INTERNATIONAL YEAR OF LIGHT 2015

100 Million Stars in the Andromeda galaxy.

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Astronomy & Physics News

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Weekly news from around the world compiled by Dr. Ilias Fernini

Inside this issue:

National security on the move with high energy physics

Scientists are developing a portable technology that will safely and quickly detect nuclear material hidden within large objects such as shipping cargo containers or sealed waste drums. The researchers, led by Berkeley Lab scientists, have been awarded over $10 million from the Department of Energy's National Nuclear Security Administration (NNSA) Defense Nuclear Nonproliferation R&D Office to combine the capabilities of conventional building-size research instruments with the transportable size of a truck for security applications on the go.

A Big Future for Small Accelerators

The core of the detection system is a next-generation source of high-energy photons, often referred to as X-rays or gamma rays. The technology will combine the capabilities of conventional building-size research instruments, such as Duke University's High Intensity Gamma-Ray Source (HIGS), which precisely control the energy (or color) of the photons generated to improve sensitivity, with the compact size needed for use in most national security applications. The problem with current techniques, such as those used by HIGS, is that there are only a few ways to produce megaelectron-volt (MeV) photons—high-energy photons at energies a million times higher than visible light—within a narrow spread or range of energy, and those usually require an electron accelerator the size of a large building. The compact photon source, which is being developed by Berkeley Lab. ...***Read More***...

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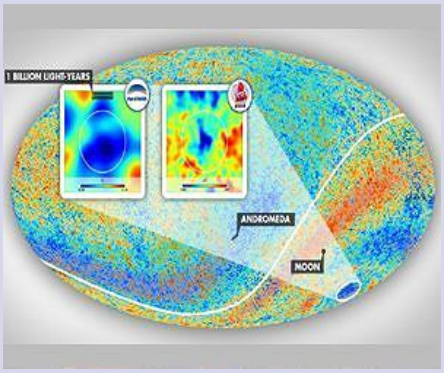
A cold cosmic mystery solved

In 2004, astronomers examining a map of the radiation leftover from the Big Bang (the cosmic microwave background, or CMB) discovered the Cold Spot, a larger-than-expected unusually cold area of the sky. The physics surrounding the Big Bang theory predicts warmer and cooler spots of various sizes in the infant universe, but a spot this large and this cold was unexpected.

Now, a team of astronomers led by Dr. Istvan Szapudi of the Institute for Astronomy at the University of Hawaii at Manoa may have found an explanation for the existence of the Cold Spot, which Szapudi says may be "the largest individual structure ever identified by humanity."

If the Cold Spot originated from the Big Bang itself, it could be a rare sign of exotic physics that the standard cosmology (basically, the Big Bang theory and related physics) does not explain. If, however, it is caused by a foreground structure between us and the CMB, it would be a sign that there is an extremely rare ...***Read More***...



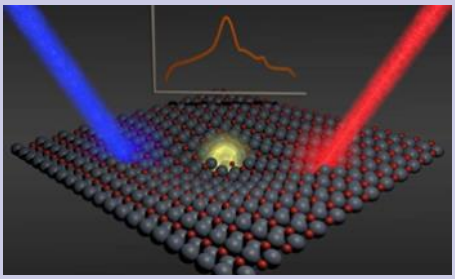
The Cold Spot area resides in the constellation Eridanus in the southern galactic hemisphere. The insets show the environment of this anomalous patch of the sky as mapped by Szapudi's team using PS1 and WISE data and as observed in the cosmic microwave background temperature data taken by the Planck satellite.

Pseudoparticles travel through photoactive material

Researchers of Karlsruhe Institute of Technology (KIT) have unveiled an important step in the conversion of light into storable energy: Together with scientists of the Fritz Haber Institute in Berlin and the Aalto University in Helsinki/Finland, they studied the formation of so-called polarons in zinc oxide. The pseudoparticles travel through the photoactive material until they are converted into electrical or chemical energy at an interface. Their findings that are of relevance to photovoltaics among others are now published in the renowned journal Nature Communications.

Processes converting light into storable energy may contribute decisively to a sustainable energy supply. For billions of years, nature has been using such processes for photosynthesis to form carbohydrates with the help of light. In research, phototcatalysis that uses light to accelerate chemical processes is gaining importance. In the past years, researchers also achieved considerable progress in photovoltaics converting incident sunlight directly into electrical energy. Efficiency constantly improved.

However, the processes underlying photovoltaics have hardly been studied in detail so far. "Conversion of photons, i.e. light particles, into electricity takes several steps," Professor Christof Wöll, Head of the Institute of Functional Interfaces (IFG) of KIT, explains. First, light is absorbed in a photoactive material. Single electrons are removed from their site and leave a hole there. The electron-hole pairs are stable for a short term only. Then, they either ...***Read More***...



Using the photoactive zinc oxide material, scientists studied the formation and migration of so-called polarons. Credit: Patrick Rinke/Aalto University

Portable MRI could aid wounded soldiers and children in the third world

Scientists at Los Alamos National Laboratory are developing an ultra-low-field Magnetic Resonance Imaging (MRI) system that could be low-power and lightweight enough for forward deployment on the battlefield and to field hospitals in the World's poorest regions.

"MRI technology is a powerful medical diagnostic tool," said Michelle Espy, the Battlefield MRI (bMRI) project leader, "ideally suited for imaging soft-tissue injury, particularly to the brain."

But hospital-based MRI devices are big and expensive, and require considerable infrastructure, such as large quantities of cryogens like liquid nitrogen and helium, and they typically use a large amount of energy.

"Standard MRI machines just can't go everywhere," said Espy. "Soldiers wounded in battle usually have to be flown to a large hospital and people in emerging nations just don't have access to MRI at all. We've been in contact with doctors who routinely work in the Third World and report that MRI would be extremely valuable in treating pediatric encephalopathy, and other serious diseases in children."

So the Los Alamos team started thinking about a way to make an MRI device that could be relatively easy to transport, set up, and use in an unconventional setting.

Conventional MRI machines use very large magnetic fields that align the protons in water molecules to then create magnetic resonance signals, which are detected by the machine and turned ...***Read More***...

Second generation "portable" MRI device uses low-power magnetic fields to image the brain and other soft-tissue anatomy.

Quantum model reveals surface structure of water

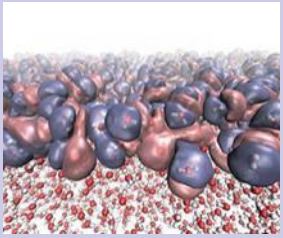
The National Physical Laboratory (NPL), the UK's National Measurement Institute in collaboration with IBM and the University of Edinburgh, has used a new quantum model to reveal the molecular structure of water's liquid surface.

The liquid-vapour interface of water is one of the most common of all heterogeneous (or non-uniform) environments. Understanding its molecular structure will provide insight into complex biochemical interactions underpinning many biological processes. But experimental measurements of the molecular structure of water's surface are challenging, and currently competing models predict various different arrangements.

NPL has been working with IBM and the University of Edinburgh to make materials simulation more predictive and intuitive, by developing a new class of materials model based on quantum mechanical effects.

The model is based on a single charged particle, the quantum Drude oscillator (QDO), which mimics the way the electrons of a real water molecule fluctuate and respond to their environment. This simplified representation retains interactions not normally accessible in classical models and accurately captures the properties of liquid water.

In new research, published in a featured article in the journal Physical Chemistry Chemical Physics, the team used the QDO model to determine the molecular structure of water's liquid surface. The results provide new insight ...***Read More***….



This shows the heterogeneous electronic density created by the diverse molecular orientations at the liquid-vapor interface of water. Image courtesy NPL/University of Edinburgh.

First exoplanet visible light spectrum

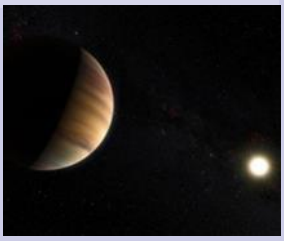
The exoplanet 51 Pegasi b [1] lies some 50 light-years from Earth in the constellation of Pegasus. It was discovered in 1995 and will forever be remembered as the first confirmed exoplanet to be found orbiting an ordinary star like the Sun [2]. It is also regarded as the archetypal hot Jupiter -- a class of planets now known to be relatively commonplace, which are similar in size and mass to Jupiter, but orbit much closer to their parent stars.

Since that landmark discovery, more than 1900 exoplanets in 1200 planetary systems have been confirmed, but, in the year of the twentieth anniversary of its discovery, 51 Pegasi b returns to the ring once more to provide another advance in exoplanet studies.

The team that made this new detection was led by Jorge Martins from the Instituto de Astrofisica e Ciencias do Espaco (IA) and the Universidade do Porto, Portugal, who is currently a PhD student at ESO in Chile. They used the HARPS instrument on the ESO 3.6-metre telescope at the La Silla Observatory in Chile.

Currently, the most widely used method to examine an exoplanet's atmosphere is to observe the host star's spectrum as it is filtered through the planet's atmosphere during transit -- a technique known as transmission spectroscopy. An alternative approach is to observe the system when the star passes in front of the planet, which primarily provides information about the exoplanet's temperature.

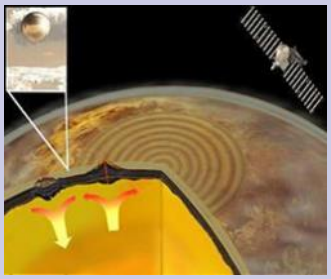
The new technique does not depend on finding a planetary transit, and so can potentially be used to study many more exoplanets. It allows the planetary spectrum to be directly detected in visible light, which means that different characteristics of the planet that are inaccessible to other techniques can be inferred….***Read More***...



This artist's view shows the hot Jupiter exoplanet 51 Pegasi b, sometimes referred to as Bellerophon, which orbits a star about 50 light-years from Earth in the northern constellation of Pegasus (the Winged Horse). This was the first exoplanet around a normal star to be found in 1995. Twenty years later this object was also the first ...

Can sound help us detect 'earthquakes' on Venus ?

Detecting an "earthquake" on Venus would seem to be an impossible task. The planet's surface is a hostile zone of crushing pressure and scorching temperatures--about 874 degrees F, hot enough to melt lead--that would destroy any of the normal instruments used to gauge seismic activity. But conditions in Venus' atmosphere are much more hospitable, and it is here that researchers hope to deploy an array of balloons or satellites that could detect Venusian seismic activity--using sound.
These kinds of low frequency or infrasonic sound waves, much lower than an audible voice, are already measured on Earth. The rumbling or "hum" can be generated by sources as diverse as volcanoes, earthquakes, ocean storms and meteor air blasts.
In recent years, says Los Alamos National Laboratory researcher Stephen Arrowsmith, infrasonic observations have undergone a renaissance of sorts, especially as a relatively inexpensive way to monitor atmospheric nuclear weapons tests. But last year, a team of experts convened by the Keck Institute for Space Studies began thinking of ways to use infrasonic observations to get a better look at the geological dynamics of Venus.
At about 50-60 kilometers above Venus' surface, the temperature and pressure conditions are much more like those on Earth, albeit with a denser atmosphere.
This dense atmosphere helps translate ...***Read More***….



Seismic waves radiating from a Venus quake propagate as Rayleigh waves in the Venus surface layers and generate infrasonic waves traveling upwards through the dense Venus atmosphere.

Pulsing light may indicate supermassive black hole merger

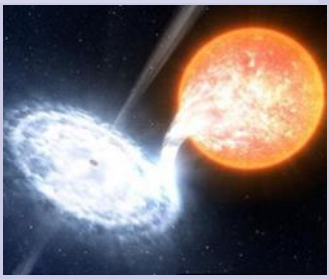
As two galaxies enter the final stages of merging, scientists have theorized that the galaxies' supermassive black holes will form a "binary," or two black holes in such close orbit they are gravitationally bound to one another. In a new study, astronomers at the University of Maryland present direct evidence of a pulsing quasar, which may substantiate the existence of black hole binaries.

"We believe we have observed two supermassive black holes in closer proximity than ever before," said Suvi Gezari, assistant professor of astronomy at the University of Maryland and a co-author of the study. "This pair of black holes may be so close together that they are emitting gravitational waves, which were predicted by Einstein's theory of general relativity."

The study was published online in the Astrophysical Journal Letters. The discovery could shed light on how often black holes get close enough to form a gravitationally bound binary and eventually merge together.

Black holes typically gobble up matter, which accelerates and heats up, emitting electromagnetic energy and creating some of the most luminous beacons in the sky called quasars. When two black holes orbit as a binary, they absorb matter cyclically, leading theorists to predict that the binary's quasar would respond by periodically brightening and dimming.

The researchers conducted a systematic search for so-called variable quasars using the Panoramic Survey Telescope and Rapid Response System (Pan-STARRS1) Medium Deep Survey. This Haleakala, Hawaii-based telescope imaged the same patch of sky once every three days and collected ..***Read More***...



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Hubble Telescope Celebrates 25 Years in Space With Spectacular New Image

This NASA/ESA Hubble Space Telescope image of the cluster Westerlund 2 and its surroundings has been released to celebrate Hubble's 25th year in orbit and a quarter of a century of new discoveries, stunning images and outstanding science.

The image's central region, containing the star cluster, blends visible-light data taken by the Advanced Camera for Surveys and near-infrared exposures taken by the Wide Field Camera 3. The surrounding region is composed of visible-light observations taken by the Advanced Camera for Surveys. Credit: NASA, ESA, the Hubble Heritage Team (STScI/AURA), A. Nota (ESA/STScI), and the Westerlund 2 Science Team

Exploding stars help to understand thunderclouds on Earth

How is lightning initiated in thunderclouds? This is difficult to answer - how do you measure electric fields inside large, dangerously charged clouds? It was discovered, more or less by coincidence, that cosmic rays provide suitable probes to measure electric fields within thunderclouds. This surprising finding is published in Physical Review Letters on April 24th. The measurements were performed with the LOFAR radio telescope located in the Netherlands.

'We used to throw away LOFAR measurements taken during thunderstorms. They were too messy.' says astronomer Pim Schellart. 'Well, we didn't actually throw them away of course, we just didn't analyze them.' Schellart, who completed his PhD in March this year at Radboud University in Nijmegen and is supervised by Prof. Heino Falcke, is interested in cosmic rays. These high-energy particles, originating from exploding stars and other astrophysical sources, continuously bombard Earth from space.

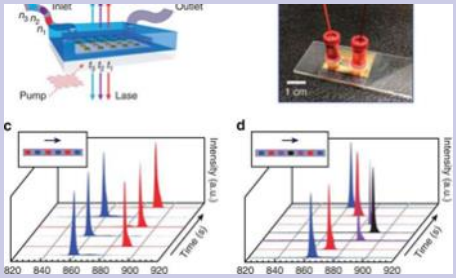
High in the atmosphere these particles strike atmospheric molecules and create 'showers' of elementary particles. These ...***Read More***…

This shows a particle shower initiated by a cosmic ray reaches LOFAR through a thundercloud. Image courtesy Radboud University

Researchers build real-time tunable plasmon laser

A combined team of researchers from Northwestern and Duke Universities has succeeded in building a plasmon laser that is tunable in real-time. In their paper published in the journal Nature Communications, the team describes how they built their device and to what uses it might be put.

Traditionally, light can only ever be focused down to a point half the size of its frequency—aka the diffraction limit. Scientists have found a way around that limit, however, by building what are known as plasmon lasers, which are ..***Read More***...



Lasing emissions from Au NP arrays tuned in real time. Credit: Nature Communications 6, Article number: 6939 doi:10.1038/ncomms7939