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Astronomy & Physics Weekly News

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Top News

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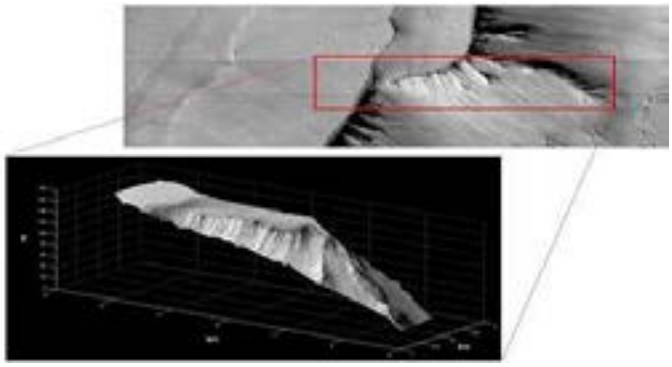
First views of Mars show potential for ESA's new orbiter



The first stereo reconstruction of a small area in a region called Noctis Labyrinthus. The image gives an altitude map of the region with a resolution of less than 20 m. The images used to make the 3D profile were taken on 22 November 2016 and are among the first to be acquired by the Colour and Stereo Surface Imaging System (CaSSIS) on the ExoMars Trace Gas Orbiter. The images were taken as part of an eight-day campaign to test the science instruments for the first time since arriving at the Red Planet on 19 October. Image courtesy ESA/Roscosmos/ExoMars/CaSSIS/UniBE.

ESA's new ExoMars orbiter has tested its suite of instruments in orbit for the first time, hinting at a great potential for future observations. The Trace Gas Orbiter, or TGO, a joint endeavour between ESA and Roscosmos, arrived at Mars on 19 October. Its elliptical orbit takes it from 230-310 km above the surface to around 98 000 km every 4.2 days.

It spent the last two orbits during 20-28 November testing its four science instruments for the first time since arrival, and making important calibration measurements.

Data from the first orbit has been made available for this release to illustrate the range of observations to be expected once the craft arrives into its near-circular 400 km-altitude orbit late next year.

TGO's main goal is to make a detailed inventory of rare gases that make up less than 1% of the atmosphere's volume, including methane, water vapour, nitrogen dioxide and acetylene.

Of high interest is methane, which on Earth is produced primarily by biological activity, and to a smaller extent by geological processes such as some hydrothermal reactions.

The two instruments tasked with this role have now demonstrated they can take highly sensitive spectra of the atmosphere. During the test observations last week, the Atmospheric Chemistry Suite focused on carbon dioxide, which makes up a large volume of the planet's atmosphere, while the Nadir and Occultation for Mars Discovery instrument homed in on water. They also coordinated observations with ESA's Mars Express and NASA's Mars Reconnaissance Orbiter, as they will in the future. ...Read More...

Quantum physics offers new way to factor numbers

Credit: CC0 Public Domain

Any number can, in theory, be written as the product of prime numbers. For small numbers, this is easy (for example, the prime factors of 12 are 2, 2, and 3), but for large numbers, prime factorization becomes extremely difficult—so difficult that many of today's cryptography algorithms rely on the complexity of the prime factorization of numbers with hundreds of digits to keep private information secure.

However, no one is exactly sure of just how difficult it is to decompose very large numbers into their prime factors. This question, called the factorization problem, is one of the biggest unsolved problems in computer science, despite the use of advanced mathematical and computer science strategies in attempts to solve it.

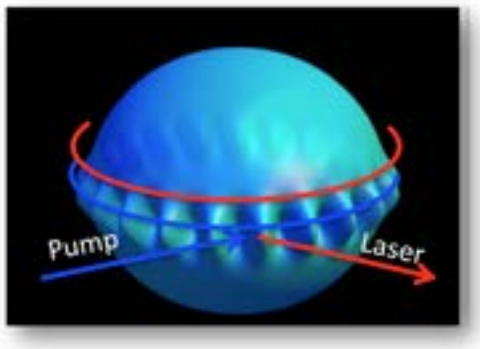
Now in a new study published in Physical Review Letters, researchers Jose Luis Rosales and Vicente Martin at the Technical University of Madrid have taken a different approach to the problem.

The researchers have shown that the arithmetic used in factoring numbers into their prime factors can be translated into the physics of a device—a "quantum simulator"—that physically mimics the arithmetic rather than trying to directly calculate a solution like a computer does.

Although the researchers have not yet built a quantum simulator, they show that the prime factors of large numbers would correspond to the energy values of the simulator. Measuring the energy values would then give the solutions to a given factoring problem, suggesting that factoring large numbers into primes may not be as difficult as currently thought.

"The work opens a new avenue to factor numbers, but we do not yet know about its power," Rosales told Phys.org. "It is very striking to find a completely new way to factor that comes directly from quantum physics. It does not demonstrate that factoring numbers is easy, but finding new ways to factor certainly does not add to the strength of algorithms based on its assumed complexity." For now, the researchers do not know the technical complexity of building such a device, or whether it would even be possible to factor very large numbers. ...Read More...

First 'water-wave' laser created



Artistic illustration of "Water-Wave" Laser. Credit: Technion Spokesperson's Office

Technion researchers have demonstrated, for the first time, that laser emissions can be created through the interaction of light and water waves. This "water-wave laser" could someday be used in tiny sensors that combine light waves, sound and water waves, or as a feature on microfluidic "lab-on-a-chip" devices used to study cell biology and to test new drug therapies.

For now, the water-wave laser offers a "playground" for scientists studying the interaction of light and fluid at a scale smaller than the width of a human hair, the researchers write in the new report, published last week in Nature Photonics.

The study was conducted by Technion-Israel Institute of Technology students Shmuel Kaminski, Leopoldo Martin, and Shai Maayani, under the supervision of Professor Tal Carmon, head of the Optomechanics Center at the Mechanical Engineering Faculty at Technion. Carmon said the study is the first bridge between two areas of research that were previously considered unrelated to one another: nonlinear optics and water waves.

A typical laser can be created when the electrons in atoms become "excited" by energy absorbed from an outside source, causing them to emit radiation in the form of laser light. Professor Carmon and his colleagues now show for the first time that water wave oscillations within a liquid device can also generate laser radiation.

The possibility of creating a laser through the interaction of light with water waves has not been examined, Carmon said, mainly due to the huge difference between the low frequency of water waves on the surface of a liquid (approximately 1,000 oscillations per second) and the high frequency of light wave oscillations (1014 oscillations per second). This frequency difference reduces the efficiency of the energy transfer between light and water waves, which is needed to produce the laser emission.

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Researchers make one-way street for light

Credit: Suus van den Akker

Researchers at FOM institute AMOLF and the University of Texas at Austin have created a compact one-way street for light. That is remarkable because light waves can generally move in both directions inside a material. Optical chips could benefit from the new functionality, as it enables a new way to route data encoded in the light signals.

The researchers published their results in Nature Communications on 29 November.

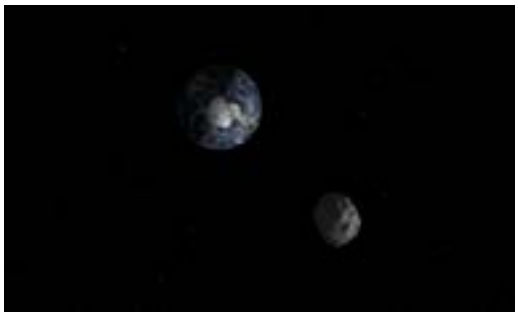
How does it work?

Although the effect is not usually noticeable, light that hits an object exerts a small force, slightly 'pushing' the object it illuminates. In some cases, light can even cause a small object to move. The researchers used this fact to produce a one-way street for light. They achieved this by temporarily trapping light that passes through an optical fibre in a perfectly formed ring with a diameter smaller than that of a human hair. In such a ring, light can easily circulate 100,000 times, which considerably strengthens the force it exerts on the walls. As a result, the ring expands slightly. The researchers subsequently introduced a second light wave with a slightly different colour than the first. Due to the interference of both light waves, the ring vibrates, but only if the two waves move through the ring in the same direction. As the system has been designed in such a way that the optical fibre only allows light to pass through if the ring vibrates, light from the opposite direction is blocked.

Application

The demonstrated principles could be very important for ensuring that light moves in the right direction in optical chips. Present-day data is already largely transported in the form of light. The processing of information in optical circuits on chips has major advantages compared to electronic alternatives, especially as light uses far less energy. However, a missing component on these optical chips to date has been an optical isolator: a component that allows waves to pass through in one direction, but blocks waves in the other direction, ...Read More...

Smallest known asteroid characterized using Earth-based telescopes



Small near-Earth asteroids are important targets of study because not much is known about them. By characterizing the smallest of the bunch, scientists can better understand the population of objects from which they originate: large asteroids, which have a much smaller likelihood of impacting Earth. Credit: NASA/JPL-Caltech

Astronomers have obtained observations of the smallest asteroid ever characterized in detail. At 2 meters (6 feet) in diameter, the tiny space rock is small enough to be straddled by a person in a hypothetical space-themed sequel to the iconic bomb-riding scene in the movie "Dr. Strangelove."

Interestingly, the asteroid, named 2015 TC25, is also one of the brightest near-Earth asteroids ever discovered. Using data from four different telescopes, a team of astronomers led by Vishnu Reddy, an assistant professor at the University of Arizona's Lunar and Planetary Laboratory, reports that 2015 TC25 reflects about 60 percent of the sunlight that falls on it.

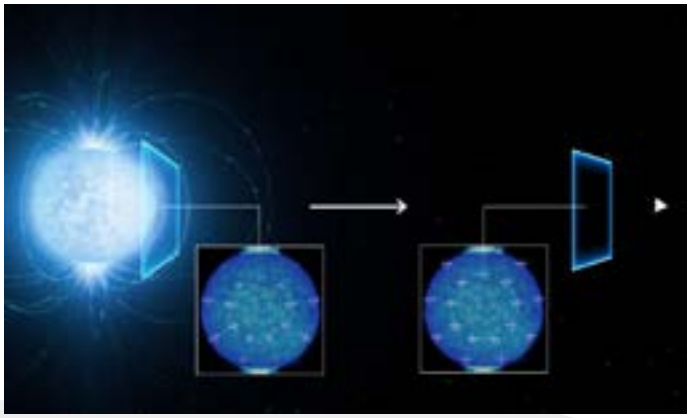
Discovered by the UA's Catalina Sky Survey last October, 2015 TC25 was studied extensively by Earth-based telescopes during a close flyby that saw the micro world sailing past Earth at 128,000 kilometers, a mere third of the distance to the moon.

In a paper published in The Astronomical Journal, Reddy argues that new observations from the NASA Infrared Telescope Facility and Arecibo Planetary Radar show that the surface of 2015 TC25 is similar to a rare type of highly reflective meteorite called an aubrite. Aubrites consist of very bright minerals, mostly silicates, that formed in an oxygen-free, basaltic environment at very high temperatures. Only one out of every 1,000 meteorites that fall on Earth belong to this class.

"This is the first time we have optical, infrared and radar data on such a small asteroid, which is essentially a meteoroid," Reddy said. "You can think of it as a meteorite floating in space that hasn't hit the atmosphere and made it to the ground—yet."

Small near-Earth asteroids such as 2015 TC25 are in the same size range as meteorites that fall on Earth. Astronomers discover them frequently, but not very much is known about them as they are difficult to characterize. By studying such objects in more detail, astronomers hope to better understand the parent bodies from which these meteorites originate. ...Read More...

First signs of weird quantum property of empty space?



This artist's view shows how the light coming from the surface of a strongly magnetic neutron star (left) becomes linearly polarised as it travels through the vacuum of space close to the star on its way to the observer on Earth (right). The polarisation of the observed light in the extremely strong magnetic field suggests that the empty space around the neutron star is subject to a quantum effect known as vacuum birefringence, a prediction of quantum electrodynamics (QED). This effect was predicted in the 1930s but has not been observed before. The magnetic and electric field directions of the light rays are shown by the red and blue lines. Model simulations by Roberto Taverna (University of Padua, Italy) and Denis Gonzalez Caniulef (UCL/MSSL, UK) show how these align along a preferred direction as the light passes through the region around the neutron star. As they become aligned the light becomes polarised, and this polarisation can be detected by sensitive instruments on Earth. Credit: ESO/L. Calçada

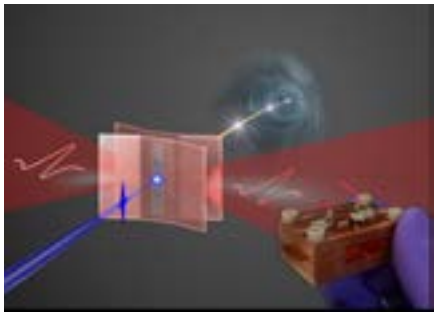
By studying the light emitted from an extraordinarily dense and strongly magnetized neutron star using ESO's Very Large Telescope, astronomers may have found the first observational indications of a strange quantum effect, first predicted in the 1930s. The polarization of the observed light suggests that the empty space around the neutron star is subject to a quantum effect known as vacuum birefringence.

A team led by Roberto Mignani from INAF Milan (Italy) and from the University of Zielona Gora (Poland), used ESO's Very Large Telescope (VLT) at the Paranal Observatory in Chile to observe the neutron star RX J1856.5-3754, about 400 light-years from Earth.

Despite being amongst the closest neutron stars, its extreme dimness meant the astronomers could only observe the star with visible light using the FORS2 instrument on the VLT, at the limits of current telescope technology.

Neutron stars are the very dense remnant cores of massive stars—at least 10 times more massive than our Sun—that have exploded as supernovae at the ends of their lives. They also have extreme magnetic fields, billions of times stronger than that of the Sun, that permeate their outer surface and surroundings. ...Read More...

Scientists shrink electron gun to matchbox size



A miniature electron gun driven by Terahertz radiation: An ultraviolet pulse (blue) back-illuminates the gun photocathode, producing a high density electron bunch inside the gun. The bunch is immediately accelerated by ultra-intense single cycle Terahertz pulses to energies approaching one kilo-electronvolt (keV). These high-field optically-driven electron guns can be utilized for ultrafast electron diffraction or injected into the accelerators for X-ray light sources. Image courtesy W. Ronny Huang, CFEL/DESY/MIT.

In a multi-national effort, an interdisciplinary team of researchers from DESY and the Massachusetts Institute of Technology (MIT) has built a new kind of electron gun that is just about the size of a matchbox. Electron guns are used in science to generate high-quality beams of electrons for the investigation of various materials, from biomolecules to superconductors.

They are also the electron source for linear particle accelerators driving X-ray free-electron lasers. The team of DESY scientist Franz Kartner, who is also a professor at University of Hamburg and continues to run a research group at MIT, where he taught till 2010 before coming to Hamburg, presents its new electron gun in the scientific journal Optica.

The new device uses laser generated terahertz radiation instead of the usual radio-frequency fields to accelerate electrons from rest. As the wavelength of the terahertz radiation is much shorter than radio-frequency radiation, the device can shrink substantially. While state-of-the-art electron guns can have the size of a car, the new device measures just 34 by 24.5 by 16.8 millimetres.

"Electron guns driven by terahertz radiation are miniature and efficient," explains main author Dr. W. Ronny Huang from MIT, who carried out this work at the Center for Free-Electron Laser Science CFEL in Hamburg, a cooperation of DESY, the University of Hamburg and the German Max Planck Society.

"Also, the materials used to guide the radiation are susceptible to much higher fields at terahertz wavelengths as compared to radio frequency wavelengths, allowing terahertz radiation to give a much stronger 'kick' to the electrons. This has the effect of making the electron beams much brighter and shorter." Ultrashort electron beams with narrow energy spread, high charge and ..Read More...

'Tennessine': Element 117 officially named

The new element tennessine is denoted by the symbol Ts on the Periodic Table. Credit: ORNL

The recently discovered element 117 has been officially named "tennessine" in recognition of Tennessee's contributions to its discovery, including the efforts of the Department of Energy's Oak Ridge National Laboratory and its Tennessee collaborators at Vanderbilt University and the University of Tennessee.

"The presence of tennessine on the Periodic Table is an affirmation of our state's standing in the international scientific community, including the facilities ORNL provides to that community as well as the knowledge and expertise of the laboratory's scientists and technicians," ORNL Director Thom Mason said.

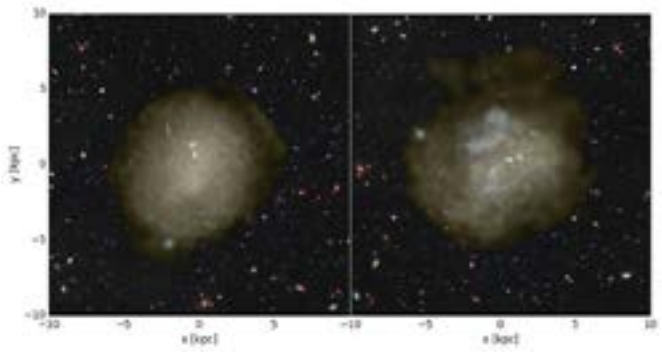
"The historic discovery of tennessine is emblematic of the contributions Tennessee institutions like Oak Ridge National Laboratory, the University of Tennessee and Vanderbilt University make toward a better world," Tennessee Gov. Bill Haslam said. "On behalf of all Tennesseans we thank this world body for honoring our state this way."

The International Union of Pure and Applied Chemistry (IUPAC)—which validates the existence of newly discovered elements and approves their official names—gave its final approval to the name "tennessine" following a yearlong process that began Dec. 30, 2015, when IUPAC and the International Union of Pure and Applied Physics announced verification of the existence of the superheavy element 117, more than five years after scientists first reported its discovery in April 2010.

ORNL had several roles in the discovery, the most prominent being production of the radioisotope berkelium-249 for the search. The berkelium-249 used in the initial discovery and subsequent confirmatory experiments for element 117 was produced by ORNL and the Department of Energy's Isotope Program, and was provided as a U.S. contribution to those experiments.

Superheavy elements, which do not occur naturally, are synthesized by exposing a radioisotope target to a beam of another specific isotope. In theory, the nuclei will in rare cases combine into a "superheavy" ...Read More...

Mystery of ultra-diffuse faint galaxies solved



A visualization of the stellar distribution in simulated ultra-diffuse galaxies. The galaxies are just as faint as dwarf galaxies, but are distributed over an area just as large as the Milky Way. New research shows that if there are a lot of supernovae during the star formation process, it can result in the stars and the dark matter in the galaxy to be pushed outwards, causing the extent of the galaxy to expand. The fact that the galaxy is spread over a larger area means that it becomes more diffuse and hard to observe with telescopes. The picture shows two simulated Ultra-Diffuse galaxies, over imposed on a Hubble Space Telescope image of background galaxies. Credit: Arianna Di Cintio, Chris Brook, NIHAO simulations and HST

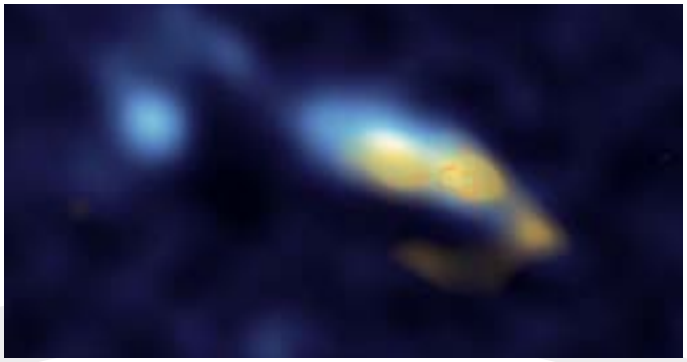
Over the last year, researchers have observed some very faint, diffuse galaxies. The galaxies are as faint as dwarf galaxies, but are distributed over an area just as large as the Milky Way.

It has been a mystery, how galaxies so faint - containing up to 1000 times fewer stars than the Milky Way could still be just as large. Now new research from the Niels Bohr Institute shows that if a lot of supernovae explode during the star formation process, it can result in both the stars and the dark matter being pushed outwards, causing the galaxy to expand. The results are published in the scientific journal, Monthly Notices of the Royal Astronomical Society, Oxford University Press.

Galaxies are gigantic collections of stars, gas and so-called dark matter. The smallest galaxies contain a few million stars, while the largest may contain several hundred billion stars. The first stars already emerged in the very early universe about 200 million years after the Big Bang, formed from the gases hydrogen and helium. These giant clouds of gas and dust contract and eventually the gas is so compact that that the pressure heats up the material, creating glowing balls of gas and new stars are born. The stars are collected into galaxies, the first of which were baby galaxies of a sort.

The theory of the astronomers is that the baby galaxies gradually grew larger and more massive by constantly forming new stars and by colliding with neighbouring galaxies to form new, larger galaxies. The largest galaxies in our current universe have thus been under constant formation throughout the history of the universe. ..Read More...

New observations confirm long-standing theory that stars are copious producers of heavy elements



In the galaxy II Zw 40, dust (shown in yellow) is strongly associated with clusters of stars (shown in orange). UCLA researchers have used new observations of this galaxy to confirm that these stars are creating enormous amounts of dust. Credit: S. M. Consiglio et al., Astrophysical Journal Letters, 2016

Galaxies are often thought of as sparkling with stars, but they also contain gas and dust. Now, a team led by UCLA astronomers has used new data to show that stars are responsible for producing dust on galactic scales, a finding consistent with long-standing theory. Dust is important because it is a key component of rocky planets such as Earth.

This research is published online today in the Astrophysical Journal Letters.

Jean Turner, a UCLA professor in the department of astronomy and physics, her graduate student S. Michelle Consiglio, and two other collaborators observed a galaxy roughly 33 million light-years away. The researchers focused on this galaxy, called "II Zw 40," because it is vigorously forming stars and therefore useful for testing theories of star formation. "This galaxy has one of the largest star-forming regions in the local universe," Turner said.

The researchers, led by Consiglio, obtained images of II Zw 40 using the Atacama Large Millimeter/submillimeter Array telescope. This telescope, located in Chile's Atacama desert, is composed of an array of 66 individual telescopes that function as a single large observatory. In 2011, Turner took a three-month sabbatical from UCLA to help prepare the Atacama Array to be used by the astronomical community. "I helped with reducing data and served as astronomer on duty," she said.

The telescope is sensitive to light in the millimeter and submillimeter part of the electromagnetic spectrum, just slightly shorter than microwaves. Capturing this kind of light requires a telescope at high altitudes—this one is built on a plateau at 16,400 feet—because "the Earth's atmosphere is beginning to absorb very strongly at those wavelengths," Turner said. "All ALMA scientists ...Read More...

IAU Formally Approves 227 Star Names

Ursa Major, the constellation of the Great Bear, from Urania's Mirror, a colourful set of constellation cards published by Samuel Leigh in England in 1824. Over the years, the star at the end of the tail has been known by two popular names, Alkaid and Benetnasch. On this card it is called Benetnasch, but the IAU Working Group on Star Names (WGSN) has chosen the more common alternative of Alkaid as its official name. Among the star names on this 1824 map of Ursa Major that are recognised by the IAU as official proper names are Alcor, Alioth, Dubhe, Megrez, Merak, and Mizar. Other names on this map have been included in a growing database of cultural and historical names for stars, and some of these may eventually be adopted as official IAU names after further research and deliberation by the WGSN. Image courtesy IAU.

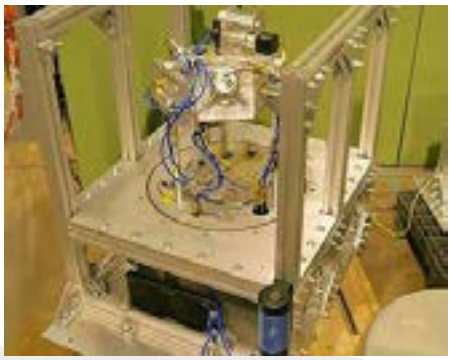
The creation of a specialised IAU Working Group, the Working Group on Star Names (WGSN), was approved by the IAU Executive Committee in May 2016 to formalise star names that have been used colloquially for centuries. WGSN has now established a new catalogue of IAU star names, with the first set of 227 approved names published on the IAU website.

Composed of an international group of astronomers, the Working Group on Star Names (WGSN) is an initiative that stemmed from the IAU Division C (Education, Outreach, and Heritage). Under the scope of the Division, the WGSN is expected first to delve into worldwide astronomical history and culture, with the aim of cataloguing traditional star names, and approving unique star names with standardised spellings.

In the future, it is anticipated that the group will turn its focus to defining the rules, criteria and process by which new names for stars and significant substellar objects can be proposed by members of the international astronomical community, including professional astronomers and the general public.

For many years, the standard practice for astronomers has been to name the stars they study using an alphanumerical designation. These designations are practical, since star catalogues, such as that recently released from ESA's Gaia satellite, typically contain thousands, millions, or even billions of objects. These alphanumerical designations will continue to be used and will not be changed by the WGSN. Instead, the group aims to decide ...Read More...

British Scientists Develop a 3D Metal Printer That Works in Space



File Image.

British scientists at the Birmingham University, have developed a 3D metal printer that can function in zero gravity and will enable astronauts to easily produce vital spare parts while they are on space missions.The process of 3D metal printing of advanced engineering components, is also known as 'addictive manufacturing' or 'selective laser melting.' It is a process by which complex items - such as an engine component - can be printed in 3D in their finished state, rather than machining them from bulk.

The technology was developed by PHD student Dr. Luke Carter from the University of Birmingham, who has worked extensively on the technology.

"We are at the heart of the third industrial revolution - using 3D printing techniques to make components out of metal. We are the only university in the UK to use a variety of metals in this way, especially the laser and powder based techniques," Dr. Carter told Sputnik. The prototype has even been tested on the European Space Agency's (ESA) 'Vomit Comet,' a device used to stimulate the weightlessness of space.

Dr. Carter said that the impact of this device on the world of 3D printing is good and that it will hopefully add huge benefits: "In its current form the demonstrator is an experimental system for a very specific application, however we are hopeful that in the future some of the benefits of this system may filter through to a 'terrestrial' commercial model aimed at the hobbyists and niche users who may want to 3D print metal as well as the established polymer systems."

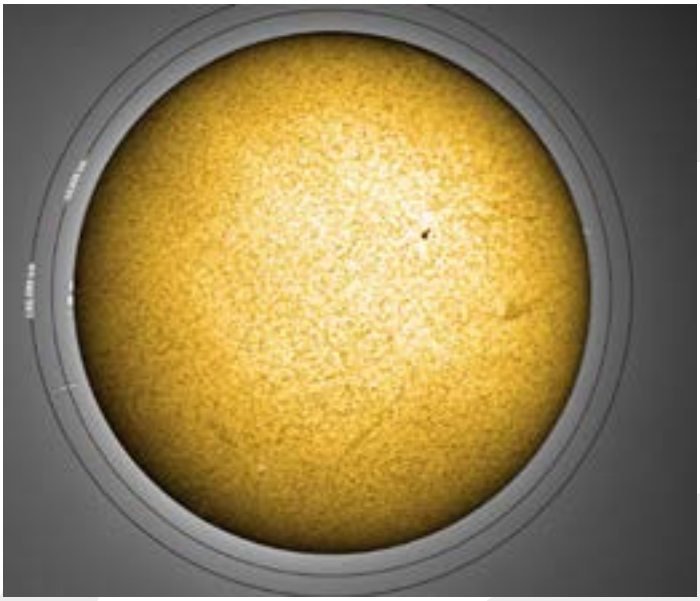
The system also offers cost saving methods, as compared to current solutions it is less expensive and could save the industry hundreds of thousands of pounds.

"The system could potentially offer a very cost effective solution to 3D printing aluminium compared to the current solutions for metal 3D printing, typically Selective Laser Melting, which costs several ...Read More...

This Week's Sky at a Glance - Dec. 03 - 09

Dec. 03	Venus 5.8°S of Moon (16:34)
Dec. 06	Moon at Descending Node (21:35)
Dec. 07	First Quarter Moon (13:03)

SCASS Observatory Exceptional Pictures
Solar Eruption and Rabi I Crescent Moon



Huge solar eruption on Nov. 27, 2016 reaching about 100,000 km above the Sun's surface - Credit: Mohamed Talafha - SCASS Observatory

Crescent Moon of Rabi I 1438 - Canon Camera - Exposure: 2 sec. - ISO 400 / f5.4 - Credit: Mohamed Talafha - SCASS Observatory

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