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Astronomy & Physics News

Department of Physics—United Arab Emirates University
Weekly news from around the world compiled by Dr. Ilias Fernini

100 Million Stars in the Andromeda galaxy.

Inside this issue:

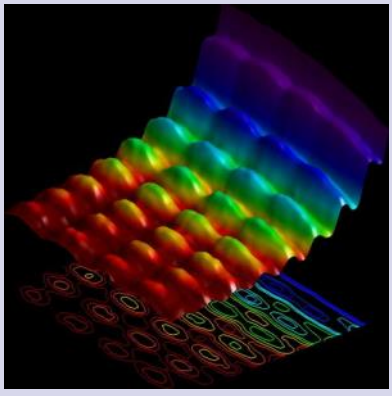
The first ever photograph of light as both a particle and wave

Light behaves both as a particle and as a wave. Since the days of Einstein, scientists have been trying to directly observe both of these aspects of light at the same time. Now, scientists at EPFL have succeeded in capturing the first-ever snapshot of this dual behavior.

Quantum mechanics tells us that light can behave simultaneously as a particle or a wave. However, there has never been an experiment able to capture both natures of light at the same time; the closest we have come is seeing either wave or particle, but always at different times. Taking a radically different experimental approach, EPFL scientists have now been able to take the first ever snapshot of light behaving both as a wave and as a particle. The breakthrough work is published in Nature Communications.

When UV light hits a metal surface, it causes an emission of electrons. Albert Einstein explained this "photoelectric" effect by proposing that light – thought to only be a wave – is also a stream of particles. Even though a variety of experiments have successfully observed both the particle- and wave-like behaviors of light, they have never been able to observe both at the same time.

A research team led by Fabrizio Carbone at EPFL has now carried out an ...***Read More***...



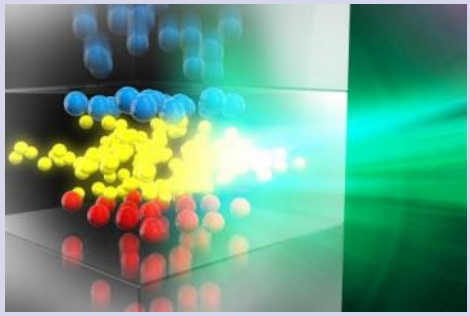
Breakthrough in OLED technology

Organic light emitting diodes (OLEDs), which are made from carbon-containing materials, have the potential to revolutionize future display technologies, making low-power displays so thin they'll wrap or fold around other structures, for instance.

Conventional LCD displays must be backlit by either fluorescent light bulbs or conventional LEDs whereas OLEDs don't require back lighting. An even greater technological breakthrough will be OLED-based laser diodes, and researchers have long dreamed of building organic lasers, but they have been hindered by the organic materials' tendency to operate inefficiently at the high currents required for lasing.

Now a new study from a team of researchers in California and Japan shows that OLEDs made with finely patterned structures can produce bright, low-power light sources, a key step toward making organic lasers. The results are reported in a paper appearing this week on the cover of the journal Applied Physics Letters, from AIP Publishing.

The key finding, the researchers say, is to confine charge transport and recombination to nanoscale areas, which extends electroluminescent efficiency roll off the current density at ...***Read More***...



Charge diffusion in the transport region of an OLED. Credit: Thuc-Quyen Nguyen/UCSB

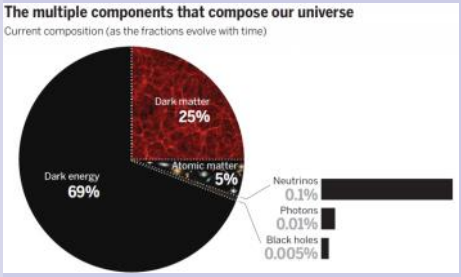
The dark side of cosmology

It's a beautiful theory: the standard model of cosmology describes the universe using just six parameters. But it is also strange. The model predicts that dark matter and dark energy – two mysterious entities that have never been detected—make up 95% of the universe, leaving only 5% composed of the ordinary matter so essential to our existence.

In an article in this week's Science, Princeton astrophysicist David Spergel reviews how cosmologists came to be certain that we are surrounded by matter and energy that we cannot see. Observations of galaxies, supernovae, and the universe's temperature, among other things, have led researchers to conclude that the universe is mostly uniform and flat, but is expanding due to a puzzling phenomenon called dark energy. The rate of expansion is increasing over time, counteracting the attractive force of gravity. This last observation, says Spergel, implies that if you throw a ball upward you will see it start to accelerate away from you.

A number of experiments to detect dark matter and dark energy are underway, and some researchers have already claimed to have found particles of dark matter, although the results are controversial. New findings expected in the coming years from the Large Hadron Collider, the world's most powerful particle accelerator, could provide evidence for a proposed theory, supersymmetry, that could explain the dark particles.

But explaining dark energy, and why the universe is accelerating, is a tougher ...***Read More***...



The components of our universe. Dark energy comprises 69% of the mass energy density of the universe, dark matter comprises 25%, and "ordinary" atomic matter makes up 5%. Three types of neutrinos make up at least 0.1%, the cosmic background radiation makes up 0.01%, and black holes comprise at least 0.005%. Credit: Science/AAAS

Important step towards quantum computing: Metals at atomic scale

German scientists from RWTH Aachen, Research Center Jülich, TU Dresden and of the Leibniz Institute for Solid State and Materials Research Dresden report that the current flow on the surface of a topological insulator is channeled along tiny paths, which have been theoretically calculated and experimentally observed. Their work has been published in the issue from March 2, 2015 of the journal Nature Physics. The team shows for Bismuth-Rhodium-Iodine that these channels are tied to one dimensional surface features and run along steps formed by the edges of atomic layers. Scanning tunneling spectroscopy reveals the electron channels to be continuous in both energy and space and less than one nanometer wide.

Due to the properties of topological insulators, electric current flows unimpeded within these channels while charge can barely move from one channel to another. In this way, the surface acts as a set of electric wires that is defined by the atomic steps at the crystals surface. The scientists demonstrated that the surface can be engraved in any arrangement, allowing channel networks to be patterned with nanometer precision. The channeled current flow enables the transport of electrons while preventing the "scattering" typically associated with power consumption, in which electrons deviate from their trajectory. Thus, the resulting energy losses and heat generation are substantially diminished. These properties make topological insulators interesting for application in electronics. Furthermore, they are expected to enable ...***Read More***...

Microscopic image of the topological insulator Bismuth-Rhodium-Iodine (Bi14Rh3I9). The engraved letters BiRhI act as artificially introduced steps at the crystal surface. Credit: M. Morgenstern, RWTH Aachen

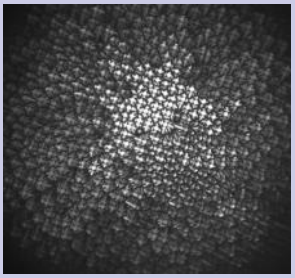
Watching alloys change from liquid to solid could lead to better metals

If you put a camera in the ice machine and watched water turn into ice, the process would look simple. But the mechanism behind liquids turning to solids is actually quite complex, and understanding it better could improve design and production of metals. A recent investigation aboard the International Space Station contributed to that understanding.

A series of experiments conducted in the Directional Solidification Insert (DSI) of the Device for the study of Critical Liquids and Crystallization (DECLIC) used transparent alloys to observe microstructures that form at the point the material solidifies. These alloys, or "plastic crystals," freeze or solidify the same way metals do and form the same microstructures in the process. But because metals are opaque, researchers have to analyze the process of solidification after the fact. With the transparent alloys, they can observe solidification as it happens. Using transparent alloys also makes it possible to perform multiple experiments on the same sample, and transferring images to the ground for analysis, rather than actual samples, greatly reduces the cost.

The DSI recorded images during the entire solidification process. Top views clearly show the microstructure pattern forming at the interface between liquid and solid, and side views provide the shape and motion of that interface.

Alloy solidification involves crystallizing or freezing a liquid mixture of different atomic constituents. For example, a mixture of ..***Read More***...



Dendritic pattern of the Succinonitrile-Camphor alloy grown in microgravity, seen from the top. Credit: Nathalie Bergeon

Astronomers Find Dust in the Early Universe

Dust plays an extremely important role in the universe -- both in the formation of planets and new stars. But dust was not there from the beginning and the earliest galaxies had no dust, only gas. Now an international team of astronomers, led by researchers from the Niels Bohr Institute, has discovered a dust-filled galaxy from the very early universe.

The discovery demonstrates that galaxies were very quickly enriched with dust particles containing elements such as carbon and oxygen, which could form planets. The results are published in the scientific journal Nature.

Cosmic dust grains are smoke-like particles made up of either carbon (fine soot) or silicates (fine sand). The dust is comprised primarily of elements such as carbon, silicon, magnesium, iron and oxygen.

The elements are synthesized by the nuclear combustion process in stars and driven out into space when the star dies and explodes. In space, they gather in clouds of dust and gas, which form new stars, and for each generation of new stars, more elements are formed. This is a slow process and in the very earliest galaxies in the history of the universe, dust had not yet formed.

But now a team of researchers have discovered a very distant galaxy that contains a large amount of dust, changing astronomers' previous calculations of how quickly the dust was formed.

File image.

"It is the first time dust has been discovered in one of the most distant galaxies ever observed -- only 700 million years after the Big Bang. It is a galaxy of modest size and yet it is already full of dust. This is very surprising and it tells us that ordinary galaxies were enriched with heavier elements far faster than expected," explains Darach Watson, an astrophysicist with the Dark Cosmology Centre at ...***Read More***...

Breakthrough in energy harvesting could power life on Mars

Martian colonists could use an innovative new technique to harvest energy from carbon dioxide thanks to research pioneered at Northumbria Univ.

The technique, which has been proven for the first time by researchers at the university, has been published in Nature Communications.

The research proposes a new kind of engine for producing energy based on the Leidenfrost effect—a phenomenon which happens when a liquid comes into near contact with a surface much hotter than its boiling point. This effect is commonly seen in the way water appears to skitter across the surface of a hot pan, but it also applies to solid carbon dioxide, commonly known as dry ice. Blocks of dry ice are able to levitate above hot surfaces protected by a barrier of evaporated gas vapor. Northumbria's research proposes using the vapor created by this effect to power an engine. This is the first time the Leidenfrost effect has been adapted as a way of harvesting energy.

The technique has exciting implications for working in extreme and alien environments, such as outer space, where it could be used to make long-term exploration and colonization sustainable by using ...***Read More***...

File image.

The sun has more impact on the climate in cool periods

The activity of the Sun is an important factor in the complex interaction that controls our climate. New research now shows that the impact of the Sun is not constant over time, but has greater significance when the Earth is cooler.

There has been much discussion as to whether variations in the strength of the Sun have played a role in triggering climate change in the past, but more and more research results clearly indicate that solar activity - i.e. the amount of radiation coming from the Sun - has an impact on how the climate varies over time.

In a new study published in the scientific journal Geology, researchers from institutions including Aarhus University in Denmark show that, during the last 4,000 years, there appears to have been a close correlation between solar activity and the sea surface temperature in summer in the North Atlantic. This correlation is not seen in the preceding period.

Since the end of the Last Ice Age about 12,000 years ago, the Earth has generally experienced a warm climate. However, the climate has not been stable during this period, when temperatures have varied for long periods. We have generally had a slightly cooler climate during the last 4,000 years, and the ocean currents in the North Atlantic have been weaker.

File image.

"We know that the Sun is very important for our climate, but the impact is not clear. Climate change appears to be either strengthened or weakened by solar activity.

"The extent of the Sun's influence over time is thus not constant, but we can now conclude that the climate system is more ...***Read More***...

Physics Department

College of Science - United Arab Emirates University
POB 15551
Al-Ain
United Arab Emirates

Phone: 00-971-3-7136336
Fax: 00-971-3-713-6909
E-mail: physics@uaeu.ac.ae

http://www.cos.uaeu.ac.ae/en/departments/physics/index.shtml

UAEU College of Science

جامعة الإمارات العربية المتحدة
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The Physics Department cordially invites you to the seminar:

Chalcogenide Glass Photonics

Dr. Clara Dimas
Masdar (MIST), Abu-Dhabi

Abstract

Chalcogenide Glasses (ChG) have a commercial history & continued relevance enabling re-writable CDs and DVDs as well as phase change memory incorporated in today's Samsung phones. Relatively new ChG materials have key enabling properties for high speed photonics devices, IR sensors, and CMOS photonics. There is therefore ample opportunity to develop processing and device designs based on these materials for high volume applications of telecom and micro-sensors. This talk will outline the state of the art, where MIST research fits in and where opportunities of growth lie.

Thursday, March 12th 2015 @ 11:00 AM, Room F1-2119
All are Welcome!

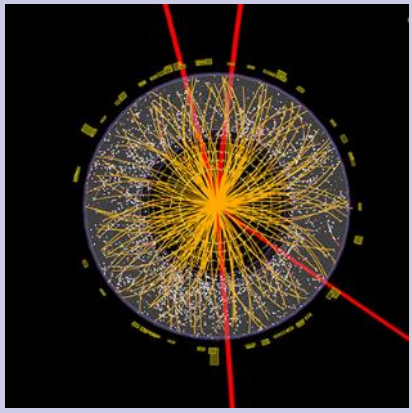
Higgs particle can disintegrate into particles of dark matter...

The 'Standard Model' of particle physics successfully describes the smallest constituents of matter. But the model has its limitations – it does not explain the dark matter of the universe. Christoffer Petersson, a research scientist at Chalmers University of Technology, has found a solution. His theories are now being tested at the particle physics laboratory CERN.

Physicists describe the smallest constituents of nature – elementary particles and forces acting between them using a set of theories known as "the Standard Model". This model was developed in the 1970s and has been very successful, particularly in predicting the existence of undiscovered particles.

In recent decades, particle physicists have discovered one of the predicted particles in the Standard Model after another in their particle accelerators. The last in the series was the Higgs particle, the existence of which was confirmed by the scientists at the particle accelerator Large Hadron Collider (LHC) at CERN in 2012. This completed the Standard Model.

The problem is that there are ...***Read More***…



A Higgs particle has been created in an LHC detector and has then disintegrated into four muons (the four red lines). According to Christoffer Petersson's model the Higgs particle can also disintegrate into a photon and particles of dark matter. Credit: CERN

NASA Spacecraft Becomes First to Orbit a Dwarf Planet

NASA's Dawn spacecraft has become the first mission to achieve orbit around a dwarf planet. The spacecraft was approximately 38,000 miles (61,000) kilometers from Ceres when it was captured by the dwarf planet's gravity at about 4:39 a.m. PST (7:39 a.m. EST) Friday….***Read More***...

Ceres is seen from NASA's Dawn spacecraft on March 1, just a few days before the mission achieved orbit around the previously unexplored dwarf planet. The image was taken at a distance of about 30,000 miles (about 48,000 kilometers).