 2013, in a quest to understand the nature of dark energy, the mysterious force that is accelerating the expansion of the universe. Using the Dark Energy Camera, a 520-megapixel digital camera funded by the U.S. Department of Energy Office of Science and mounted on the Blanco 4-meter telescope at the National Science Foundation's Cerro Tololo Inter-American Observatory in Chile, scientists on DES took data on 758 nights over six years. DES collaboration continues to release scientific results from their storehouse of data. Highlights from the previous years include:

- the [most precise measurement of dark matter structure in the universe](#), which, when compared with cosmic microwave background results, allows scientists to trace the evolution of the cosmos.
- the [discovery of many more dwarf satellite galaxies](#) orbiting our Milky Way, which provide tests of theories of dark matter.
- the creation of the [most accurate dark matter map](#) of the universe.
- the spotting of the [most distant supernova](#) ever detected.
- the [public release of the survey's first three years of data](#), enabling astronomers around the world to make additional discoveries.
- DES scientists also spotted the [first visible counterpart of gravitational waves ever detected](#), a collision of two neutron stars that occurred 130 million years ago. DES was one of several sky surveys that detected this gravitational wave source, opening the door to a new kind of astronomy.
- Recently DES issued its [first cosmology results based on supernovae](#) (207 of them taken from the first three years of DES data) using a method that provided the first evidence for cosmic acceleration 20 years ago. More comprehensive results on dark energy are expected within the next few years.  
(Fermilab)

[Dark Energy Survey completes six-year mission](#) (8 January 2019)

## **SOLAR FLARES: FROM EMERGENCE TO ERUPTION**



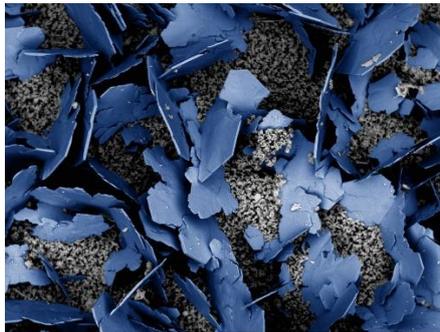
*The violet colour represent plasma with temperature less than 1 million Kelvin. Red represents temperatures between 1 million and 10 million Kelvin, and green represents temperatures above 10 million Kelvin.*

*Image Credit: Mark Cheung and Matthias Rempel*

A team of scientists has, for the first time, used a single, cohesive computer model to simulate the entire life cycle of a solar flare: from the build-up of energy thousands of kilometres below the solar surface, to the emergence of tangled magnetic field lines, to the explosive release of energy in a brilliant flash. (NCAR)

[Solar flares: from emergence to eruption](#) (14 January 2019)

## **CONCRETE IN SPACE**

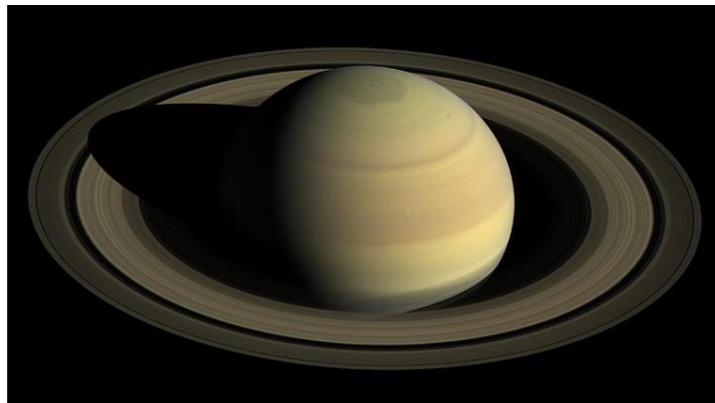


This image, taken from a scanning electron microscope, shows false-coloured portlandite (calcium hydroxide) crystals sitting on top of a C-S-H matrix, seen from the surface of a 3 mm-thick sample. The sample is hydrated tricalcium-silicate, which is the main compound of ordinary Portland cement. Image: MSFC - EM31 Materials Diagnostics Lab

The team sent 120 pre-packaged samples to the International Space Station (ISS), a working science lab in space. Sample packets included two or three separated compartments containing cement and water, or cement, water and alcohol (the latter was used to stop the hydration reaction at given time interval). While in orbit, an astronaut onboard the ISS was tasked with hydrating each sample by bursting the water packet into the cement packet and then halting the hydration at a given point using the alcohol for certain samples. This series of experiments varied the type of cement, the type of additives, the number of additives, the amount of water, and the length of time until the hydration was stopped. The samples were then returned to the Marshall Flight Centre in Huntsville, Alabama and then transported to Penn State where they are currently being tested and characterized in detail. The researchers then sent 28 additional samples to the ISS. In this phase, the astronauts mixed the two-compartment samples as they did in the first phase but then used a centrifuge to simulate three gravity levels. These gravity levels included the Moon, Mars, and 0.7-g, which is in

between the other two. This phase of the study will help the team determine the differences in the hydration reaction based on varying levels of gravity. All planets vary in their gravity levels. Mars is only one third of the Earth's gravity, but there is still some gravitational force. Once the results have been compiled, this research will be helpful in understanding how to use cement as a building material in space, but the knowledge gleaned will also be beneficial to improving Earth-based cement and concrete processing. Concrete is the single most widely used human-made material in the world, with global production reaching roughly 10 billion tons per year and it has a carbon footprint to match. Even a slight improvement in the process could have huge implications on the sustainability of cement-based infrastructure. (Pennsylvania State University) [Concrete in space](#) (23 January 2019)

## **SCIENTISTS FINALLY KNOW WHAT TIME IT IS ON SATURN**



*A view from NASA's Cassini spacecraft shows Saturn's northern hemisphere in 2016 as that part of the planet nears its northern hemisphere summer solstice. A year on Saturn is 29 Earth years; days only last 10:33:38, according to a new analysis of Cassini data. Credit: NASA/JPL-Caltech/Space Science Institute*

Using new data from NASA's Cassini spacecraft, researchers believe they have solved a longstanding mystery of solar system science: the length of a day on Saturn. It's 10 hours, 33 minutes and 38 seconds. The figure has eluded planetary scientists for decades, because the gas giant has no solid surface with landmarks to track as it rotates, and it has an unusual magnetic field that hides the planet's rotation rate. The answer, it turned out, was hidden in the rings. During Cassini's orbits of Saturn, instruments examined the icy, rocky rings in unprecedented detail. During Cassini's orbits of Saturn, instruments examined the icy, rocky rings in unprecedented detail, using the data to study wave patterns within the rings. This determined that the rings respond to vibrations within the planet itself, acting similarly to the seismometers used to measure movement caused by earthquakes. The interior of Saturn vibrates at frequencies that cause variations in its gravitational field. The rings, in turn, detect those movements in the field. Particles throughout the rings can't help but feel these oscillations in the gravity field. At specific locations in the rings these oscillations catch ring particles at just the right time in their orbits to gradually build up energy, and that energy gets carried away as an observable wave. They developed models of Saturn's internal structure that would match the rings' waves. That allowed them to track the movements of the interior of the planet - and thus, its rotation. (JPL)

[Scientists finally know what time it is on Saturn](#) (18 January 2019)

## **LINKS TO OTHER SPACE NEWS PUBLISHED IN JANUARY 2019**

### **ASTEROIDS**

[CubeSats joining Hera mission to asteroid system](#) (7 January 2019)

When ESA's planned Hera mission journeys to its target binary asteroid system, it will not be alone. The spacecraft will carry two tiny CubeSats for deployment around, and eventual landing on, the Didymos asteroids. Each companion spacecraft will be small enough to fit inside a briefcase, as compared to the desk-sized Hera. (ESA)

### **ASTRONOMY**

[Arianespace to launch a French astronomy mission in 2019: the EyeSat triple Cubesat](#)

(9 January 2019)

EyeSat is a triple Cubesat-sized nanosatellite designed to study the zodiacal light and image the Milky Way. It has three main objectives:

- Scientific, by observing the zodiacal light in the visible bandwidth, in both polarized and non-polarized modes; and taking a thorough, and global image, of the Milky Way in colour.
- To demonstrate new satellite technologies.
- To train students in space engineering professions.

(Arianespace)

### **ASTROPHYSICS**

[How hot are atoms in the shock wave of an exploding star?](#) (21 January 2019)

A new method to measure the temperature of atoms during the explosive death of a star will help scientists understand the shock wave that occurs as a result of this supernova explosion. AS a result we can now accurately measure the temperatures of elements as heavy as silicon and iron and have shown that they indeed do follow the relationship that the temperature of each element is proportional to the atomic weight of that element. This result settles an important issue in the understanding of astrophysical shock waves and improves our understanding of the shock process. (PennState Eberly College of Science)

### **BLACK HOLES**

[Ricocheting black hole jet discovered by Chandra](#) (9 January 2019)

A ricocheting jet blasting from a giant black hole has been captured by NASA's Chandra X-ray Observatory. Chandra's data reveal the presence of powerful jets of particles and electromagnetic energy that have shot out from the black hole. The jet has slammed into a wall of hot gas, then ricocheted to punch a hole in a cloud of energetic particles, before it collides with another part of the gas wall. (Chandra X-ray Observatory)

[Shredded star leads to important black hole discovery](#) (9 January 2019)

In a galaxy far away, a star wandered too close to a giant black hole and was ripped apart by immense gravitational tidal forces. This catastrophe triggered a burst of light first observed in late 2014. Now astronomers have estimated how quickly that supermassive black hole is spinning, a fundamental trait of these exotic objects that has been hard to pin down. The optical outburst was detected by the All-Sky Automated Survey for Supernovae (ASASSN), a network of telescopes. Astronomers then used other telescopes to study the X-rays emitted as the remains of the star swirl toward the black hole. The combined observations revealed a rise and fall in X-ray brightness that repeats every 131 seconds, which is likely associated with hot gas orbiting very near the point of no return, called the black hole event horizon. The radius of the black hole event horizon depends on the geometry of space-time around a black hole, which depends on the mass of the black hole and how rapidly it is spinning. Spacetime itself rotates for a spinning black hole, and this is what drags material around it. Astronomers can estimate a black hole's mass relatively easily from a relationship between it and the properties of the host galaxy. Getting good estimates of black hole spin, on the other hand, have been notoriously difficult. The fact that we can track this region of bright X-ray emission as it circles the black hole lets us track just how quickly material in the disk is spinning. That gives us information about the spin rate of the supermassive black hole itself. The observations imply that the black hole's event horizon and space-time are spinning rapidly, at about half the speed of light or faster. (Chandra X-ray Observatory)

[Astronomers uncover the brightest lensed quasar in the early universe](#) (9 January 2019)

Astronomers have discovered the brightest gravitationally lensed object ever seen at a time when the universe was less than one billion years old. With the help of multiple world-class telescopes in Hawaii the researchers discovered that the brilliant beacon is a quasar, the core of a galaxy with a black hole ravenously eating material surrounding it. (WM Keck Observatory)

[Birth of a black hole or neutron star captured for the first time](#) (10 January 2019)

A Northwestern University-led international team of astronomers is getting closer to understanding the mysterious bright object that burst in the northern sky this summer, dubbed AT2018cow or 'The Cow.' The multi-institutional team now has evidence that they likely captured the exact moment a star collapsed to form a compact object, such as a black hole or neutron star. The stellar debris, approaching and swirling around the object's event horizon, caused the remarkably bright glow. (W. M. Keck Observatory)

[Lifting the veil on the black hole at the heart of our Galaxy | Max Planck Institute for Radio Astronomy](#) (21 January 2019)

Including the powerful ALMA into an array of telescopes for the first time, astronomers have found that the emission from the supermassive black hole Sagittarius A\* (Sgr A\*) at the centre of our Galaxy comes from a smaller region than previously thought. This may indicate that a radio jet from Sgr A\* is pointed almost directly towards the Earth. (Max Planck Institute for Radio Astronomy)

## **DARK MATTER**

[Dark matter on the move](#) (3 January 2019)

Scientists have found evidence that dark matter can be heated up and moved around, as a result of star formation in galaxies. The findings provide the first observational evidence for the effect known as ‘dark matter heating’ and give new clues as to what makes up dark matter. The team of astrophysicists measured the amount of dark matter at the centres of 16 dwarf galaxies with very different star formation histories. They found that galaxies that stopped forming stars long ago had higher dark matter densities at their centres than those that are still forming stars today. This supports the theory that the older galaxies had less dark matter heating. They found a truly remarkable relationship between the amount of dark matter at the centres of these tiny dwarfs, and the amount of star formation they have experienced over their lives. The dark matter at the centres of the star-forming dwarfs appears to have been ‘heated up’ and pushed out." The findings provide a new constraint on dark matter models: dark matter must be able to form dwarf galaxies that exhibit a range of central densities, and those densities must relate to the amount of star formation. This study may be the “smoking gun” evidence that takes us a step closer to understanding what dark matter is. The finding that it can be heated up and moved around helps to motivate searches for a dark matter particle. The team hope to expand on this work by measuring the central dark matter density in a larger sample of dwarfs, pushing to even fainter galaxies, and testing a wider range of dark matter models. (University of Surrey)

## **EARTH**

[ESA chooses Thales Alenia Space to lead the FLEX mission](#) (10 January 2019)

Thales Alenia Space announced that it has signed a contract with the European Space Agency (ESA) to lead the Fluorescence Explorer (FLEX) satellite mission. FLEX was selected in 2015 as ESA's eighth Earth Explorer mission and is scheduled for launch in 2023. It will make use of an innovative instrument, named FLORIS, to map the Earth's vegetation fluorescence to quantify photosynthetic activity. (Thales Alenia Space)

[Jason-3 to continue high precision measurement of Earth's sea level](#) (17 January 2019)

The most accurate source of measurements of the Earth's rising sea levels, the Jason-3 satellite mission, will continue for at least two more years after the extension of its mission. (Eumetsat)

## **EXOPLANETS**

[TESS discovers its third new planet, with longest orbit yet](#) (7 January 2019)

NASA's Transiting Exoplanet Survey Satellite, TESS, has discovered a third small planet outside our solar system, scientists announced this week at the annual American Astronomical Society meeting in Seattle. The new planet, named HD 21749b, orbits a bright, nearby dwarf star about 53 light years away, in the constellation Reticulum, and appears to have the longest orbital period of the three planets so far identified by TESS. HD 21749b journeys around its star in a relatively leisurely 36 days, compared to the two other planets Pi Mensae b, a “super-Earth” with a 6.3-day orbit, and LHS 3844b, a rocky world that speeds

around its star in just 11 hours. All three planets were discovered in the first three months of TESS observations. The surface of the new planet is likely around 300 degrees Fahrenheit, relatively cool, given its proximity to its star, which is almost as bright as the sun. (MIT)

[Young planets orbiting red dwarfs may lack ingredients for life](#) (8 January 2019)

Rocky planets orbiting red dwarf stars may be bone dry and lifeless, according to a new study using NASA's Hubble Space Telescope. Water and organic compounds, essential for life as we know it, may get blown away before they can reach the surface of young planets. This hypothesis is based on surprising observations of a rapidly eroding dust-and-gas disk encircling the young, nearby red dwarf star AU Microscopii (AU Mic). (STScI)

[Nature's magnifying glass reveals unexpected intermediate mass exoplanets](#) (8 January 2019)

Astronomers have found a new exoplanet that could alter the standing theory of planet formation. With a mass that's between that of Neptune and Saturn, and its location beyond the "snow line" of its host star, an alien world of this scale was supposed to be rare. (WM Keck Observatory)

## **FAST RADIO BURSTS**

[CHIME telescope detects second repeating fast radio burst](#) (9 January 2019)

A Canadian-led team of scientists has found the second repeating fast radio burst (FRB) ever recorded. FRBs are short bursts of radio waves coming from far outside our Milky Way galaxy. Scientists believe FRBs emanate from powerful astrophysical phenomena billions of light years away. The discovery of the extragalactic signal is among the first, eagerly awaited results from the Canadian Hydrogen Intensity Mapping Experiment (CHIME), a revolutionary radio telescope inaugurated in late 2017 by a collaboration of scientists. In a resounding endorsement of the novel telescope's capabilities, the repeating FRB was one of 13 bursts detected over a period of just three weeks during the summer of 2018, while CHIME was in its pre-commissioning phase and running at only a fraction of its full capacity. Additional bursts from the repeating FRB were detected in following weeks by the telescope. (McGill University)

[Magnetar mysteries in our galaxy and beyond](#) (9 January 2019)

In a new Caltech-led study, researchers from campus and the Jet Propulsion Laboratory (JPL) have analyzed pulses of radio waves coming from a magnetar, a rotating, dense, dead star with a strong magnetic field, that is located near the supermassive black hole at the heart of the Milky Way galaxy. The new research provides clues that magnetars like this one, lying in close proximity to a black hole, could perhaps be linked to the source of "fast radio bursts," or FRBs. FRBs are high-energy blasts that originate beyond our galaxy but whose exact nature is unknown. (Caltech)

## **GALAXIES**

['Missing' galactic mergers come to light with new technique](#) (8 January 2019)

Galaxy mergers, in which two galaxies join together over billions of years in sometimes

dramatic bursts of light, aren't always easy for astronomers to spot. Now, scientists from CU Boulder have developed a new technique for finding these cosmic couplings. A team led by Rebecca Nevin designed a computer program that scans through surveys of galaxies to look for a wide range of signs that a merger might be happening. That includes the shape of the resulting galaxies and how the stars inside are moving. The method could help scientists to identify hundreds or thousands more merging galaxies. That's important because such mergers may be an important step in the building of huge, spiral galaxies like the Milky Way and in kicking off the formation of new stars. (University of Colorado Boulder)

[Active galaxies point to new physics of cosmic expansion](#) (28 January 2019)

In the earlier phases that we can only probe with quasars, we find a discrepancy between the observed evolution of the Universe and what we would predict based on the standard cosmological model. Looking into this previously poorly explored period of cosmic history with the help of quasars, the astronomers have revealed a possible tension in the standard model of cosmology, which might require the addition of extra parameters to reconcile the data with theory. One of the possible solutions would be to invoke an evolving dark energy, with a density that increases as time goes by. This particular model would also alleviate another tension that has kept cosmologists busy lately, concerning the Hubble constant, the current rate of cosmic expansion. This discrepancy was found between estimates of the Hubble constant in the local Universe, based on supernova data and, independently, on galaxy clusters and those based on Planck's observations of the cosmic microwave background in the early Universe. This model is quite interesting because it might solve two puzzles at once, but the jury is definitely not out yet and we'll have to look at many more models in great detail before we can solve this cosmic conundrum. (ESA)

## **JUPITER AND MOONS**

[Juno mission captures images of volcanic plumes on Jupiter's moon Io](#) (31 December 2018)

The latest images can lead to new insights into the gas giant's interactions with its five moons, causing phenomena such as Io's volcanic activity or freezing of the moon's atmosphere during eclipse. JIRAM recently documented Io's volcanic activity before and after eclipse. Io's volcanoes were discovered by NASA's Voyager spacecraft in 1979. Io's gravitational interaction with Jupiter drives the moon's volcanoes, which emit umbrella-like plumes of SO<sub>2</sub> gas and produce extensive basaltic lava fields. (SwRI)

## **KUIPER BELT OBJECTS**

[New Horizons mission reveals entirely new kind of world](#) (2 January 2019)

Scientists from NASA's New Horizons mission released the first detailed images of the most distant object ever explored — the Kuiper Belt object nicknamed Ultima Thule. Its remarkable appearance, unlike anything we've seen before, illuminates the processes that built the planets four and a half billion years ago. (JHU APL)

[Missing-link in planet evolution found](#) (29 January 2019)

For the first time ever, astronomers have detected a 1.3 km radius body at the edge of the

Solar System. Kilometre sized bodies like the one discovered have been predicted to exist for more than 70 years. These objects acted as an important step in the planet formation process between small initial amalgamations of dust and ice and the planets we see today. The Edgeworth-Kuiper Belt is a collection of small celestial bodies located beyond Neptune's orbit. The most famous Edgeworth-Kuiper Belt Object is Pluto. Edgeworth-Kuiper Belt Objects are believed to be remnants left over from the formation of the Solar System. While small bodies like asteroids in the inner Solar System have been altered by solar radiation, collisions, and the gravity of the planets over time; objects in the cold, dark, lonely Edgeworth-Kuiper Belt preserve the pristine conditions of the early Solar System. Astronomers study them to learn about the beginning of the planet formation process. Edgeworth-Kuiper Belt Objects with radii from 1 kilometre to several kilometres have been predicted to exist, but they are too distant, small, and dim for even world-leading telescopes, like the Subaru Telescope, to observe directly. So, a research team at the National Astronomical Observatory of Japan used a technique known as occultation: monitoring a large number of stars and watching for the shadow of an object passing in front of one of the stars. The OASES (Organized Autotelescopes for Serendipitous Event Survey) team placed two small (28 cm) telescopes on the roof of the Miyako open-air school on Miyako Island, Miyakojima-shi, Okinawa Prefecture, Japan, and monitored approximately 2000 stars for a total of 60 hours. Analysing the data, the team found an event consistent with a star appearing to dim as it is occulted by a 1.3 km radius Edgeworth-Kuiper Belt Object. This detection indicates that kilometre sized Edgeworth-Kuiper Belt Objects are more numerous than previously thought. This supports models where planetesimals first grow slowly into kilometre sized objects before runaway growth causes them to merge into planets. (NAOJ)

## **MARS**

[French SEIS seismometer up and running on Mars](#) (9 January 2019)

For the first time in the history of space exploration, a seismometer is now operating on Mars. SEIS (Seismic Experiment for Interior Structure), for which France has engineering responsibility and is the instrument principal investigator, was deployed on the surface of the red planet by the InSight lander on 19 December 2018. It was tested out on 1 January and is working well. This is a historic moment and a great hope for geophysics. The two U.S. Viking 1 and Viking 2 missions launched by NASA in 1975 were each carrying a seismometer. One failed to function, while the other, fixed to the deck of the lander, was unable to measure Mars' seismic activity as it was too sensitive to the background noise generated by winds. SEIS is thus the first instrument of its kind to be placed on the surface of the red planet. (CNES)

[ExoMars software passes ESA Mars Yard driving test](#) (17 January 2019)

Navigation software destined for the ExoMars 2020 mission to the Red Planet has passed a rover-based driving test at ESA's 'Mars Yard'. ESA's ExoMars rover will drive to multiple locations and drill down to two metres below the surface of Mars in search of clues for past life preserved underground. (ESA)

[Rover team beaming new commands to Opportunity on Mars](#) (25 January 2019)

Engineers at NASA's Jet Propulsion Laboratory in Pasadena, California, have begun

transmitting a new set of commands to the Opportunity rover in an attempt to compel the 15-year-old Martian explorer to contact Earth. The rover's last communication with Earth was received June 10, 2018, as a planet-wide dust storm blanketed the solar-powered rover's location on Mars. The new transmission strategies are expected to go on for several weeks. They address three possible scenarios: that the rover's primary X-band radio which Opportunity uses to communicate with Earth has failed; that both its primary and secondary X-band radios have failed; or that the rover's internal clock, which provides a timeframe for its computer brain, is offset. A series of unlikely events would need to have transpired for any one of these faults to occur. The potential remedies being beamed up to address these unlikely events include a command for the rover to switch to its backup X-band radio and commands directed to reset the clock and respond via UHF. (JPL)

## MISCELLANEOUS

### [World's largest digital sky survey issues biggest astronomical data release ever](#)

(28 January 2019)

Data from the world's largest digital sky survey is being publicly released today by the Space Telescope Science Institute (STScI) in Baltimore, Maryland, in conjunction with the University of Hawai'i Institute for Astronomy in Honolulu, Hawaii. Data from the Pan-STARRS1 Surveys will allow anyone to access millions of images and use the database and catalogues containing precision measurements of billions of stars and galaxies. This data release contains over 1.6 petabytes of data (a petabyte is one million gigabytes), making it the largest volume of astronomical information ever released. The survey data resides in the Mikulski Archive for Space Telescopes (MAST), which serves as NASA's repository for all its optical and ultraviolet-light observations. (STScI)

## MOON

### [NASA's Moon data sheds light on Earth's asteroid impact history](#) (17 January 2019)

The rate of large crater formation on the Moon has been two to three times higher over approximately the last 290 million years than it had been over the previous 700 million years. The reason for this jump in the impact rate is unknown. It might be related to large collisions taking place more than 300 million years ago in the main asteroid belt between the orbits of Mars and Jupiter. Such events can create debris that can reach the inner solar system. The next surprise came from comparing the ages of large craters on the Moon to those on Earth. Their similar number and ages challenges the theory that Earth had lost so many craters through erosion that an impact rate could not be calculated. The Earth has fewer older craters on its most stable regions not because of erosion, but because the impact rate was lower about 290 million years ago. (NASA Goddard)

### [Earth's oldest rock found on the Moon](#) (24 January 2019)

An international team of scientists associated with the Centre for Lunar Science and Exploration (CLSE), part of NASA's Solar System Exploration Research Virtual Institute, found evidence that the rock was launched from Earth by a large impacting asteroid or comet. This impact jettisoned material through Earth's primitive atmosphere, into space, where it

collided with the surface of the Moon (which was three times closer to Earth than it is now) about 4 billion years ago. The rock was subsequently mixed with other lunar surface materials into one sample (USRA)

#### [NASA research could reshape understanding of Moon formation](#) (31 January 2019)

New NASA research combining experimental studies with analyses of samples collected nearly 50 years ago during Apollo provides compelling evidence that the Moon formed from the same materials as Earth in the aftermath of a giant impact between the young Earth and a Mars-sized impactor. By simulating the main processes contributing to the Moon's formation and early differentiation, they were able to predict the level of each element that should be present in the Moon's mantle. The results show that the other five elements - the most volatile of the 14 zinc, tin, cadmium, indium, and thulium – have systematically and significantly lower concentrations than the model predictions. Righter proposes that these five elements may be in such low concentrations in the lunar mantle because they never re-condensed after the giant impact. He suggests that they stayed in a gas phase that was subsequently separated from the material that ultimately formed the Moon. (NASA)

### **SATURN AND MOONS**

#### [Cassini data show Saturn's rings relatively new](#) (17 January 2019)

The rings of Saturn may be iconic, but there was a time when the majestic gas giant existed without its distinctive halo. In fact, the rings may have formed much later than the planet itself, according to a new analysis of gravity science data from NASA's Cassini spacecraft. The findings indicate that Saturn's rings formed between 10 million and 100 million years ago. From our planet's perspective, that means Saturn's rings may have formed during the age of dinosaurs. (JPL)

#### [Evidence of changing seasons, rain on Titan's north pole](#) (16 January 2019)

An image from the international Cassini spacecraft provides evidence of rainfall on the north pole of Titan, the largest of Saturn's moons. The rainfall would be the first indication of the start of a summer season in the moon's northern hemisphere. (AGU)

### **SOLAR SYSTEM**

#### [Mystery orbits in outermost reaches of solar system not caused by 'Planet Nine'](#)

(21 January 2019)

The strange orbits of some objects in the farthest reaches of our solar system, hypothesised by some astronomers to be shaped by an unknown ninth planet, can instead be explained by the combined gravitational force of small objects orbiting the Sun beyond Neptune (University of Cambridge)

### **SPACE**

#### [New Shepard successfully flies 8 NASA research & technology payloads to space](#)

(23 January 2019)

Blue Origin demonstrated the versatility of the New Shepard system by taking 8 NASA-sponsored research and technology payloads into space. This flight was dedicated to NASA's Flight Opportunities program, an essential program for researchers providing access to microgravity for technology development. New Shepard's reusability is lowering launch costs and creating routine access to space. Lowering the cost of microgravity research increases the opportunities for universities, government researchers and entrepreneurs to test payloads and technologies in space. The launch was the 10th successful mission for the New Shepard program and the 4th flight for this vehicle. (Blue Origin)

## STARS AND STAR CLUSTERS

[ALMA discover early protostar with a warped disk](#) (31 December 2018)

Using the Atacama Large Millimeter/submillimeter Array (ALMA) in Chile, researchers have observed, for the first time, a warped disk around an infant protostar that formed just several tens of thousands of years ago. This implies that the misalignment of planetary orbits in many planetary systems, including our own, may be caused by distortions in the planet-forming disk early in their existence. The planets in the Solar System orbit the Sun in planes that are at most about seven degrees offset from the equator of the Sun itself. It has been known for some time that many extrasolar systems have planets that are not lined up in a single plane or with the equator of the star. One explanation for this is that some of the planets might have been affected by collisions with other objects in the system or by stars passing by the system, ejecting them from the initial plane. However, the possibility remained that the formation of planets out of the normal plane was actually caused by a warping of the star-forming cloud out of which the planets were born. Recently, images of protoplanetary disks, rotating disks where planets form around a star, have in fact showed such warping. But it was still unclear how early this happened. (ALMA)

[Ultracold simulators of super-dense stars](#) (3 January 2019)

Rice University physicists have created the world's first laser-cooled neutral plasma, completing a 20-year quest that sets the stage for simulators that re-create exotic states of matter found inside Jupiter and white dwarf stars. (Rice University)

[Gaia reveals how Sun-like stars turn solid after their demise](#) (9 January 2019)

Data captured by ESA's galaxy-mapping spacecraft Gaia has revealed for the first time how white dwarfs, the dead remnants of stars like our Sun, turn into solid spheres as the hot gas inside them cools down. This process of solidification, or crystallisation, of the material inside white dwarfs was predicted 50 years ago but it wasn't until the arrival of Gaia that astronomers were able to observe enough of these objects with such a precision to see the pattern revealing this process. (ESA)

[What 100,000 star factories in 74 galaxies tell us about star formation across the universe](#) (9 January 2019)

Galaxies come in a wide variety of shapes and sizes. Some of the most significant differences among galaxies, however, relate to where and how they form new stars. The Atacama Large Millimeter/submillimeter Array (ALMA) is conducting an unprecedented survey of nearby

disk galaxies to study their stellar nurseries. With it, astronomers are beginning to unravel the complex and as-yet poorly understood relationship between star-forming clouds and their host galaxies. A vast, new research project with ALMA, known as PHANGS-ALMA (Physics at High Angular Resolution in Nearby GalaxieS), delves into this question with far greater power and precision than ever before by measuring the demographics and characteristics of a staggering 100,000 individual stellar nurseries spread throughout 74 galaxies. (NRAO)

#### [Double star system flips planet-forming disk into pole position](#) (14 January 2019)

New research has found the first confirmed example of a double star system that has flipped its surrounding disc to a position that leaps over the orbital plane of those stars. The international team of astronomers used the Atacama Large Millimeter/sub-millimetre Array (ALMA) to obtain high-resolution images of the Asteroid belt-sized disc. The overall system presents the unusual sight of a thick hoop of gas and dust circling at right angles to the binary star orbit. Until now this setup only existed in theorists' minds, but the ALMA observation proves that polar discs of this type exist and may even be relatively common. (Harvard & Smithsonian Centre for Astrophysics)

## TECHNOLOGY

#### [Scientists team up with industry to mass-produce detectors for next-gen cosmic experiment](#) (17 January 2019)

Chasing clues about the infant universe in relic light known as the cosmic microwave background, or CMB, scientists are devising more elaborate and ultrasensitive detector arrays to measure the properties of this light with increasing precision. To meet the high demand for these detectors that will drive next-generation CMB experiments, and for similar detectors to serve other scientific needs, researchers at the Department of Energy's Lawrence Berkeley National Laboratory (Berkeley Lab) are pushing to commercialize the manufacturing process so that these detectors can be mass-produced quickly and affordably. (Berkeley Lab)

#### [Signal And Data Transport Consortium concludes SKA design work](#) (25 January 2019)

The international Signal and Data Transport (SaDT) engineering consortium has concluded its work to design the complex system of networking that forms the backbone of the SKA. The detailed design of this vital element has been led by the Jodrell Bank Centre for Astrophysics (JBCA) group at University of Manchester (UoM) in the UK, as part of a consortium that brought together 15 different organisations spread across eight countries. They faced the challenge of designing a system that will be required to transport unprecedented amounts of data over vast distances, while ensuring that signals are synchronised in a way that enables the arrays to operate together like a single telescope, a huge challenge given the large number of antennas spread over hundreds of kilometres. During four and a half years of collaboration, consortium members were responsible for the design of two data transport networks: the first being the Digital Data Backhaul (DDBH) that transports signals from the radio telescopes to the Central Signal Processor (CSP) on site, where the initial processing takes place, known as beamforming and correlation. The second network transfers data products from the CSP to the Science Data Processor (SDP), located hundreds of kilometres away. There the data for actual science will be processed before being

distributed to the SKA Regional Centres around the world. The data rates involved are huge, in total equivalent to about a third of the world's internet traffic. In addition, SaDT also designed a network that connects all the telescopes locations and transports the telescopes' monitoring and control information, together with the general communications traffic. The consortium's work also included the design of clocks and a custom-made frequency distribution system. (SKA Organisation)

### [The Netherlands will partner to build the largest radio telescope in the world](#)

(28 January 2019)

Construction of the SKA will move forward over the next few years. On 12 March 2019 the international partners, now including the Netherlands, will sign a treaty agreement in Rome. The 30 million Euros allocated by the Dutch Ministry of Education, Culture and Science is the basis for Dutch participation to realise the SKA. The SKA is expected to give an enormous boost to the broad astronomical research portfolio: it will allow astronomers to perform extreme tests of Albert Einstein's general theory of relativity, research the early phases of the Universe including the formation of the first stars and galaxies, map magnetic fields, unravel the nature of the enigmatic fast radio bursts, study of planets around nearby stars, and seek the answer to one of the greatest mysteries for humankind: are we alone in the Universe? The SKA will be a truly transformational instrument, able to directly image pristine hydrogen gas in the infant Universe. This gas shaped nearly everything that we see around us today. Discovering and charting hydrogen will fill a large gap in our knowledge just after Cosmic Microwave Background Radiation was emitted. (ASTRON)

### [Significant progress made to upgrades that boost NASA's space communications capabilities](#)

(29 January 2019)

NASA's Space Network (SN), a constellation of Tracking and Data Relay Satellites (TDRS) and ground-based antennas forges critical links between Earth and space, making exploration and discovery possible. The SN's ground stations at the White Sands Complex in Las Cruces, New Mexico, are undergoing modifications which will make these links faster and simpler. The Space Network Ground Segment Sustainment (SGSS) project is managing upgrades to SN ground stations which will increase data rates and volumes, improve data quality and user coverage, reduce maintenance requirements and extend the system's longevity. All of this means greater potential for science missions. On Earth, photo and video technology constantly advance to take higher resolution imagery, which then require higher data rates to send and stream that content. Similarly, missions are gathering more data and NASA communications systems must keep up. For example, the Hubble Space Telescope captures 844 gigabytes of science data per month (that's 13 times the storage space on a 64-gigabyte iPhone). Hubble relies on the SN and its ground stations to get that data to Earth. Enhancements through the sustainment project could quadruple the rate of data that could be transmitted to Earth on a future, similar mission. (NASA Goddard)

## **VENUS**

### [Giant pattern discovered in the clouds of planet Venus](#) (10 January 2019)

A Japanese research group has identified a giant streak structure among the clouds covering planet Venus based on observation from the spacecraft Akatsuki. The team also revealed the

origins of this structure using large-scale climate simulations. This study revealed the giant streak structure on the planetary scale in the lower cloud levels of Venus, replicated this structure with simulations, and suggested that this streak structure is formed from two types of atmospheric fluctuations (waves), baroclinic instability and jet streams. The successful simulation of the planetary-scale streak structure formed from multiple atmospheric phenomena is evidence for the accuracy of the simulations for individual phenomena calculated in this process. (JAXA)

*Pat Williams January 2019*