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Astronomy & Physics Weekly News

Dept. of Applied Physics & Astronomy - **University of Sharjah**
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مركز الشارقة لعلوم الفضاء والفلك
Sharjah Center for Astronomy & Space Sciences

Top News

New Weekly Addition:
This Week's Sky at a Glance, Aug. 06 -12

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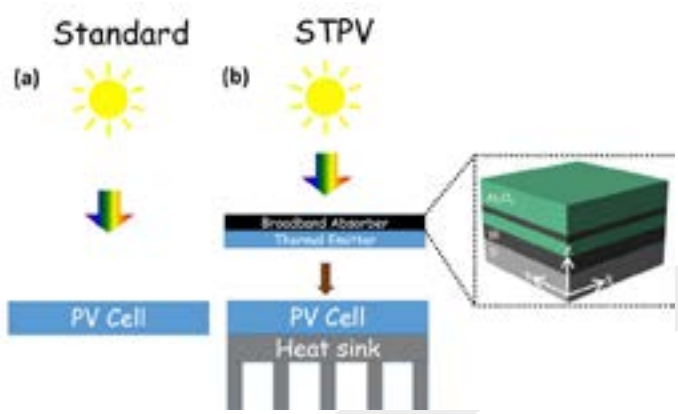
IT Support Issam Jami
Design by Mohamed Bakir

New high-temperature device captures a broader solar wavelength spectrum, improves solar cell efficiency



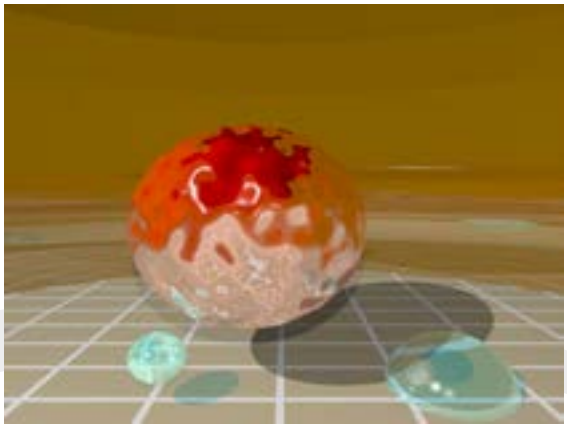
The schematic energy flow of standard and solar thermophotovoltaic (STPV) systems. In standard solar cells, a PV cell is directly illuminated by the sun. Whereas in STPV systems (b), an absorber placed between the sun and PV cell is heated by absorbing the broad solar spectrum. A thermal emitter connected to the absorber converts the heat into narrowband thermal radiation that illuminates the PV cell. The inset represents the schematic of the multilayer broadband absorber device. Credit: Manohar Chirumamilla

The photovoltaic (PV) cells in traditional solar cells convert sunlight efficiently within a narrow range of wavelengths determined by the material used in the PV cells. This limits their efficiency, as long wavelengths of sunlight are not converted at all and the energy of short wavelength light is largely wasted. Scientists have sought to increase the efficiency of photovoltaics by creating "multi-junction" solar cells, made from several different semiconductor materials that absorb at varying wavelengths of light. The problem is, such multi-junction cells are expensive to make.

Broadband solar absorption previously has been achieved using metal-insulator-metal (or MIM) resonators, which consist of an insulator sandwiched between a thick bottom and a thin top layer, each made of metals like chromium and gold. The metal components used in MIM resonators have relatively low melting points—temperatures that are reduced further when the materials are in very thin layers, as in the resonators, because of a phenomenon called melting point depression, in which the melting point of a material scales down as the dimensions of the material decrease. The metals in standard MIM resonators melt at around 500 degrees Celsius, hindering their usefulness in solar cells.

Now a group of researchers in Denmark have discovered an alternative method to capture a broad spectrum of sunlight using a heat-resistant device made of tungsten and alumina layers that can be fabricated using inexpensive and widely available film-deposition ...Read More...

Scientists discover light could exist in a previously unknown form



Artistic image of light trapped on the surface of a nanoparticle topological insulator. Credit: Vincenzo Giannini

New research suggests that it is possible to create a new form of light by binding light to a single electron, combining the properties of both.

According to the scientists behind the study, from Imperial College London, the coupled light and electron would have properties that could lead to circuits that work with packages of light - photons - instead of electrons.

It would also allow researchers to study quantum physical phenomena, which govern particles smaller than atoms, on a visible scale.

In normal materials, light interacts with a whole host of electrons present on the surface and within the material. But by using theoretical physics to model the behaviour of light and a recently-discovered class of materials known as topological insulators, Imperial researchers have found that it could interact with just one electron on the surface. This would create a coupling that merges some of the properties of the light and the electron. Normally, light travels in a straight line, but when bound to the electron it would instead follow its path, tracing the surface of the material.

In the study, published today in Nature Communications, Dr Vincenzo Giannini and colleagues modelled this interaction around a nanoparticle - a small sphere below 0.00000001 metres in diameter - made of a topological insulator.

Their models showed that as well as the light taking the property of the electron and circulating the particle, the electron would also take on some of the properties of the light. Normally, as electrons are travelling along materials, such as electrical circuits, they will stop when faced with a defect. However, Dr Giannini's team ...Read More...

Programmable ions set the stage for general-purpose quantum computers

An ion trap with four segmented blade electrodes used to trap a linear chain of atomic ions for quantum information processing. Each ion is addressed optically for individual control and readout using the high optical access of the trap. Credit: Emily Edwards

Quantum computers promise speedy solutions to some difficult problems, but building large-scale, general-purpose quantum devices is a problem fraught with technical challenges.

To date, many research groups have created small but functional quantum computers. By combining a handful of atoms, electrons or superconducting junctions, researchers now regularly demonstrate quantum effects and run simple quantum algorithms—small programs dedicated to solving particular problems.

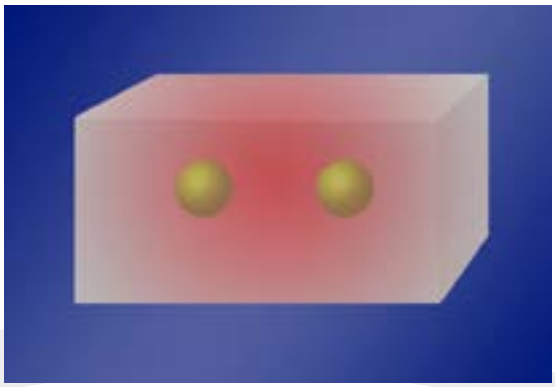
But these laboratory devices are often hard-wired to run one program or limited to fixed patterns of interactions between the quantum constituents. Making a quantum computer that can run arbitrary algorithms requires the right kind of physical system and a suite of programming tools. Atomic ions, confined by fields from nearby electrodes, are among the most promising platforms for meeting these needs.

In a paper published as the cover story in Nature on August 4, researchers working with Christopher Monroe, a Fellow of the Joint Quantum Institute and the Joint Center for Quantum Information and Computer Science at the University of Maryland, introduced the first fully programmable and reconfigurable quantum computer module. The new device, dubbed a module because of its potential to connect with copies of itself, takes advantage of the unique properties offered by trapped ions to run any algorithm on five quantum bits, or qubits—the fundamental unit of information in a quantum computer.

"For any computer to be useful, the user should not be required to know what's inside," Monroe says. "Very few people care what their iPhone is actually doing at the physical level. Our experiment brings high-quality quantum bits up to a higher level of functionality by allowing them to be programmed and reconfigured in software."

The new module builds on decades of research into trapping and controlling ions. It uses standard techniques but also introduces novel methods for control and measurement. This includes manipulating many ions at once using an array of tightly-focused laser beams, as well as dedicated detection ..Read More...

Simulations show a single photon can simultaneously excite two atoms



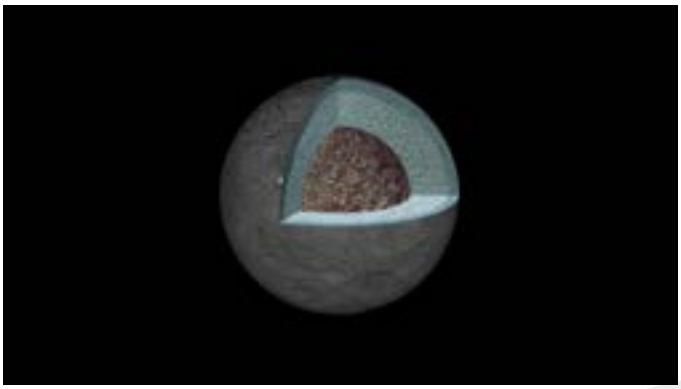
Two or more atoms in an optical cavity can absorb a single photon, according to theory. The cavity allows standing light waves of a single frequency (red glow), which can be limited to one photon. Credit: APS/Joan Tycko/via Physics, 9, 83.

A small team of researchers with affiliations to institutions in Italy, Japan and the U.S. has created a simulation that suggests that it should be possible for a single photon to simultaneously excite two atoms. In their paper published in the open access journal Physical Review Letters, the team describes the process leading to their simulation, what it showed and why they believe their findings have applications in quantum computers.

Scientists have known for several years that it is possible to have a single atom absorb two photons, causing it to move to a higher energy state. The process has actually been observed many times and is now used in microscopy and spectroscopy—its reverse, extracting the two photons from a single atom, has also been used as a means for producing entangled photons. In this new effort, the researchers wanted to know if the same would hold true for causing a single photon to be absorbed by two different atoms—theory has already suggested it should be possible.

To find out, the team created a simulation in which two atoms were held in place by mirrors inside of a chamber—creating a virtual optical cavity. They reasoned that the size of the cavity should be based on the frequency and wavelength of the photon that would be introduced (i.e. it should be double that of the photon). They then introduced the photon and found that in such a circumstance, both atoms were able to absorb the photon—each grabbing half of its energy—and moving into a higher energy state. And because the process could be reversed—the two atoms together producing a single photon, the team believes it might be possible to use the phenomenon in a quantum system—one of the atoms would theoretically serve as a qubit, carrying information. To give up its information, the qubit would move the information to the cavity where the second atom could be used to control ...Read More...

What's inside Ceres? New findings from gravity data



This artist's concept shows a diagram of how the inside of Ceres could be structured, based on data about the dwarf planet's gravity field from NASA's Dawn mission. Credit: NASA/JPL-Caltech/UCLA/MPS/DLR/IDA

In the tens of thousands of photos returned by NASA's Dawn spacecraft, the interior of Ceres isn't visible. But scientists have powerful data to study Ceres' inner structure: Dawn's own motion.

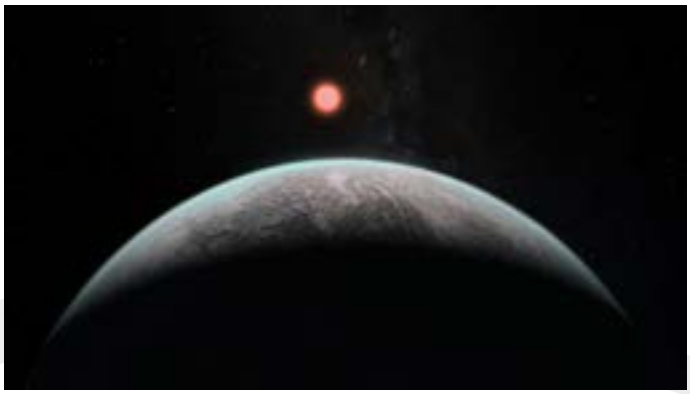
Since gravity dominates Dawn's orbit at Ceres, scientists can measure variations in Ceres' gravity by tracking subtle changes in the motion of the spacecraft. Using data from Dawn, scientists have mapped the variations in Ceres' gravity for the first time in a new study in the journal Nature, which provides clues to the dwarf planet's internal structure.

"The new data suggest that Ceres has a weak interior, and that water and other light materials partially separated from rock during a heating phase early in its history," said Ryan Park, the study's lead author and the supervisor of the solar system dynamics group at NASA's Jet Propulsion Laboratory, Pasadena, California.

Ceres' gravity field is measured by monitoring radio signals sent to Dawn, and then received back on Earth, by NASA's Deep Space Network. This network is a collection of large antennas at three locations around the globe that communicate with interplanetary spacecraft. Using these signals, scientists can measure the spacecraft's speed to a precision of 0.004 inches (0.1 millimeters) per second, and then calculate the details of the gravity field.

Ceres has a special property called "hydrostatic equilibrium," which was confirmed in this study. This means that Ceres' interior is weak enough that its shape is governed by how it rotates. Scientists reached this conclusion by comparing Ceres' gravity field to its shape. Ceres' hydrostatic equilibrium is one reason why astronomers classified the body as a dwarf planet in 2006. The data indicate that Ceres is "differentiated," which means that it has compositionally distinct layers at different depths, with the densest layer at the core. Scientists also have found that, as they suspected, Ceres is much less dense than Earth, the moon, giant asteroid Vesta (Dawn's previous target) and other rocky bodies in our solar system. Additionally, Ceres has long been suspected to contain low-density materials such as water ... Read More...

Focusing on 'Second-Earth' candidates in the Kepler catalog



Artist's impression of how an infant earth might look. Credit: ESO.

The ongoing hunt for exoplanets has yielded some very interesting returns in recent years. All told, the Kepler mission has discovered more than 4000 candidates since it began its mission in March of 2009. Amidst the many "Super-Jupiters" and assorted gas giants (which account for the majority of Kepler's discoveries) astronomers have been particularly interested in those exoplanets which resemble Earth.

And now, an international team of scientists has finished perusing the Kepler catalog in an effort to determine just how many of these planets are in fact "Earth-like". Their study, titled "A Catalog of Kepler Habitable Zone Exoplanet Candidates" (which will be published soon in the Astrophysical Journal), explains how the team discovered 216 planets that are both terrestrial and located within their parent star's "habitable zone" (HZ).

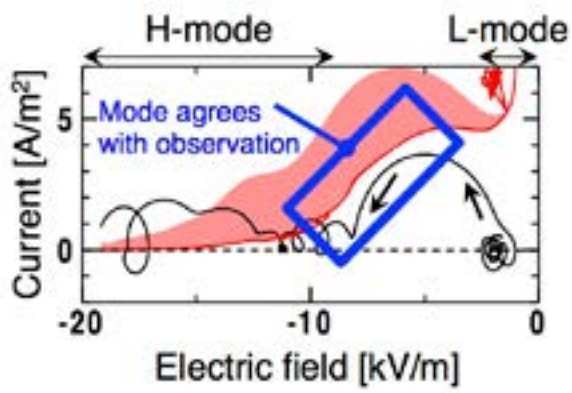
The international team was made up of researchers from NASA, San Francisco State University, Arizona State University, Caltech, University of Hawaii-Manoa, the University of Bordeaux, Cornell University and the Harvard-Smithsonian Center for Astrophysics. Having spent the past three years looking over the more than 4000 entries, they have determined that 20 of the candidates are most like Earth (i.e. likely habitable).

As Stephen Kane, an associate professor of physics and astronomy at San Fransisco University and lead author of the study, explained in a recent statement:

"This is the complete catalog of all of the Kepler discoveries that are in the habitable zone of their host stars. That means we can focus in on the planets in this paper and perform follow-up studies to learn more about them, including if they are indeed habitable."

In addition to isolating 216 terrestrial planets from the Kepler catalog, they also devised a system of four categories to determine which of these were most like Earth. These included "Recent Venus", where conditions are like that of Venus (i.e. extremely hot); "Runaway Greenhouse", where planets are undergoing serious heating; "Maximum Greenhouse", where planets are within their star's HZ; and "Recent Mars", where conditions approximate those of Mars. ..Read More...

Clarifying the fusion plasma confinement improvement mechanism



The right side of the figure where the electric field's absolute value is small corresponds to the L-mode plasma and the left side having large electric field to the H-mode. The black line indicates the experimental value of the electric current and the red line the theoretical value used in the model based upon differences in the trajectories. Credit: Tatsuya Kobayashi

At the National Institutes of Natural Sciences, National Institute for Fusion Science (NIFS), as a result of measuring electric potential of JFT-2M tokamak plasma using the "Heavy Ion Beam Probe" and analyzing experimental data, they achieved the important result of clarifying the confinement improvement mechanism, which had been a riddle for the past thirty years. This confinement improvement mode is being used as the standard operation mode in the International Thermonuclear Experimental Reactor (ITER).

In seeking the realization of the fusion reactor, research on confining high temperature and high density plasma in the magnetic field is being conducted around the world. One of the most important issues in realizing the power generation reactor is the problem that "turbulence," which is the turbulent flow of plasma, causes plasma confinement deterioration. When turbulence exists, plasma with a high core temperature is expelled to outside the plasma, and the condition for producing fusion cannot be achieved. The key to solving this problem was accidentally discovered on a German experimental device in 1982. There, turbulence in the edge region was suppressed, and the plasma state called the "H-mode", in which the temperature of the entire plasma was raised, was realized. In contrast to this, plasma in which turbulence is great and the temperature is low is called "L-mode" plasma. Subsequently, H-mode plasma was reproduced in devices around the world. H-mode is used as the standard operation mode in the ITER.

In research to date, many researchers have attempted to clarify the H-mode mechanism. In the normal condition in which there is a balance of ions and electrons, there cannot be a strong electric field in a plasma....Read More...

Physicists reach lowest temperature ever recorded in solids using laser cooling

UNM Research Assistant Aram Gragossian tests lasers in one of the Department of Physics & Astronomy's optics laboratories. Credit: University of New Mexico

When most people think about lasers, they usually imagine them generating heat and even setting something on fire. But, for a group of scientists in The University of New Mexico's Department of Physics & Astronomy, lasers are actually being used to reach temperatures colder than the arctic circle.

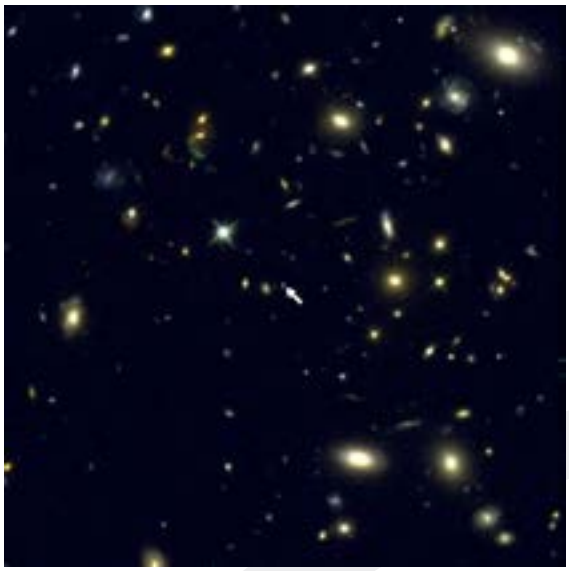
Dr. Mansoor Sheik-Bahae, professor of physics and astronomy, along with his research group, are advancing a technique called optical refrigeration to reach cryogenic temperature. Essentially, the group is using laser light to chill a special type of crystal, which can then be attached to a device that requires constant and reliable cooling, like infrared detectors on satellites. What sets their technique apart is the temperatures it can cool to without having any moving parts.

"Right now, anything that cools other parts of a system has moving parts. Most of the time, there's liquid running through it that adds vibrations which can impact the precision or resolution of the device," explained Aram Gragossian, a research assistant in Sheik-Bahae's lab. "But, when you have optical refrigeration, you can go to low temperatures without any vibrations and without any moving parts, making it convenient for a lot of applications."

Earlier this year, Sheik-Bahae, along with collaborators at UNM, and Los Alamos National Labs, reached the lowest temperatures ever recorded using an all-solid-state cryocooler – 91 kelvin or -296o Fahrenheit – temperatures that were previously only able to be reached using liquid nitrogen or helium. The research, Solid-state optical refrigeration to sub-100 Kelvin regime, was published in Scientific Reports.

"Here at UNM, we are the only group in the world that's been able to cool to cryogenic temperatures with an all-solid-state optical cryocooler," said ...Read More...

Astronomers make first accurate measurement of oxygen in distant galaxy



Galaxy COSMOS-1908 is in the center of this Hubble Space Telescope image, indicated by the arrow. Nearly everything in the image is a galaxy; many of these galaxies are much closer to the Earth than COSMOS-1908. Credit: Ryan Sanders and the CANDELS team

UCLA astronomers have made the first accurate measurement of the abundance of oxygen in a distant galaxy. Oxygen, the third-most abundant chemical element in the universe, is created inside stars and released into interstellar gas when stars die. Quantifying the amount of oxygen is key to understanding how matter cycles in and out of galaxies.

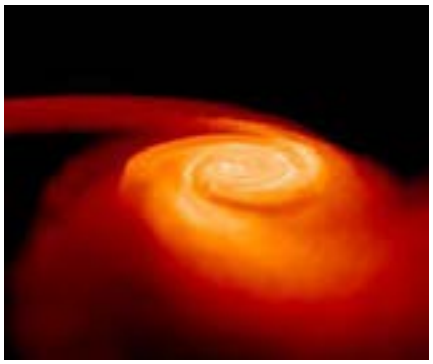
This research is published online in the Astrophysical Journal Letters, and is based on data collected at the W. M. Keck Observatory on Mauna Kea, in Hawaii.

"This is by far the most distant galaxy for which the oxygen abundance has actually been measured," said Alice Shapley, a UCLA professor of astronomy, and co-author of the study. "We're looking back in time at this galaxy as it appeared 12 billion years ago."

Knowing the abundance of oxygen in the galaxy called COSMOS-1908 is an important stepping stone toward allowing astronomers to better understand the population of faint, distant galaxies observed when the universe was only a few billion years old and galaxy evolution, Shapley said.

COSMOS-1908, contains approximately 1 billion stars. In contrast, the Milky Way contains approximately 100 billion stars; some galaxies in the universe contain many more, while others contain many fewer. Furthermore, COSMOS-1908 contains approximately only 20 percent the abundance of oxygen that is observed in the sun. Typically, astronomers rely on extremely indirect and imprecise techniques for estimating oxygen ...Read More...

Mapping the exotic matter inside neutron stars



File Image.

The recent detection of gravitational waves emitted by two merging black holes by the LIGO and Virgo collaborations has opened up a new observational window into the cosmos.

Future observations of similar mergers between two neutron stars or a neutron star and a black hole may revolutionize what we know today about the properties of neutron stars, the densest stellar objects in the universe.

By providing detailed dynamical information about the material properties of these stars, such measurements will shed light on their internal composition.

Ultimately, they may answer the question, whether neutron stars are composed solely of ordinary atomic nuclei, or if they contain more exotic matter in the form of dense deconfined quark matter, says physicist Aleksi Vuorinen at the University of Helsinki.

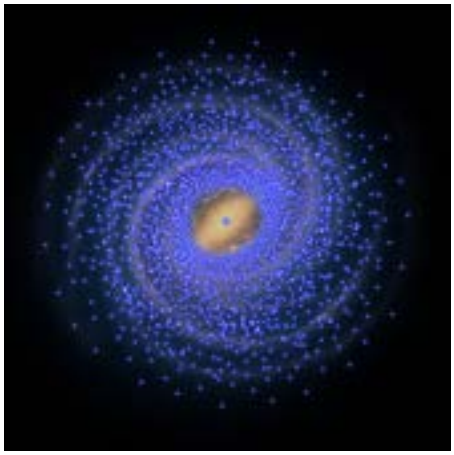
Towards accurate theoretical understanding, as well
In order to be able to properly take advantage of the future observational data, it is essential that our theoretical understanding of the possible constituents of neutron star matter - dense nuclear and quark matter - be as accurate as possible.

This is, however, an extremely challenging problem, as few first principle tools exist for studying such a strongly interacting medium due to the complexity of the underlying microscopic theory, Quantum Chromodynamics (QCD).

The most important tools available for such studies are so-called chiral effective theories for the nuclear interactions, applicable for nuclear matter, and thermal perturbation theory, applicable for deconfined quark matter.

In their recent paper, Cool quark matter, published in Physical Review Letters on 22.7.2016, Aleksi Kurkela (CERN and University of Stavanger) and Aleksi Vuorinen were able to perform the first accurate determination of the thermodynamic properties of dense quark matter under the violent conditions that take place in neutron star mergers. They applied thermal perturbation theory to a high order, generalizing previous work applicable only ...Read More...

A Giant Stellar Void in the Milky Way



An artist's impression of the implied distribution of young stars, represented here by Cepheids shown as blue stars plotted on the background of a drawing of the Milky Way. With the exception of a small clump in the Galactic centre, the central 8000 light years appear to have very few Cepheids, and hence very few young stars. Image courtesy The University of Tokyo

A major revision is required in our understanding of our Milky Way Galaxy according to an international team led by Prof Noriyuki Matsunaga of the University of Tokyo. The Japanese, South African and Italian astronomers find that there is a huge region around the centre of our own Galaxy, which is devoid of young stars. The team publish their work in a paper in Monthly Notices of the Royal Astronomical Society.

The Milky Way is a spiral galaxy containing many billions of stars, with our Sun about 26,000 light years from its centre. Measuring the distribution of these stars is crucial to our understanding of how our Galaxy formed and evolved.

Pulsating stars called Cepheids are ideal for this. They are much younger (between 10 and 300 million years old) than our Sun (4.6 billion years old) and they pulsate in brightness in a regular cycle.

The length of this cycle is related to the luminosity of the Cepheid, so if astronomers monitor them they can establish how bright the star really is, compare it with what we see from Earth, and work out its distance.

Despite this, finding Cepheids in the inner Milky Way is difficult, as the Galaxy is full of interstellar dust which blocks out light and hides many stars from view.

Matsunaga's team compensated for this, with an analysis of near-infrared observations made with a Japanese-South African telescope located at Sutherland, South Africa.

To their surprise they found hardly any Cepheids in a huge region stretching for thousands of light years from the core of the Galaxy.

Noriyuki Matsunaga explains: "We already found some while ago that there are Cepheids in the ...Read More...

As dry as the moon

The Chang'e 3 has been working continually on the moon since its soft landing in December 2013. According to the State Administration of Science, Technology and Industry of National Defense, this is the longest operation of lunar probes.

Data sent back to the Earth by Chinese lunar probe Chang'e 3 has proved for the first time that there is no water on the moon, said a Chinese astronomer.

The Chang'e 3 has gathered data on the moisture content above the lunar surface and "got a figure so low that we have never seen before," said Wei Jianyan, a researcher of the National Astronomical Observatory at the Chinese Academy of Sciences.

The result is in line with the expectations of experts. It's also the first time that mankind has proved there is no water on the moon.

Also, the Chang'e 3 has achieved several other firsts in the scientific field. It drew the first geological section map of the moon and found a lunar basaltic rock, which can help us understand the evolution of the moon.

It also conducted the first survey of the celestial body above the north pole of the moon, which can help astronomers do comparison studies in the future.

Also, it has obtained the first images of the Earth's plasmasphere, which will be a boon to space weather forecasts, terrestrial communication and the communication between the Earth and spacecrafts.

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The Chang'e 3 is composed of a lander and a lunar rover called "Yutu" (Jade Rabbit). It carries eight scientific instruments, including panoramic cameras, a soil probe, a lunar-based optical telescope and an extreme ultraviolet (EUV) camera to observe the moon, the Galaxy and the Earth. ...Read More...

New Weekly Addition:

This Week's Sky at a Glance, Aug. 06 - 12

Aug 10	Moon at apogee (404266 km) – Local Time: 04:05
Aug 10	First Quarter Moon (22:21) - Meridian passage (18:05) – Altitude: 53°
Aug 12	Perseids meteor shower – Parent comet: Swift-Tuttle (Active dates: 23 Jul – 20 Aug)

All Five Naked Eye Planets Visible:

The view for the five naked eye planets (Mercury, Venus, Mars, Jupiter and Saturn) is getting better as Venus and Mercury are getting higher and higher day after day. The Moon will move in between daya after day.

Crescent Moon and a shooting jet - Aug. 05, 2016 - Miliana (Algeria) Photo Credit: Ridwan Fernini

Crescent Moon and Jupiter - Aug. 05, 2016 Miliana (Algeria) - Photo Credit: Ridwan Fernini

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